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CRITERIA AND LEVELS OF PROFESSIONAL COMPETENCE OF FUTURE IT PROFESSIONALS

S. V. Petrenko*

The article reveals approaches to determining criteria and indicators for measuring the levels of professional competence of future IT specialists in the conditions of the information and educational environment of a higher education institution. The review of scientific and pedagogical literature on the construction of criterion-indicator systems is carried out and the requirements for their formation are substantiated. It is determined that the criteria must comply with the principles of materiality, consistency, validity, measurability and verifiability. Given the analysis of European educational standards and frameworks (European e-Competence Framework, EQF, CDIO Syllabus, Computing Curricula 2020, etc.), a criterion-indicator system for assessing the professional competence of IT specialists is proposed. The system identifies four criteria: cognitive and content, operational and activity, professional and communicative, and ethical and value. For each criterion, a system of quantitative indicators has been developed that allow diagnosing the level of professional competence. A 5-level scale for assessing professional competence for each indicator and a method for calculating the integral indicator of the level of professional competence are presented. In accordance with the e-CF scale, the levels of professional competence from performing tasks under supervision (e-1) to initiating innovations (e-5) are substantiated. The proposed system is the basis for further pedagogical measurements within the framework of an experimental study of the influence of educational factors on the formation of professional competence of future IT specialists.

Keywords: *professional competence, IT specialists, criteria, indicators, levels of formation, criterion-indicator system, e-CF, pedagogical assessment.*

КРИТЕРІЇ ТА РІВНІ ПРОФЕСІЙНОЇ КОМПЕТЕНТНОСТІ МАЙБУТНІХ ІТ-ФАХІВЦІВ

С. В. Петренко

У статті розкриваються підходи до визначення критеріїв та показників для вимірювання рівнів професійної компетентності майбутніх ІТ-фахівців в умовах інформаційно-освітнього середовища вищого навчального закладу. Проведено огляд науково-педагогічної літератури з питань побудови систем критеріїв-показників та обґрунтовано вимоги до їх формування. Визначено, що критерії повинні відповідати принципам суттєвості, узгодженості, валідності, вимірюваності та верифікативності. З урахуванням аналізу європейських освітніх

* Candidate of Pedagogical Science (PhD in Pedagogy), Docent
(Rivne State University of the Humanities)
serhii.petrenko@rshu.edu.ua
ORCID: 0000-0002-5311-0743

стандартів та рамок (Європейська рамка електронної компетентності, Європейська рамка кваліфікацій, Система CDIO, Програма навчання інформатики 2020, тощо), запропоновано систему критеріїв-показників для оцінки професійної компетентності IT-фахівців. Система визначає чотири критерії: когнітивний та змістовний, операційний та діяльнісний, професійний та комунікативний, етичний та ціннісний. Для кожного критерію розроблено систему кількісних показників, що дають змогу діагностувати рівень професійної компетентності. Представлено 5-бальну шкалу оцінки професійної компетентності за кожним показником та метод розрахунку інтегрального показника рівня професійної компетентності. Відповідно до шкали e-CF обґрунтовано рівні професійної компетентності від виконання завдань під наглядом (e-1) до ініціювання інновацій (e-5). Запропонована система є основою для подальших педагогічних вимірювань у рамках експериментального дослідження впливу освітніх факторів на формування професійної компетентності майбутніх IT-фахівців.

Ключові слова: *професійна компетентність, IT-фахівці, критерії, показники, рівні формування, система критеріїв-показників, e-CF, педагогічна оцінка.*

Introduction of the issue. In today's world, which is rapidly transforming under the influence of digital technologies, the problem of training highly qualified information technology professionals (IT professionals) is becoming particularly relevant. The professional competence of an IT specialist is a key factor in his or her competitiveness in the labor market, professional efficiency, and ability to adapt to the challenges of the digital environment. Therefore, it is important not only to define the essence of this competence, but also to create effective tools for its diagnosis and development in the information and educational space of higher education institutions.

Pedagogical assessment of the level of professional competence requires a scientifically based system of criteria and indicators that allows for objective and verifiable monitoring of the results of professional training. The creation of such a system, taking into account international and national approaches, the specifics of the IT sector and the capabilities of the information and educational environment of the higher education institution (HEI), is a prerequisite for the implementation of a high-quality educational process.

Current state of the issue. A comprehensive **analysis** of the essence and content of scientific and pedagogical research, different approaches to determining criterion-indicator systems for organizing and conducting pedagogical experiments is presented in the works of I. Annenkova and others [1], O. Bashkir [2], L. Kovalchuk [4] and others.

The literature analysis shows that the design of a system of criteria and indicators for the implementation of research requires compliance with a number of requirements, as it determines the completeness and objectivity of the phenomena and processes under study. In particular, according to the results of E. Khrykov's analysis [5], the research criteria must meet, in particular, the requirements of materiality as a reflection of essential characteristics; systematicity as a provision of multidimensionality and reflection of the entire system; validity as the presence of theoretical and logical justification; measurability and realism as the possibility of their use in research; and verified in practice. The criteria should reflect the structure of competence [6] and be disclosed by a system of indicators that clarify the content of each criterion and make it possible to measure the phenomena and processes under study.

Accordingly, an experimental study of the professional competence of IT specialists in the conditions of the information and educational environment of higher education institutions requires the identification of tools for quantifying the levels of professional competence to track the impact of experimental factors.

Aim of the research is to substantiate a system of criteria and indicators that will reflect the levels of professional competence of future IT specialists during

their studies at a higher education institution.

Results and discussion. We define a criterion as a sign for the systematic assessment of the measured phenomenon of the level of professional competence of future IT specialists, which is revealed through a set of indicators (quantitative assessment), which can be fixed and levels (qualitative integrated assessment) of professional competence of IT specialists. That is, the assignment to a certain level of professional competence of future IT specialists is carried out according to a system of criteria and indicators in accordance with the evaluation scale.

According to the analysis of the structure of professional competence of IT specialists in the European educational standards and frameworks, as well as taking into account the content of national standards, we have designed a criterion-indicator system for measuring the level of professional competence of IT specialists in the context of higher education institutions, based on cognitive and content, operational and activity, professional and communicative, and ethical and value criteria. The following documents were taken into account when constructing the defined system of criteria: European e-Competence Framework 3.0 (e-CF) [10], which defines 40 IT competencies in five domains; European Qualifications Framework (EQF) [3], which structures qualification levels by knowledge, skills and responsibilities; ENQA/ESG – Standards and Guidelines for Quality Assurance in the European Higher Education Area [9]; CDIO Syllabus 2.0 [7], which forms the competencies of engineers in the context of the full product life cycle; QAA Subject Benchmark Statement for Computing (2022) [12]; and Computing Curricula 2020 (CC2020) [8], which offers global approaches to structuring IT training programs. Taking into account the provisions of these documents made it possible to ensure that the designed criterion-indicator system meets modern international requirements for the quality of training.

Let's characterize the content of each criterion.

Cognitive and substantive criterion aimed at assessing the depth, consistency, and relevance of the IT specialist's theoretical knowledge in the field of computer science, system development, operation, project management, etc. At each year of training, the specialist's knowledge becomes more complex, taking into account and defining the content of professional training from basic concepts and terms to strategic vision and expert knowledge of interdisciplinary knowledge. Accordingly, it is the cognitive and content criterion that is crucial for the evaluation system, as it serves as the basis for further professional actions, communications and decision-making.

Operational and activity criterion, as one that assesses the ability of an IT specialist to apply knowledge in practice: develop, implement, test, administer, manage projects, and innovate. This criterion covers the practical (activity) component of professional competence, which is reflected in the skills and programmatic learning outcomes as the acquired ability to strategically manage IT architectures.

The professional communication criterion determines the ability of an IT professional to effectively interact with various audiences: technical teams, clients, management, and reflects the presentation, facilitation, and negotiation skills acquired during the training process. In today's IT environment, professional communication is a key ability for effective teamwork, especially in complex projects, distribution teams, or in agile methodologies such as Scrum [13], Kanban [11], and others.

An ethical and value-based criterion that characterizes values, responsibility, ethical decisions, compliance with professional behavior, digital ethics, as well as internal motivation, and sustainability in the professional development of IT professionals. Ethics in IT is a critical characteristic of the information society, where the values of an IT professional affect both the safety of

users' personal data and decision-making related to artificial intelligence or security. The development of the ethical component of IT professionals' professional competence is aimed at shaping the leadership and responsibility of IT professionals to society.

Each criterion is disclosed by a system of indicators that allow to diagnose the level of manifestation of each criterion in assessing the professional competence of IT specialists (see Table 1).

Table 1

Criterion and indicator system for assessing the level of professional competence of IT specialists

Criteria	Indicators			
Cognitive and content	Ability to classify and explain key concepts of computer science (algorithms, data structures, system architecture, etc.).	Awareness of modern IT standards and frameworks (Scrum, Kanban, DevOps, e-CF, etc.).	Knowledge of software lifecycle processes, networking, and information security.	Ability to integrate interdisciplinary knowledge to solve complex technical problems.
Operational and business	Ability to independently develop, test and implement software solutions.	Successful application of modern tools and technologies in professional practice (IDE, CI/CD, cloud platforms, etc.).	IT project management skills: planning, resource allocation, meeting deadlines.	Ability to solve complex technical problems with the involvement of team or cross-functional resources.
Professional and communicative	Ability to clearly and reasonably present technical solutions in a team or to a customer.	Ability to work in a team, support colleagues, and maintain a culture of professional communication.	Skills of conducting professional dialog in English (within IT communications).	Participation in collective decision-making, ability to facilitate working discussions.
Ethical and value-based	Conscious adherence to professional ethics and digital security (confidentiality, honesty, transparency).	Willingness to take responsibility for technical decisions and their consequences.	Motivation for continuous professional self-development (participation in hackathons, conferences, certification).	Adherence to the principles of inclusiveness and ethical treatment of users and colleagues.

To quantify the level of professional competence of IT specialists, based on the developed criterion-indicator system, we have created a 5-level rating scale from 1 to 5 points, where:

1 point – initial level of manifestation of the professional competence indicator (knowledge, skills, qualities are not formed, there is no ability to independently perform the tasks);

2 points – low level (knowledge, skills, qualities are fragmentary, applied with difficulty and require constant correction);

3 points – average level (knowledge, skills, qualities are applied in familiar situations or with the help of a mentor);

4 points – sufficient level (knowledge, skills, qualities are applied independently in typical situations or with little help);

5 points – high level (knowledge, skills, qualities are demonstrated at a consistently high level, applied in new situations; the specialist independently

initiates professional growth and improvement).

Thus, the level of professional competence of IT specialists will be assessed by the formula:

$P_{пк}=\frac{\sum_1^4 К}{4}$, where $P_{пк}$ – level of professional competence, K – the number of points scored for each criterion as the sum of the scores of individual indicators.

In accordance with the European e-Competence Framework (e-CF) 3.0 [14], we will consider 5 levels of professional competence of IT specialists (from e-1 to e-5) depending on the degree of their autonomy in performing professionally oriented educational tasks, the complexity of the tasks performed, as well as the formation of communication and professional and ethical abilities:

- e-1: Performing tasks under supervision ($P_{пк}$ from 1 to 4 points);
- e-2: Performing standard tasks independently ($P_{пк}$ from 5 to 8 points);
- e-3: Coordination and control of tasks ($P_{пк}$ from 9 to 12 points);
- e-4: Defining and implementing strategies ($P_{пк}$ from 13 to 16 points);
- e-5: Initiating and managing innovations ($P_{пк}$ from 17 to 20 points).

The proposed five-level scale for assessing the level of professional competence of IT specialists can be effectively used in the process of current and final control, monitoring the dynamics of student development, as well as in the development of individual educational trajectories. Such a system allows the teacher not only to objectively record the level of professional competence of IT specialists, but also to identify areas of learning difficulties that require pedagogical support or correction.

Conclusions and research perpectives. The article presents a scientifically grounded criterion-indicator system for assessing the level of professional competence of future IT specialists, based on four key criteria: cognitive and content, operational and activity, professional and communicative, and ethical and value. Each criterion is specified by a system of relevant indicators, which allows for both qualitative and quantitative assessment of the professional development of students.

The proposed five-level scale for assessing professional competence, adapted to the European framework (e-CF), allows to classify the levels of competence depending on the level of autonomy, complexity of tasks and the formation of communicative and ethical components. This creates conditions for a systematic analysis of the dynamics of students' professional growth and improving the efficiency of the educational process in the IT field.

Promising areas for further research are the empirical testing of the proposed criterion-indicator system in the real educational process of higher education institutions, as well as the development of tools for automated monitoring of the levels of professional competence of IT specialists. Particular attention should be paid to deepening the methods of assessing the ethical and value component of competence, which is extremely relevant in the context of digital ethics, cybersecurity and social responsibility of IT professionals.

REFERENCES (TRANSLATED & TRANSLITERATED)

1. Annenkova, I.P., Kuznetsova, N.V., & Raskola, L.A. (2021). *Osnovy pedahohichnykh vymiryuvan' [Fundamentals of pedagogical measurements].* Odesa: Odes'kyy natsional'nyy universytet im. I.I. Mechnykova, 210 [in Ukrainian].

2. Bashkir, O.I. (2020). *Metodolohiya naukovo-pedahohichnoho doslidzhennya ta prezentatsiya yoho rezul'tativ [Methodology of scientific and pedagogical research and presentation of its results].* Kharkiv: Kharkiv. nats. ped. un-t imeni H.S. Skovorody, 93 [in Ukrainian].

3. *European Qualifications Framework (EQF).* Retrievsd from: https://europa.eu/europass/en/european-qualifications-framework-eqf [in English].

4. Kovalchuk, L. (2020). *Modeliuvannia naukovo-pedahohichnykh doslidzhen [Modeling of scientific and pedagogical research].* Lviv: Vydavnychyi tsentr LNU imeni Ivana Franka, 520 [in Ukrainian].

5. *Metodolohiya pedahohichnoho doslidzhennya [Methodological foundations of pedagogical research]:* monohrafiya / ed. by V.S. Kurylo, E.M. Khrykov. (2013). Luhans`k: Derzhavnyy zaklad "Luhans′kyy natsional′nyy universytet imeni Tarasa Shevchenka", 248 [in Ukrainian].

6. Yagupov, V., Yergidzei, K., & Rozumovska, Y. (2024). Kryteriyi ta pokaznyky diahnostuvannya rozvynenosti informatsiyno-komunikatsiynoyi kompetentnosti ofitseriv taktychnoyi lanky upravlinnya [Criteria and indicators for diagnosing the development of information and communication competence of tactical command officers]. *Aktual'ni pytannya humanitarnykh nauk – Topical Issues of the Humanities,* is. 77, vol. 3, 316-328. DOI: 10.24919/2308-4863/77-3-43 [in Ukrainian].

7. *CDIO Syllabus 2.0.* Retrievsd from: http://www.cdio.org/benefits-cdio/cdio-syllabus [in English].

8. *Computing Curricula.* (2020). (CC2020). Retrievsd from: https://www.acm.org/education/curricula-recommendations [in English].

9. *ENQA/ESG – Standards and guidelines for quality assurance in the European Higher Education Area Retrievsd.* from: https://enqa.eu/index.php/home/esg/ [in English].

10. *European e-Competence Framework 3.0 (e-CF).* Retrievsd from: https://esco.ec.europa.eu/en/about-esco/escopedia/escopedia/european-e-competence-framework-e-cf [in English].

11. Mauvius Group Inc. (2021). *The official guide to the Kanban method.* Retrievsd from: https://kanban.university/wp-content/uploads/2022/03/The-Official-Kanban-Guide_Ukrainian_A4.pdf [in English].

12. *QAA Subject Benchmark Statement for Computing.* (2022). Retrievsd from: https://www.qaa.ac.uk/the-quality-code/subject-benchmark-statements/computing [in English].

13. Schwaber, K., & Sutherland, J. (2020). *Complete Scrum tutorial: the rules of the game.* Retrievsd from: https://scrumguides.org/docs/scrumguide/v2020/2020-Scrum-Guide-Ukrainian.pdf [in English].

14. *User guide for the application of the European e-Competence Framework 3.0. CWA 16234-2:2014,* part 2. Retrievsd from: https://www.myecole.it/biblio/wp-content/uploads/2020/11/User-guide-for-the-application-of-the-e-CF-3.0_CEN_CWA_16234-2_2014.pdf [in English].

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