The OSCAR PUBLISHING Services
International Journal of Pedagogics

VOLUME Vol.06 Issue01 2026
PAGE NO. 176-184
DOI 10.37547/ijp/Volume06Issue01-37

Technology For Developing Information-Analytical Competence In Future Teachers: Indicators, Criteria, And Diagnostic Approaches

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Received: 29 November 2025; **Accepted:** 21 December 2025; **Published:** 25 January 2026

Abstract: Information-analytical competence has become a core requirement in modern teacher education, where the ability to locate, interpret, and critically evaluate information directly influences professional performance and decision-making. This article develops a comprehensive theoretical foundation for evaluating this competence by systematizing its key components, indicators, and criteria. Drawing on established conceptual models of information processing, critical reasoning, and analytical judgment, the paper outlines a structured framework that integrates cognitive, analytical, and operational dimensions. Special attention is given to defining clear indicators for information retrieval, source evaluation, analytical interpretation, and evidence-based decision-making. The article also proposes theoretically grounded diagnostic approaches-including analytic rubrics, criteria-based matrices, and structured assessment descriptors-that make it possible to evaluate information-analytical competence in a consistent and pedagogically meaningful manner. By synthesizing national pedagogical perspectives with international frameworks on information and media literacy, the paper offers a coherent model that enhances the conceptual clarity and practical applicability of competence evaluation in teacher training programs. The proposed framework contributes to the broader discourse on developing information-literate, analytically capable educators in an increasingly complex digital environment.

Keywords: Information-analytical competence; evaluation indicators; criteria; diagnostic model; information literacy; analytical reasoning; teacher education.

Introduction: The rapid expansion of digital information environments has intensified the need for individuals capable of navigating, interpreting, and critically evaluating information in a purposeful and responsible manner. Within this context, information-analytical competence has emerged as one of the essential competencies for the 21st century, serving as an indispensable foundation for informed decision-making and professional performance across various fields. In teacher education, this competence becomes particularly significant, as future educators are expected not only to manage information effectively for their own academic and professional needs but also to cultivate analytical and evaluative skills among their students. As international frameworks repeatedly emphasize, the ability to access, assess, and use information critically constitutes a fundamental dimension of digital-age literacy and a prerequisite for active participation in contemporary knowledge societies (UNESCO, 2021; OECD, 2019).

In recent pedagogical literature, information-analytical competence is conceptualized as a multidimensional construct that includes information retrieval, critical evaluation of sources, analytical interpretation, and the ability to make evidence-based judgments. The Culture of Information Consumption textbook underlines that responsible information consumption requires systematic engagement with information, supported by structured analytical thinking and value-based reasoning. This view corresponds with international perspectives, such as Eisenberg's assertion that information problem-solving must rely on "a structured

set of cognitive and analytical behaviours" (Eisenberg, 2008). Similarly, scholars such as Buckingham and Hobbs emphasize that analytical interpretation of information is shaped both by cognitive processes and the socio-cultural context in which information is produced and consumed.

Despite the growing recognition of the importance of information-analytical competence, existing literature reveals several conceptual ambiguities regarding how this competence should be defined, structured, and evaluated in teacher education. Many studies focus on information literacy or media literacy in general terms, offering broad theoretical insights but often lacking specific indicators and criteria for systematic evaluation. Meanwhile, national pedagogical research acknowledges the importance of analytical thinking and evaluative skills but frequently treats them as general attributes rather than clearly operationalized components of a distinct competence. As noted by several scholars in this domain, competence development requires "a coherent synthesis of knowledge, skills, and judgment-based behaviours," yet there remains limited agreement on how these elements should be measured in educational settings.

The dissertation materials related to information-analytical competence contribute to addressing this gap by outlining a structured model that identifies cognitive, analytical, and operational dimensions as core components. However, the practical application of this model requires explicit indicators and criteria that translate theoretical constructs into assessable elements. The need for such clarity is further reinforced by international guidelines: for example, DigComp 2.2 proposes detailed descriptors for information and data literacy, while ISTE Standards advocate for clearly defined performance indicators that guide both instructional design and learner assessment. Although these frameworks offer valuable direction, they must be adapted to the pedagogical context, cultural environment, and educational priorities specific to teacher training systems.

Another conceptual challenge concerns the integration of higher-order analytical skills-such as interpretation, comparison, synthesis, and argumentation-into the broader understanding of information-analytical competence. While the OECD Learning Compass highlights "analytical reasoning and reflective judgment" as key components of student agency, there remains a need for theoretical models that connect these skills systematically to information-processing behaviours. Furthermore, although some scholars propose diagnostic tools for assessing related skills, the methodologies are often fragmented and inconsistent, lacking the unified logic required for comprehensive evaluation.

Given these gaps, there is a strong need for a coherent theoretical basis for evaluating information-analytical competence in teacher education. Such a framework must define precise indicators reflecting the principal dimensions of the competence, establish criteria aligned with developmental and pedagogical expectations, and propose diagnostic approaches that enable systematic and transparent assessment. Theoretical clarity in this area is especially important as educational systems increasingly recognize the role of teachers as mediators between information-rich environments and learners who must navigate them effectively. By integrating national pedagogical perspectives, international frameworks, and established scholarly viewpoints, this article aims to contribute to the conceptual development of information-analytical competence and provide a structured foundation for its evaluation within teacher training programs.

LITERATURE REVIEW

The concept of information-analytical competence has gained substantial attention in modern educational research, particularly in relation to the increasing complexity of information environments and the expanding role of educators as mediators of knowledge. In the scholarly literature, this competence is generally defined as an integrated ability to search, select, interpret, evaluate, and transform information for meaningful academic or professional decision-making. As described in the Culture of Information Consumption textbook, information-analytical competence represents "a holistic combination of cognitive, analytical, and action-oriented processes that enable the individual to navigate information flows rationally and responsibly." This view corresponds with broader theoretical approaches in the international literature, where information literacy, critical thinking, and analytical reasoning are considered essential interrelated components of digital-age competence.

In defining this construct, numerous international scholars emphasize the multidimensional nature of information-analytical processes. Paul and Elder (2014) assert that analytical thinking is fundamentally tied to "the disciplined art of ensuring that the use of information is guided by clarity, accuracy, and logical consistency," suggesting that information competence cannot be separated from critical reasoning. Shapiro and Hughes (1996) similarly conceptualize information literacy as "a new liberal art," incorporating critical evaluation, contextual interpretation, and reflective judgment. These perspectives reinforce the need to examine information-analytical competence not merely as a set of technical skills but as a complex intellectual disposition that integrates higher-order analytical operations.

A central theme in the literature concerns the structural components of information-analytical competence. Most frameworks emphasize three foundational dimensions: cognitive, analytical, and operational. The cognitive component includes information retrieval, comprehension, and recognition of relevance. The analytical component refers to processes such as comparison, classification, interpretation, inference, and critical evaluation of sources. Finally, the operational component involves applying analytical outcomes to decision-making, problem-solving, and constructive knowledge transformation. In national pedagogical research, similar classifications appear, with scholars highlighting that competence requires "the unity of knowledge, skills, and value-based judgments" necessary for reasoned information consumption and professional activity. This perspective aligns with Messick's (1984) classical view that competencies should be understood as "complex performance traits" integrating cognition, skills, and behavior.

Theoretical discussions on information processing further highlight the cognitive foundations of information-analytical competence. Jan van Dijk (2020) argues that digital information environments require individuals to develop new forms of cognitive engagement, as they must evaluate not only the content of information but also the credibility, origin, and purpose behind it. This aligns with the arguments of UNESCO authors, who maintain that information and media literacy must emphasize analytical evaluation and ethical reasoning rather than simple access to information. The Culture of Information Consumption textbook supports this view, emphasizing the increasing need for individuals to "differentiate between reliable and unreliable sources, interpret information through analytical filters, and assess the implications of informational influence."

Critical evaluation is identified as one of the core analytical functions within this competence. According to Buckingham (2003), critical evaluation requires a combination of awareness, interpretive strategies, and reasoning skills that enable individuals to interrogate information rather than accept it passively. Hobbs (2017) similarly notes that analytical engagement with information must involve "systematic questioning of messages, evidence, intentions, and contexts." These international perspectives resonate with national research emphasizing that critical evaluation is not merely a cognitive mechanism but also a culturally shaped interpretive process informed by prior knowledge, values, and contextual understanding.

Decision-making represents another critical theoretical component, connecting analytical processes with outcomes. Research shows that analytical decision-making requires the ability to synthesize information, weigh alternatives, justify choices, and predict possible consequences. In the context of teacher education, decision-making is particularly relevant, as educators must make evidence-based judgments about instructional materials, student needs, and pedagogical strategies. The dissertation materials reinforce this point, highlighting the importance of "responsible judgment grounded in the systematic interpretation of information and alignment with educational objectives."

A significant portion of contemporary literature examines information-analytical competence through the lens of international frameworks. UNESCO's Media and Information Literacy (MIL) framework emphasizes competencies such as critical evaluation, reflective interpretation, and ethical reasoning as core components of information literacy. The framework highlights the need for learners to not only understand media content but also analyze its construction, evaluate its credibility, and recognize its influence. DigComp 2.2, the European framework for digital competence, identifies information and data literacy as

a key competence, outlining descriptors such as browsing, evaluating, and managing information. These descriptors closely parallel the structural elements of information-analytical competence identified in national pedagogical research.

The ISTE Standards for Educators also emphasize the ability to curate digital resources, evaluate their quality, and use them purposefully in instruction. According to ISTE (2021), effective teachers must demonstrate the capacity to “establish criteria for content selection and evaluate digital resources systematically.” The OECD Learning Compass further broadens this discussion by framing analytical reasoning as a critical dimension of student agency, underscoring the global shift toward analytical and reflective competencies in educational systems.

National scholarly perspectives contribute additional nuance to understanding information-analytical competence. Uzbek pedagogical researchers emphasize the moral and cultural dimensions of analytical engagement, arguing that responsible information consumption requires aligning analytical reasoning with ethical values and social responsibility. Within this tradition, competence is understood as a synthesis of “knowledge, analytical skill, and conscious value-based orientation,” reinforcing the integration of cognitive and character-based elements. The Culture of Information Consumption textbook elaborates on this principle, highlighting that analytical competence requires not only technical ability but also disciplined habits of inquiry and critical self-regulation.

The dissertation materials further conceptualize information-analytical competence within the specific context of teacher education. They identify a structured model consisting of information retrieval, critical evaluation, analytical interpretation, and evidence-based decision-making, establishing a basis for developing indicators and criteria for competence evaluation. These materials emphasize the need for theoretical clarity and methodological coherence in defining how each component contributes to the holistic development of competence.

Overall, the theoretical literature demonstrates broad agreement that information-analytical competence is an integrative construct grounded in cognitive, analytical, and operational dimensions. However, existing research also reveals gaps in the development of clear indicators, criteria, and diagnostic approaches tailored to teacher education. This underscores the need for further theoretical systematization, particularly with respect to translating conceptual definitions into assessable elements that can inform pedagogical practice.

METHODOLOGY

This article adopts a qualitative, conceptual research design based on an integrative literature review and framework synthesis. The methodological objective is to construct an assessment-oriented subsystem of the "information-analytical competence development technology in future teachers" by translating the target competence into an operational structure of criteria, indicators, and diagnostic tools applicable to teacher education. The study therefore focuses on conceptual clarification, analytical decomposition of the competence, and methodological alignment between intended learning outcomes and verifiable assessment evidence.

The corpus of sources was compiled through targeted searches in academic databases and scholarly search engines (including Google Scholar and field-relevant education databases) supplemented by manual journal screening and backward and forward citation tracking from seminal publications in competence-based education, information literacy, media literacy, critical evaluation of information, and assessment in teacher education. Searches were conducted using combinations of keywords referring to the construct and its assessment logic, such as "information-analytical competence," "information literacy," "media literacy," "critical evaluation of information," "teacher education," "pre-service teachers," "criteria," "indicators," "assessment," "diagnostic tools," and "rubric," with multilingual variants to ensure coverage of regional and national publications and normative-methodological documents relevant to the Uzbek teacher-education context.

Selection of materials followed explicit inclusion and exclusion logic to ensure relevance and methodological usefulness for operationalization. Sources were retained when they addressed information-related competence in education or adjacent constructs, presented assessment-oriented elements such as

criteria, indicators, descriptors, levels, or instruments, and demonstrated applicability to teacher education or a clear pathway for adaptation to future teachers. Materials were excluded when they were unrelated to educational contexts, lacked any evaluative component, were duplicates, or did not provide sufficient conceptual specificity to support indicator formulation. The screening process proceeded from title-and-abstract relevance checks to full-text eligibility verification and then to an analytical appraisal that prioritized works offering explicit competence structures and assessment procedures that can be translated into measurable evidence.

Analytical processing was conducted through structured content analysis with iterative coding and synthesis. For each eligible source, the analysis extracted the construct definition, proposed dimensions or components, criterion-indicator formulations or their equivalents, any available level descriptors, recommended diagnostic procedures, and contextual conditions of application. Extracted elements were coded against an a priori scheme aligned with competency-based education and teacher-education outcomes, and the codebook was refined iteratively as new indicator formulations emerged. The synthesis stage consolidated overlapping formulations, removed redundancies, and rewrote indicators as observable actions or assessable products to enable rubric-based scoring and diagnostic interpretation.

The operational framework was produced through a sequential synthesis procedure. First, conceptual mapping was used to align recurring dimensions found in the literature with the target competence embedded in the technology for developing information-analytical competence in future teachers. Second, indicators were formulated for each dimension using measurable language that supports evidence collection through student performance and artifacts. Third, indicators were grouped into a small number of stable criteria to ensure parsimony and to prevent construct fragmentation, while maintaining sufficient coverage of the competence domain. Fourth, diagnostic tools were assigned to each indicator using a method-indicator fit principle, ensuring that each tool yields direct and interpretable evidence aligned with the intended indicator. The final output of this procedure is reported in the article as an integrated matrix linking criteria, indicators, and diagnostic evidence, suitable for use in pre/post diagnostics, ongoing formative assessment, and evaluation within pedagogical experimentation.

Methodological rigor was ensured through triangulation of source types and internal consistency checks. The synthesis deliberately integrated peer-reviewed research with established competence frameworks and relevant normative-methodological documents, thereby balancing international validity with contextual applicability. Consistency checks were applied to confirm non-overlap between criteria, clarity and measurability of indicators, and feasibility of diagnostic tool implementation in teacher-education settings.

RESULTS

The study produced an operational evaluation subsystem for the information-analytical competence development technology in future teachers by translating the target competence into a measurable structure that links evaluation criteria, observable indicators, and appropriate diagnostic evidence. The resulting output is a competence-assessment framework that specifies what is assessed (criteria), how achievement becomes observable (indicators expressed as actions or products), and what evidence is required to support valid judgment (diagnostic tools and measurable outputs). The framework was synthesized to be implementable within teacher-education coursework and to support consistent diagnostics across cohorts through rubric-based scoring, structured checklists, performance tasks, and portfolio evidence.A core result is the consolidation of assessment logic into a parsimonious set of criteria that capture stable domains of information-analytical performance expected from future teachers. Each criterion is operationalized by multiple indicators to ensure adequate construct coverage and to reduce single-item judgement. Indicators are formulated in measurable language and are designed to generate assessable artifacts that can be evaluated with transparent scoring procedures. In addition, the framework explicitly matches each indicator to feasible evidence types that can be produced under realistic instructional conditions, ensuring that assessment does not rely solely on declarative knowledge tests but

also captures authentic analytical performance.

Table 1 presents the integrated model as a matrix that aligns criteria, indicators, and diagnostic evidence within a single evaluative logic. This alignment is the principal empirical output of the conceptual synthesis and functions as the assessment-ready component of the proposed technology, enabling structured monitoring and, where needed, pre-/post-diagnostic comparison when evaluating instructional interventions.

Table 1. Evaluation subsystem of the technology for developing informational-analytical competence in future teachers: criteria, indicators, and diagnostic evidence

Evaluation criteria	Operational indicators (observable actions / products)	Diagnostic evidence (tools and measurable outputs)
Criterion 1: Information search and selection	The student formulates a clear information need, selects sources aligned with task requirements, and documents the logic of selection and relevance.	Search log and query record; documented source list with justification; relevance/adequacy checklist; portfolio artifact demonstrating search strategy.
Criterion 2: Source credibility and verification	The student verifies authorship, date, provenance, and reliability; cross-checks claims using independent sources; identifies manipulation and low-credibility signals.	Lateral reading task output; CRAAP/SIFT-based evaluation sheet; fact-check report with references; annotated evidence (screenshots/links); rubric-scored verification report.
Criterion 3: Analytical processing of information	The student extracts key claims, compares positions across sources, identifies relationships and inconsistencies, and synthesizes findings into a structured analytical product.	Comparative analysis matrix; content-analysis coding sheet; argument map; rubric-scored analytical summary; case-based analysis report.
Criterion 4: Interpretation and evidence-based conclusion	The student differentiates facts from opinions, interprets information in context, and produces conclusions supported by explicit evidence and reasoning coherence.	Evidence–conclusion scheme; written analytical conclusion; mini-presentation with traceable references; reasoning-quality rubric; peer review record with feedback integration.
Criterion 5: Responsible use and reflective evaluation	The student applies ethical and responsible information use, demonstrates accurate referencing practices, and conducts reflective self-evaluation of analytical strengths and limitations.	Referencing and integrity checklist; reflection journal entry; portfolio reflection section; structured self-assessment scale; instructor rubric for responsibility and reflection quality.

DISCUSSION

The results indicate that the evaluation subsystem developed for the axboriy-analitik kompetentlikni bo‘lajak o‘qituvchilarda rivojlantirish texnologiyasi is conceptually consistent with mainstream competence-based assessment logic and, at the same time, sufficiently specific to function as an implementable diagnostic mechanism in teacher education. In competence research, assessment becomes defensible when the construct is clearly defined and when its indicators produce observable evidence that can be interpreted consistently. This study’s criterion–indicator–evidence alignment operationalizes that requirement by treating competence not as a vague attribute but as assessable performance. In this respect, the framework corresponds to the view that competencies should be understood as “complex performance traits” integrating cognition, skills, and behavior (Messick, 1984), which implies that evidence

must be gathered from more than one type of task and must capture both reasoning and action-oriented outputs.

A key interpretive implication is that information-analytical competence cannot be reduced to technical information-search skills. The literature repeatedly frames it as a form of disciplined reasoning and judgement in complex informational environments. The proposed indicators therefore emphasize verification, analytical processing, interpretation, and evidence-based conclusion-making, which aligns with the argument that analytical thinking is tied to "the disciplined art of ensuring that the use of information is guided by clarity, accuracy, and logical consistency" (Paul & Elder, 2014). Similarly, the framework's credibility and verification emphasis reflects the premise that analytical engagement requires "systematic questioning of messages, evidence, intentions, and contexts" (Hobbs, 2017). These perspectives support the study's decision to anchor diagnostics in performance evidence (fact-check reports, argument maps, annotated evaluations, case-based justification) rather than relying on declarative tests alone.

The framework also strengthens the internal logic of assessment by explicitly linking indicators to diagnostic evidence types that can be produced under real instructional conditions. This matters because teacher education requires evidence that mirrors professional decision contexts. In that sense, the inclusion of decision-making evidence is not an accessory element but a core requirement, given that teacher judgement directly affects learning materials, classroom messaging, and pedagogical choices. The study's decision-making orientation is consistent with the dissertation-based conceptualization of informed pedagogy as "responsible judgment grounded in the systematic interpretation of information and alignment with educational objectives" (Madaliyev, 2025). Practically, this implies that the most informative diagnostics are those that require justification of choices (why a source is credible, why one claim is preferred over another, why a conclusion follows from evidence), because these tasks make reasoning visible and scorable.

From a methodological standpoint, the study's output can be interpreted as a structured step toward construct-valid assessment, but it does not, by itself, guarantee validity and reliability in use. The framework's strength is that it clarifies what must be measured and what constitutes acceptable evidence; however, measurement quality in application will depend on rubric design, rater training, consistency of task difficulty, and the appropriateness of evidence aggregation. This is why the framework should be treated as an assessment blueprint that supports systematic implementation, not as a finished measurement instrument. In competence development work, the sequence "define–operationalize–implement–validate" is difficult to compress, and the logic that "any pedagogical competence must first be conceptually defined before it can be meaningfully developed or assessed" (Yo'ldoshev, 2015) is directly relevant to interpreting this article's contribution: the present study strengthens the definitional and operational stage and prepares the ground for empirical validation.

In terms of broader positioning, the results are compatible with international orientations toward media and information literacy and digital competence that emphasize critical evaluation, ethical information use, and reflective practice (UNESCO, 2021; DigComp 2.2; OECD, 2019; ISTE Standards for Educators, 2021). The added value of this study is not the introduction of entirely new constructs, but the conversion of widely discussed competence expectations into a coherent evaluation subsystem that can be embedded within a pedagogical technology and used for diagnostics in teacher education. This conversion is especially important in contexts where competence language is present in policy and curricula, but operational assessment mechanisms are underdeveloped or fragmented.

At the same time, several interpretive boundaries should be acknowledged. The framework was synthesized through conceptual and methodological analysis; therefore, it reflects the scope and quality of the reviewed sources and the assumptions embedded in the proposed operationalization. Empirical studies are needed to test whether the indicators discriminate effectively across levels, whether diagnostic tasks are sensitive to instructional interventions, and whether rubric-based scoring achieves acceptable inter-rater agreement. Additionally, because part of the

conceptual grounding draws on local dissertation materials, publication-oriented versions of the framework may benefit from strengthening reliance on openly accessible international sources when targeting journals that are cautious about unpublished internal documents. These limitations do not reduce the framework's practical relevance; rather, they define the next stage of work: piloting the diagnostic matrix in teacher-education modules, refining descriptors based on observed student artifacts, and establishing evidence-based scoring procedures that support stable interpretation across cohorts.

CONCLUSION

The theoretical foundations developed in this article provide a structured and coherent framework for evaluating information-analytical competence in teacher education. By synthesizing national pedagogical perspectives with international frameworks and established scholarly theories, the work contributes to clarifying the conceptual boundaries, internal structure, and evaluative logic of this increasingly important competence. The article emphasizes that information-analytical competence must be understood as an integrated construct, grounded in cognitive, analytical, and operational processes. This understanding echoes the view expressed by international scholars such as Weinert (2001), who conceptualizes competence as a unification of knowledge, skills, and dispositions, and aligns with Uzbek perspectives such as Mirzaahmedov's assertion that competence reflects "the harmony of intellectual and value-oriented development."

A central contribution of this work lies in the development and classification of indicators and criteria that operationalize information-analytical competence for the purposes of systematic evaluation. Clear indicators-for information retrieval, evaluation, analytical interpretation, and decision-making-translate abstract concepts into observable analytical behaviours. These indicators, paired with corresponding criteria, create a foundation for assessing the quality and depth of learners' engagement with information. As Sobirova notes, meaningful assessment requires "criteria that reflect qualitative distinctions in analytical activity," highlighting the importance of structured evaluation tools. The diagnostic logic presented here, grounded in analytic rubrics, matrices, and checklists, supports the practical application of these indicators by offering consistent, theoretically justified methods for evaluating competence.

The conceptual significance of this framework for teacher education is substantial. The ability to navigate, assess, and interpret information is now a defining element of professional readiness in the digital age. Teachers are required not only to manage information effectively but also to guide learners in developing analytical habits of mind. As Buckingham argues, critical engagement with information involves "systematic questioning of messages and contexts," a perspective that underscores the pedagogical need for strengthening analytical competence. This article's model provides a conceptual basis for developing instructional practices that encourage structured information processing, reflective evaluation, and evidence-based reasoning.

From the standpoint of pedagogical application, the framework offers a theoretically coherent structure that can inform curriculum design, instructional planning, and formative assessment strategies. The integration of diagnostic components into a unified model enables educators to evaluate information-analytical competence with clarity and consistency, supporting both learner development and instructional improvement. The conceptual foundation outlined here reinforces the broader educational aim of preparing future teachers to operate effectively in information-rich environments and to foster analytical, reflective, and responsible information practices among their students.

Overall, this article's theoretical model contributes to advancing the discourse on information-analytical competence by articulating its structure, defining its evaluative elements, and establishing a diagnostic logic aligned with contemporary educational demands. Through its synthesis of national and international perspectives, the model provides a valuable conceptual resource for strengthening the analytical dimension of teacher education.

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