ISSN: 2181-3337 | SCIENTISTS.UZ VOLUME 5 ISSUE 7 JULY 2026

A COMPETENCY-BASED ASSESSMENT FRAMEWORK FOR EVALUATING WEB TECHNOLOGY COMPETENCE IN HIGHER EDUCATION

Soliev Bakhromjon
Fergana State Technical University
bahromjonsoliev@gmail.com

DOI: 10.67620/sai.57b0013

ABSTRACT

Web technology courses require students to integrate coding, interface design, data management, testing, documentation, teamwork, and independent learning. Yet assessment in such courses can become dominated by the functionality of a final product, leaving the quality of the development process and professional competencies insufficiently represented. This conceptual study proposes an operational competency-based assessment framework for project-oriented web technology courses in higher education. The framework was developed through a purposive conceptual synthesis of foundational work on constructive alignment, formative assessment, rubrics, project-based learning, digital competence, and self-regulated learning. It specifies five competency dimensions—technical, problem-solving, collaborative, communication, and self-development competence—together with observable indicators, evidence sources, assessment methods, a four-level rubric, an illustrative weighting model, and safeguards for moderation and fairness. The model treats assessment as a five-stage cycle: evidence collection, criterion-based judgement, competency-level determination, feedback and moderation, and improvement followed by reassessment. Because the framework has not yet been empirically validated, its weights and cut scores are presented as adaptable design defaults rather than universal standards. The paper offers instructors a transparent starting point for course-level implementation and defines a research agenda for content validation, inter-rater reliability testing, usability evaluation, and examination of learning effects.

ACCEPTED

02.08.26

Keywords: *competency-based assessment; web technology competence; higher education; project-based learning; analytic rubric; formative feedback.*

CC BY

1. Introduction

The rapid evolution of digital technologies has changed what higher education expects computing graduates to demonstrate. Knowledge of syntax, tools, and concepts remains necessary, but competent performance also requires learners to interpret requirements, select appropriate technologies, build maintainable solutions, communicate design decisions, collaborate with others, and continue learning as platforms and standards change. This broader expectation is consistent with competence-oriented education, which treats achievement as the integrated use of knowledge, skills, attitudes, and judgement in

meaningful contexts rather than as the reproduction of isolated information (Biggs & Tang, 2011; OECD, 2019; Voogt et al., 2013).

Web technology courses make this assessment problem particularly visible. A single project may involve front-end development, server-side logic, data storage, accessibility, testing, deployment, version control, documentation, and teamwork. A final website can therefore conceal important differences in how students reached the result. One group may produce a functional application through well-managed collaboration and systematic testing, whereas another may rely on one member, undocumented code, or late corrections that cannot be sustained. Assessing only the final product may reward surface completion while overlooking reasoning, contribution, communication, and capacity for improvement.

Project-based learning provides an authentic setting in which students can combine knowledge and practice, but its assessment is demanding. Evidence must be gathered across time and from different sources, criteria must be visible to learners, and judgements must remain sufficiently consistent across assessors and projects. Research on project-based learning indicates that outcomes and measures vary considerably across higher education settings, reinforcing the need to connect learning outcomes with explicit assessment evidence (Guo et al., 2020). Foundational work on formative assessment and rubrics similarly emphasizes that criteria and feedback should guide learning, not merely justify a final grade (Andrade, 2000; Black & Wiliam, 1998; Nicol & Macfarlane-Dick, 2006).

Existing digital competence frameworks provide useful descriptions of knowledge, skills, and attitudes, but they are generally broader than the course-level assessment of web development. DigComp 2.2, for example, offers a comprehensive citizen-oriented model of digital competence, while the UNESCO ICT Competency Framework for Teachers addresses professional use of technology in education (UNESCO, 2018; Vuorikari et al., 2022). These frameworks help establish the multidimensional nature of competence, yet an instructor still needs operational answers to four questions: What dimensions of web technology competence should be assessed? What evidence should count? How should performance levels be determined? How should feedback and reassessment be organized?

This paper addresses those questions by proposing a conceptual and operational framework for competency-based assessment in project-oriented web technology courses. Its contribution is not an empirically validated measurement instrument. Rather, it is a transparent design proposal that (a) defines five assessable dimensions, (b) links each dimension to observable evidence and appropriate assessment methods, (c) specifies a four-level rubric and an illustrative scoring rule, and (d) embeds grading within a continuous cycle of feedback, moderation, and improvement. The framework is intended to be adapted to local course outcomes and subsequently tested through expert review and classroom research.

2. Conceptual Foundations and Related Work

2.1 Competency-based and authentic assessment

Competency-based assessment begins with clearly stated outcomes and asks learners to demonstrate integrated performance against criteria. Constructive alignment requires the intended learning outcomes, learning activities, and assessment tasks to support one another (Biggs & Tang, 2011). In a web technology course, this means that an outcome such as “design and implement a secure data-driven application” should be assessed through evidence that actually shows design reasoning, implementation, testing, and explanation—not only through a written examination about those activities.

Authentic assessment is particularly relevant because competence is context-dependent. Project artefacts, demonstrations, code reviews, presentations, and reflective records can reveal different aspects of performance. Rubrics make those expectations visible by describing gradations of quality and can support both judgement and learning when students use them before and during task completion (Andrade, 2000). However, a rubric is not automatically reliable. Criteria must be sufficiently specific, assessors need shared interpretations, and representative examples are required for calibration.

ISSN: 2181-3337 | SCIENTISTS.UZ

2.2 Project-based learning and multiple evidence sources

Project-based learning places students in extended tasks that usually culminate in a product, presentation, or solution. Its value lies partly in the integration of disciplinary knowledge, practical activity, collaboration, and reflection. Guo et al. (2020) found substantial variation in how project-based learning outcomes are conceptualized and measured in higher education. For assessment design, this variation implies that the final product should be accompanied by process evidence, including planning records, repository histories, testing documentation, individual explanations, and peer-contribution records.

No single evidence source is sufficient for every competency. Project evaluation is appropriate for functionality and quality of implementation; practical demonstration and oral questioning can confirm individual understanding; observation and peer evidence can inform collaboration; presentations and technical documents reveal communication; and portfolios or reflection logs can show self-regulation and improvement. Learning analytics may support evidence collection, but digital traces should be interpreted as indicators rather than treated as complete representations of learning (Long & Siemens, 2011).

2.3 Feedback, self-assessment, and self-regulated learning

Formative assessment is most useful when feedback clarifies the expected standard, identifies the gap between current and desired performance, and enables a subsequent action (Black & Wiliam, 1998; Nicol & Macfarlane-Dick, 2006). A competency framework should therefore do more than convert evidence into a grade. It should indicate which dimension requires improvement and provide an opportunity for the learner to apply that feedback in a revised artefact or later task.

Self-assessment and peer assessment can strengthen evaluative judgement, but they should not be used uncritically. Self-regulated learning involves forethought, performance monitoring, and reflection (Panadero, 2017; Zimmerman, 2002). In web projects, students can use checklists, progress logs, code review notes, and post-project reflections to make these processes visible. Nevertheless, self- and peer scores should be calibrated against shared criteria and should supplement rather than replace instructor judgement where high-stakes grades are concerned. Sustainable assessment also requires students to develop the capacity to judge quality beyond a single course (Boud & Falchikov, 2007).

3. Framework Development Approach

The framework was developed as a conceptual design synthesis rather than a systematic review or an empirical validation study. The source base was purposively organized around five bodies of work already relevant to the problem: constructive alignment and learning design (Biggs & Tang, 2011; Laurillard, 2012), formative assessment and feedback (Black & Wiliam, 1998; Nicol & Macfarlane-Dick, 2006), rubrics and sustainable assessment (Andrade, 2000; Boud & Falchikov, 2007), project-based and digital competence perspectives (Guo et al., 2020; UNESCO, 2018; Vuorikari et al., 2022; Zhao et al., 2021), and self-regulated learning (Panadero, 2017; Zimmerman, 2002). Broader future-oriented competence perspectives were used to ensure that technical performance was not treated as the sole outcome (OECD, 2019; Voogt et al., 2013).

Development proceeded through four design steps. First, the intended construct was bounded as competence demonstrated in the design, development, explanation, and improvement of web-based solutions within higher education coursework. Second, recurring outcome domains were grouped into five dimensions: technical, problem-solving, collaborative, communication, and self-development competence. Third, each dimension was translated into observable indicators and plausible evidence sources. Fourth, the components were assembled into a cyclical assessment process with performance levels, suggested scoring rules, feedback, and reassessment. The resulting framework was then checked for internal alignment: each dimension had to be linked to evidence, each evidence type to an assessment method, and each judgement to a feedback action.

Three design principles guided the synthesis. The first was *triangulation*: important judgements should draw on more than one form of evidence. The second was *transparency*: learners should receive

ISSN: 2181-3337 | SCIENTISTS.UZ

criteria and level descriptors before undertaking the assessed task. The third was *developmental use*: assessment should produce an actionable improvement target and, where course regulations permit, an opportunity to demonstrate progress. These principles are theoretically grounded, but the specific dimensions, suggested weights, and cut scores remain propositions requiring validation.

4. Proposed Competency-Based Assessment Framework

The framework contains five interdependent components: competency dimensions, indicators and evidence, assessment methods, competency levels and scoring, and feedback with reassessment. Figure 1 presents these elements as a cycle. The cycle begins with planned evidence collection rather than with retrospective grading. Evidence is then judged against published criteria, translated into dimension-level and overall competency decisions, moderated where necessary, and used to guide improvement.

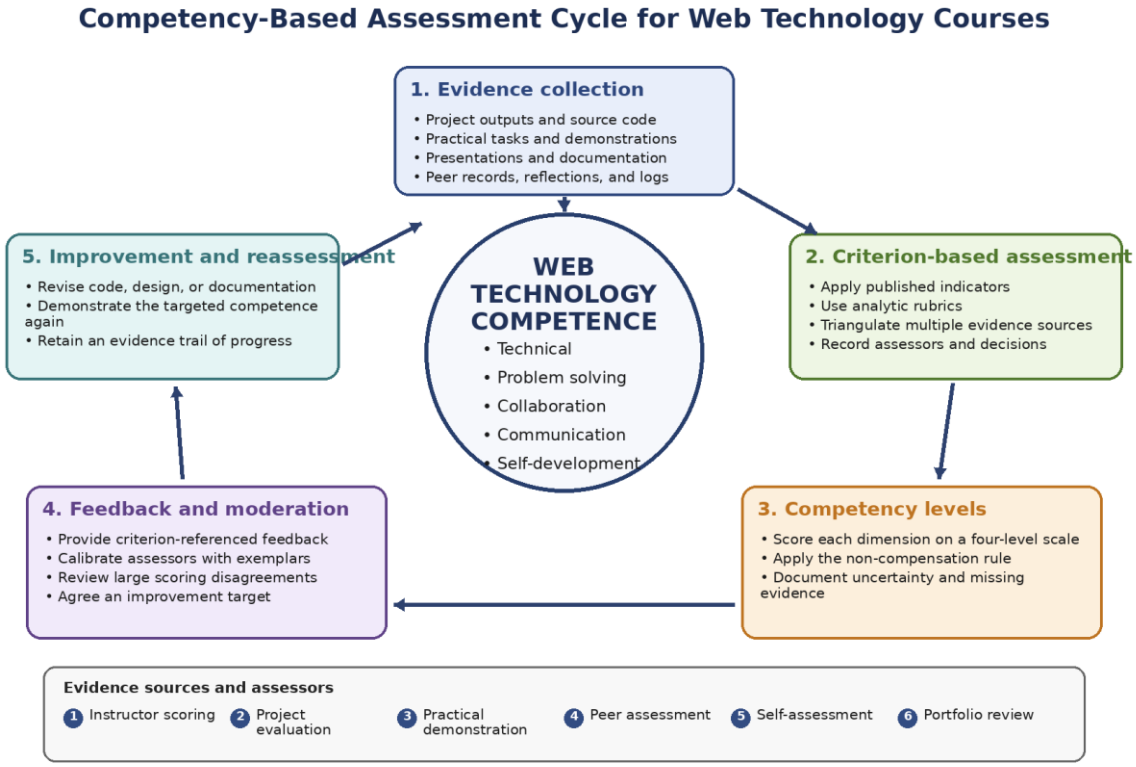


Figure 1. Competency-based assessment cycle for web technology courses.

4.1 Competency dimensions, evidence, and assessment methods

Table 1 operationalizes the five dimensions. The indicators are deliberately broad enough to be adapted across introductory and advanced courses, but each course should replace them with task-specific criteria. For example, “implementation quality” may emphasize standards-compliant HTML and CSS in an introductory course, while an advanced course may include architecture, security, testing, deployment, performance, and maintainability.

Table 1. Competency dimensions, indicators, evidence, and suggested weighting

Dimension	Observable indicators	Primary evidence and methods	Suggested weight
Technical competence	Functional correctness; code quality and maintainability; data handling; testing; accessibility, security, and deployment where relevant.	Project artefacts and source code; automated or manual tests; practical demonstration; instructor rubric.	35%
Problem-solving competence	Requirement analysis; decomposition; technology selection; design reasoning; debugging; evaluation of alternatives.	Design notes; issue records; code review; oral questioning; case or troubleshooting task.	25%

ISSN: 2181-3337 | SCIENTISTS.UZ

Dimension	Observable indicators	Primary evidence and methods	Suggested weight
Collaborative competence	Role fulfilment; contribution; coordination; constructive review; responsible use of shared tools.	Repository and task records; observation; calibrated peer assessment; individual explanation.	15%
Communication competence	Clarity of presentation; technical documentation; explanation of design choices; audience-appropriate language.	Presentation; demonstration; README or technical report; rubric-based questioning.	15%
Self-development competence	Goal setting; response to feedback; independent learning; reflection; evidence of revision and transfer.	Portfolio; reflection log; before-and-after artefacts; self-assessment checked against evidence.	10%

The weighting profile in Table 1 is an illustrative default, not a validated standard. It gives technical and problem-solving competence greater influence because these dimensions represent core disciplinary performance, while preserving a meaningful contribution from collaboration, communication, and self-development. Departments may alter the weights to match course outcomes, but they should publish the chosen profile before assessment and avoid changing it after viewing student results.

4.2 Competency levels and rubric descriptors

A four-level analytic rubric is proposed to separate emerging, developing, proficient, and advanced performance. Instructors should write dimension-specific descriptors, but the general meanings in Table 2 can be used as a common template. The descriptors focus on independence, consistency, quality, justification, and transfer rather than on vague labels such as “poor” or “excellent.”

Table 2. General four-level competency rubric

Level	Score	General descriptor
1. Emerging	1	Performance is incomplete, heavily dependent on guidance, or inconsistent with essential criteria. The learner can reproduce limited procedures but cannot yet explain or apply them reliably.
2. Developing	2	Performance meets some essential criteria but contains important weaknesses. The learner completes familiar tasks with support and gives partial explanations of decisions.
3. Proficient	3	Performance consistently meets the essential criteria. The learner works with reasonable independence, justifies major decisions, identifies limitations, and responds effectively to feedback.
4. Advanced	4	Performance exceeds the essential criteria through well-justified choices, integration across dimensions, efficient or innovative solutions, critical evaluation, and transfer to less familiar conditions.

4.3 Scoring and decision rules

For each dimension, assessors first score the relevant criteria from 1 to 4 and calculate the mean criterion score. The suggested overall score is:

Overall competence = 0.35(Technical) + 0.25(Problem solving) + 0.15(Collaboration) + 0.15(Communication) + 0.10(Self-development)

The illustrative interpretation bands are 1.00–1.74 = Emerging, 1.75–2.49 = Developing, 2.50–3.24 = Proficient, and 3.25–4.00 = Advanced.

An overall average can conceal a serious weakness if strong communication or peer ratings compensate for deficient technical performance. The framework therefore includes a non-compensation rule: a learner cannot be classified as Proficient or Advanced overall unless both technical competence and problem-solving competence reach at least 2.50. Courses may identify additional threshold dimensions where safety, security, academic integrity, or professional accreditation requires them.

Self- and peer assessment should normally contribute no more than 20% of any high-stakes dimension score unless local validation demonstrates sufficient accuracy. Their principal value is

ISSN: 2181-3337 | SCIENTISTS.UZ

developmental: they reveal contribution patterns, prompt reflection, and enable students to practise applying criteria. Where peer reports materially affect grades, the instructor should require specific evidence, examine outliers, and retain final responsibility for the decision.

4.4 Feedback, moderation, and reassessment

Feedback should be criterion-referenced and dimension-specific. Instead of stating only that a project is "good" or "weak," the assessor identifies the strongest evidence, the unmet criterion, and one feasible next action. A useful feedback record therefore contains three elements: the demonstrated level, the evidence on which the judgement was based, and the improvement target. This structure supports the feedback principles described by Nicol and Macfarlane-Dick (2006) and helps learners monitor their own progress.

Moderation is necessary when several instructors assess different projects or when scoring has substantial consequences. Before grading, assessors should discuss the rubric and independently score one or more sample projects. Large discrepancies should be resolved by examining the evidence and clarifying the descriptor, not merely by averaging scores. During implementation, a second assessor can review borderline cases, unusually high or low results, and a random sample. These procedures do not guarantee reliability, but they create an auditable basis for evaluating it.

Where course regulations allow, students should have an opportunity to act on feedback. Reassessment does not require unrestricted resubmission of an entire project. It may involve correcting a security flaw, rewriting documentation, explaining a design decision, completing an individual practical task, or submitting a reflection that connects feedback with revision. The reassessment task should target the deficient competency and generate new evidence rather than simply reward cosmetic changes.

5. Implementation Guidance

The framework can be implemented through the following sequence. First, instructors map course learning outcomes to the five dimensions and remove any dimension that is genuinely outside the course scope. Second, they define task-specific criteria and identify the evidence that will demonstrate each criterion. Third, learners receive the rubric, evidence requirements, weighting profile, and rules for individual accountability before beginning the project. Fourth, formative checkpoints are scheduled so that feedback can influence subsequent work. Fifth, assessors calibrate their interpretations using sample artefacts. Sixth, final decisions are recorded at criterion, dimension, and overall levels, with the evidence trail retained for review.

Table 3. Minimum implementation and quality-control requirements

Stage	Minimum requirement	Quality-control question
Planning	Map learning outcomes, dimensions, criteria, evidence, and weights.	Does every graded criterion correspond to a stated learning outcome and observable evidence?
Orientation	Provide the rubric, exemplars, deadlines, collaboration rules, and reassessment conditions.	Could a student explain what counts as Proficient before starting the task?
Evidence collection	Collect product, process, and individual evidence at planned checkpoints.	Is the evidence sufficient to distinguish team output from individual competence?
Judgement	Score criteria analytically and document the basis for borderline decisions.	Would another assessor be able to reconstruct why the level was assigned?
Moderation	Calibrate assessors and review discrepancies, outliers, and a sample of decisions.	Are disagreements used to improve the rubric and shared interpretation?
Feedback and improvement	Provide a targeted action and obtain new evidence after improvement where feasible.	Did the feedback lead to a demonstrable change rather than only a final grade?

Implementation should remain proportionate. An introductory course may use a small number of criteria and two major evidence points, whereas a capstone course may require a detailed rubric, repository

ISSN: 2181-3337 | SCIENTISTS.UZ

analysis, individual defence, and formal moderation. The framework is compatible with digital portfolios and learning-management systems, but technology should serve the assessment design rather than determine it. Automated test results, repository statistics, and activity logs can support decisions, yet they cannot by themselves establish the quality of reasoning, collaboration, or learning.

Fairness also requires accessible tasks and multiple ways to demonstrate competence where the learning outcome permits. For example, communication competence may be shown through a live presentation, recorded demonstration, or structured technical explanation, provided the same criteria are applied. Group work should include a mechanism for individual accountability. Students should know how peer information will be used, how disagreements can be challenged, and how privacy will be protected.

6. Discussion

The proposed framework advances beyond a product-only model by treating web technology competence as multidimensional and evidence-based. Its central design choice is the separation of dimensions before aggregation. This makes strengths and weaknesses visible: a student may produce functional code but need substantial development in documentation or collaboration, while another may communicate effectively but lack independent technical control. A single undifferentiated project grade would obscure those patterns.

The framework also connects summative judgement with formative use. Black and Wiliam (1998) established the importance of assessment that informs learning, and Nicol and Macfarlane-Dick (2006) linked feedback with self-regulation. In the present model, feedback is not an optional comment added after scoring; it is a required stage that identifies a criterion, cites evidence, and directs a next action. This design is compatible with Laurillard's (2012) view of teaching as an iterative design process in which learners act, receive feedback, and refine performance.

A further contribution is the explicit treatment of evidence quality and assessor responsibility. Peer and self-assessment are retained because they can reveal contribution and support evaluative judgement, but their limits are acknowledged. Similarly, digital traces and analytics can help instructors monitor activity, yet they are not equated with competence (Long & Siemens, 2011). The framework therefore uses triangulation and moderation to reduce dependence on any single score source.

The model differs from broad digital competence frameworks in scale and purpose. DigComp 2.2 and the UNESCO framework offer wide-ranging descriptions of digital knowledge, skills, and attitudes (UNESCO, 2018; Vuorikari et al., 2022), whereas the present proposal translates a narrower course-level construct into assessable evidence and decision rules. This specialization is useful, but it also limits generalizability: the framework should not be presented as a universal standard for all computing programs or professional certification.

7. Limitations and Research Agenda

This study has four main limitations. First, the framework is conceptual and has not been tested with students, instructors, or employers. Second, the source base was purposive rather than systematic, so relevant assessment and computing-education literature may be absent. Third, the proposed dimensions and weights reflect a defensible design rationale but not empirical factor structure or stakeholder consensus. Fourth, the general rubric descriptors require course-specific elaboration before use; applying them without adaptation would create an appearance of precision without adequate content validity.

The next stage should begin with expert content validation. Specialists in web development, computing education, and educational assessment can rate the relevance and clarity of each dimension, criterion, descriptor, and evidence source. Cognitive interviews with instructors and students can identify ambiguous language. A classroom pilot should then examine feasibility, scoring time, missing evidence, student understanding, and the distribution of scores. Inter-rater reliability should be calculated using an appropriate coefficient for ordinal ratings, and disagreement patterns should be used to revise descriptors and exemplars.

ISSN: 2181-3337 | SCIENTISTS.UZ

Subsequent research can test whether framework-guided assessment improves feedback use, project quality, self-regulation, or alignment between course results and independent practical performance. Researchers should also examine fairness across individual and group projects, introductory and advanced courses, and different institutional contexts. Only after such evidence is available should the proposed weights, thresholds, or claims of reliability be treated as more than provisional design choices.

8. Conclusion

This paper proposed an operational competency-based assessment framework for project-oriented web technology courses in higher education. The framework defines technical, problem-solving, collaborative, communication, and self-development competence; links each dimension to observable indicators and evidence; uses a four-level analytic rubric; and embeds scoring within a cycle of moderation, feedback, improvement, and reassessment. It also provides an illustrative weighting model and a non-compensation rule to prevent strong peripheral performance from masking inadequate core technical competence.

The framework should be understood as a transparent starting point rather than a validated instrument. Its practical value lies in making assessment assumptions explicit and auditable: instructors must specify what competence means, what evidence will count, how levels will be determined, and how learners can improve. Empirical validation, reliability testing, and contextual adaptation are necessary before the model can support strong claims about effectiveness, objectivity, or fairness.

REFERENCES

1. Andrade, H. L. (2000). Using rubrics to promote thinking and learning. *Educational Leadership, 57*(5), 13–18. https://www.ascd.org/el/articles/using-rubrics-to-promote-thinking-and-learning
2. Biggs, J., & Tang, C. (2011). *Teaching for quality learning at university* (4th ed.). Open University Press.
3. Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in Education: Principles, Policy & Practice, 5*(1), 7–74. https://doi.org/10.1080/0969595980050102
4. Boud, D., & Falchikov, N. (Eds.). (2007). *Rethinking assessment in higher education: Learning for the longer term*. Routledge. https://www.routledge.com/Rethinking-Assessment-in-Higher-Education-Learning-for-the-Longer-Term/Boud-Falchikov/p/book/9780415397780
5. Guo, P., Saab, N., Post, L. S., & Admiraal, W. (2020). A review of project-based learning in higher education: Student outcomes and measures. *International Journal of Educational Research, 102*, Article 101586. https://doi.org/10.1016/j.ijer.2020.101586
6. Laurillard, D. (2012). *Teaching as a design science: Building pedagogical patterns for learning and technology*. Routledge.
7. Long, P., & Siemens, G. (2011). Penetrating the fog: Analytics in learning and education. *EDUCAUSE Review, 46*(5), 31–40. https://er.educause.edu/articles/2011/9/penetrating-the-fog-analytics-in-learning-and-education
8. Nicol, D. J., & Macfarlane-Dick, D. (2006). Formative assessment and self-regulated learning: A model and seven principles of good feedback practice. *Studies in Higher Education, 31*(2), 199–218. https://doi.org/10.1080/03075070600572090
9. OECD. (2019). *OECD Learning Compass 2030: A series of concept notes*. OECD Publishing. https://www.oecd.org/content/dam/oecd/en/about/projects/edu/education-2040/1-1-learning-compass/OECD_Learning_Compass_2030_Concept_Note_Series.pdf
10. Panadero, E. (2017). A review of self-regulated learning: Six models and four directions for research. *Frontiers in Psychology, 8*, Article 422. https://doi.org/10.3389/fpsyg.2017.00422
11. UNESCO. (2018). *UNESCO ICT competency framework for teachers* (Version 3). https://unesdoc.unesco.org/ark:/48223/pf0000265721

ISSN: 2181-3337 | SCIENTISTS.UZ

12. Voogt, J., Erstad, O., Dede, C., & Mishra, P. (2013). Challenges to learning and schooling in the digital networked world of the 21st century. *Journal of Computer Assisted Learning, 29*(5), 403–413. https://doi.org/10.1111/jcal.12029
13. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). *DigComp 2.2: The Digital Competence Framework for Citizens—with new examples of knowledge, skills and attitudes*. Publications Office of the European Union. https://doi.org/10.2760/115376
14. Zhao, Y., Pinto Llorente, A. M., & Sánchez Gómez, M. C. (2021). Digital competence in higher education research: A systematic literature review. *Computers & Education, 168*, Article 104212. https://doi.org/10.1016/j.compedu.2021.104212
15. Zimmerman, B. J. (2002). Becoming a self-regulated learner: An overview. *Theory Into Practice, 41*(2), 64–70. https://doi.org/10.1207/S15430421TIP4102_2

ISSN: 2181-3337 | SCIENTISTS.UZ