

Mechanisms for Developing the Competence of Teaching Staff in Using Innovative Educational Technologies

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Abstract

This article analyzes the theoretical foundations and methodological mechanisms for developing the competence of teaching staff in using innovative educational technologies. The aim of the study is to develop a conceptual model designed to develop the competence of educators in selecting innovative technologies, adapting them to the educational content, implementing them in practice, and evaluating their results.

Keywords: Teaching staff, innovative educational technologies, professional competence, professional development, individual development trajectory, pedagogical diagnostics, reflection, mentoring.

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1. Introduction

Improving the educational process requires teachers not only to convey educational content but also to organize the active participation of students, consider their individual needs, and make methodological decisions based on learning outcomes. In carrying out these tasks, the purposeful use of innovative educational technologies is of particular importance.

In this article, innovative educational technology is understood as a pedagogical solution aimed at solving a specific educational problem, integrating goals, content, learning activities, tools, and assessment, while enabling the improvement of existing practices. Such technologies can include problem-based and project-based learning, blended learning, the flipped classroom, collaborative learning, and the organization of differentiated learning

through digital tools. Their innovative nature is determined not only by the novelty of the tool used but also by how it serves the pedagogical task under specific conditions.

An educator's ability to use a technical tool does not fully reflect their ability to effectively design the educational process. The Technological Pedagogical Content Knowledge model developed by Mishra and Koehler substantiates the interdependence of subject content, pedagogical methods, and technological capabilities when integrating technology into education [1].

In the 2017 edition of the DigCompEdu model dedicated to the digital competence of educators, 22 competencies are organized within six areas. This approach allows digital competence to be viewed as a concept related to professional activity, which is broader than mere technical skills [2].

At the same time, although digital competence and competence in the use of innovative educational technologies are interconnected, they are not the exact same concept. An innovative pedagogical solution can be implemented even without digital tools. Therefore, in this study, international digital competence models are used as a theoretical foundation for designing broader pedagogical competence.

The theoretical roots of pedagogical competence are also linked to Shulman's approach to pedagogical content knowledge: it is necessary to consider the connection between knowing the subject content and presenting it in a way that is understandable to the student [4]. In this article, this principle is interpreted as a basis for co-designing content explanation, the organization of student activities, and assessment when selecting innovative technology.

The content of professional development is also important. Desimone discusses content focus, active learning, coherence, duration, and collective participation as key characteristics of professional development [5]. Darling-Hammond, Hyler, and Gardner's analysis also highlights practical models, expert support, as well as feedback and reflection [6]. Based on these sources, a conceptual conclusion is drawn that a one-time seminar must be supplemented with a continuous development process linked to the teacher's classroom practice.

The scientific contribution of the article consists of linking existing competence domains with professional development mechanisms, demonstrating a verifiable practical product for each stage, and proposing a cycle aimed at tracking development results through evidence. This contribution does not imply that the model is absolutely novel or that its practical effectiveness has been proven.

The research problem consists of identifying the development mechanisms that link a teacher's knowledge of innovative technologies with the activities of practical design, application in lessons, and analysis of results.

The aim of the research is to develop a conceptual model and its implementation mechanisms aimed at developing the competence of teaching staff in using innovative educational technologies.

To achieve this goal, the following tasks have been defined:

1. Clarifying the content of competence in the use of innovative educational technologies.
2. Identifying the structural components and evaluation criteria of the competence.
3. Describing the mechanisms that ensure the individual professional development of a teacher.
4. Integrating these mechanisms into a coherent activity cycle.
5. Implementing the model into practice and determining the directions for empirical verification.

Main research question: Through what mechanisms can a teacher's study, practical implementation, and results-based improvement of innovative technologies be integrated into a unified professional development process?

2. Methods

The research is theoretical and conceptual in nature. To determine the content of competence, the technological pedagogical content knowledge model, the 2017 edition of the DigCompEdu model, and the UNESCO ICT Competency Framework for Teachers were taken as a basis [1–3]. Additional scientific and methodological sources were drawn upon to substantiate the mechanisms of professional development [4–11].

The sources were selected based on their direct relevance to educators' professional knowledge, the integration of technologies into education, and the organization of professional development. The UNESCO framework was developed as a methodological tool to guide the use of ICT in the pre-service training and in-service professional development of educators [3].

This work is not presented as a systematic review covering all existing research. The selected sources serve as a theoretical basis for developing the conceptual model.

A targeted corpus consisting of a total of 11 sources was compiled for the expanded analysis. It included theoretical works on pedagogical knowledge and technological integration [1, 4], international competence frameworks [2, 3], conceptual research and reviews on professional development [5–9], a review on classroom assessment [10], and recommendations on the use of generative artificial intelligence in education [11]. The publications span the years 1986 to 2023; they were

selected as the main theoretical and methodological basis for the topic and are not presented as an exhaustive list of the latest works.

The inclusion criteria were determined by the direct relevance of the source to the teacher's professional activity, the verification of bibliographic data, and the coverage of at least one aspect of competence development. Product advertisements or recommendations with unidentified sources were excluded from the analysis. Since the search process was not conducted based on a systematic review protocol, potential selection bias and scope limitations remain.

Methods of analysis. The following methods were used in the study:

- **Conceptual analysis:** working definitions of the concepts of competence, innovative educational technology, and development mechanism were formulated.
- **Comparative analysis:** approaches to professional knowledge, pedagogical application, and assessment in the sources were compared with each other.
- **Classification and generalization:** the content of competence was divided into structural components.
- **Pedagogical modeling:** mechanisms for component development and their inter-stage connections were designed.

The analysis was conducted based on the following questions: what the educator needs to know; what activities they should be able to perform; how they justify their decision to choose a technology; how they evaluate the results; and what conditions are necessary for professional development?

When comparing sources, ideas regarding pedagogical knowledge, practical application, collaboration, assessment, and organizational conditions were taken as

the unit of analysis. Each idea was linked to a competence component, development activity, and observable product. Subsequently, similar contents were merged, and the application boundaries of different approaches were defined. For instance, the selection of a digital resource is described within the DigCompEdu framework, whereas collaborative problem-solving without digital tools is considered a broader innovative pedagogical activity [2].

The analysis distinguished three types of conclusions: a rule stated directly in the source; an interpretation obtained from comparing several sources; and a mechanism or evaluation tool proposed by the author. This distinction prevents interpreting the six mechanisms as a ready-made classification copied from international frameworks. Verification involving independent coders was not conducted; the replicability of the conceptual classification remains a task for future verification.

Limits of interpreting the results. Within the framework of the study, no surveys, lesson observations, or experiments were conducted with the participation of respondents. Therefore, the results represent the developed conceptual proposals. The competence components, mechanisms, and evaluation criteria are the author's synthesis, and their reliability and practical effectiveness require separate empirical verification.

3. Results

Based on theoretical synthesis, the teacher's competence in using innovative educational technologies is defined as the readiness and ability to select, adapt, and apply technology, evaluate its results, and improve their own practice based on the educational goal, subject content, student needs, and existing conditions.

This definition is based on considering competence as a unity of knowledge, activity, and professional relationships. Four components are proposed within its structure.

Table 1. Structure of competence in using innovative educational technologies

Component	Content	Observable indicator
Motivational-value	Striving for professional development, an attitude based on innovation, and pedagogical responsibility	Explains the purpose of selecting the technology and defines the professional development task

Cognitive	Knowledge of the essence, capabilities, limitations, and conditions of application of technologies	Compares various solutions and justifies the choice with pedagogical evidence
Applied-technological	Lesson design, resource adaptation, organization of learning activities and assessment	Creates a lesson plan that integrates goals, assignments, and assessment
Reflective-evaluative	Analysis of activity results and revision of methodological decisions	Develops an improvement plan based on student work and observational evidence

These components complement each other. A teacher may know the theoretical foundations of a technology but find it difficult to adapt it to a specific class. Furthermore, a teacher capable of applying a ready-made lesson plan may not possess sufficient skills to evaluate the results of the chosen technology. Therefore, it is advisable to assess competence based on individual components.

The connection between components is revealed through a practical task. The educator recognizes the student's difficulty as significant, explains the capabilities of the appropriate technology, designs the task, and analyzes the evidence after implementation. In this process, motivation serves to initiate the activity, knowledge to justify the choice, practical skills to implement the solution, and reflection to review it. Components do not need to develop at the same pace; therefore, it is recommended to maintain an individual profile along with the total score.

Competence development mechanisms. In the study, the development mechanism was interpreted as a procedure of activities that ensures a connection between the pedagogical goal, practical actions, participants, necessary conditions, and feedback. Based on this approach, six mechanisms are proposed.

Diagnostic mechanism. Its task is to determine the educator's current level of competence and development needs. Diagnosis is based on a joint review of the results of self-assessment, practical assignments, lesson plan analysis, and lesson observations. For example, an educator's ability to prepare a digital presentation does

not automatically imply the ability to design an assessment tool. The diagnosis should indicate exactly in which activity methodological assistance is needed.

Individual design mechanism. Diagnostic results are transformed into specific professional development goals. The educator's plan defines the skill to be developed, the practical work to be performed, the deadline, the form of assistance, and the expected evidence. For example, instead of a general goal such as "learning blended learning," a task such as "designing a lesson where the independent preparation task, classroom activity, and assessment are interconnected" is set.

An individual plan should be based on a goal that allows for the monitoring of performance outcomes. For example, the educator develops tasks of two different difficulty levels and corresponding rubrics for future lessons, while the mentor reviews the alignment of the goal, task, and criteria. The execution of the plan is evaluated not by course attendance, but by the presence and quality of the agreed-upon product. The focus on goal setting, feedback, and the reinforcement of learned activities aligns with the mechanism-oriented approach in the EEF recommendations [7].

Practical integration mechanism. Theoretical knowledge is reinforced through the creation of a real pedagogical product. The educator identifies the learning problem, selects the technology, develops tasks, conducts the lesson, and gathers evidence. The practical product can be a lesson plan, a project assignment, an assessment rubric, or a set of differentiated resources.

Collaboration and mentorship mechanism. The educator's activity is supported through collaborative planning with colleagues, lesson observations, and criteria-based feedback. Rather than merely providing ready-made solutions, the mentor helps the educator clarify the problem, justify their choices, and analyze the results.

When organizing collaboration, the goal of the observation is agreed upon in advance: for example, the quality of task explanation or the students' reasoning activities. The post-observation conversation focuses not on evaluating the individual, but on the evidence from the lesson and subsequent actions. Kraft, Blazar, and Hogan's meta-analysis examines teacher coaching programs in relation to teaching practices and learning outcomes [8]. This evidence helps justify the inclusion of mentoring in the model, but the outcomes of coaching programs cannot be directly transferred to every form of mentoring or to local conditions.

Reflective-corrective mechanism. The educator analyzes the appropriateness of the applied technology through student work, errors, participation, and assessment results. Reflection ensures a transition from a general conclusion like "the lesson went well" to a specific methodological decision. Based on the identified problem, the task complexity, resources, time allocation, or assessment criteria are reviewed.

Three questions are recommended for reflection: what was the expected outcome; what does the existing evidence indicate; and what exactly will be changed in the next lesson? Black and Wiliam's review of classroom assessment highlights the importance of using

assessment information to improve teaching and learning [10]. Based on this, assessment in this model is not limited to final evaluation but is considered a source of information for correction.

Organizational support mechanism. The educational organization creates conditions for methodological advice, collaboration time, access to resources, and the discussion of experience for the teacher's development. This mechanism is aimed at reducing the dependence of professional development solely on the teacher's personal initiative.

Practical forms of support include the analysis of lesson products at a meeting of the methodological association, agreed meeting times with a mentor, a shared resource fund, and the discussion of a trial lesson. In schools with limited resources, solutions based on printed assignments, group discussions, and mutual observation can also be used. The main object of observation for the management is not the number of platforms used, but the teacher's decisions and how they manifest in their teaching activities.

Cyclical model of competence development

The proposed model is based on the following functional sequence:

Diagnostics → individual design → practical activity → reflection → correction → updated development trajectory.

In the model, the result of each stage serves as the basis for the next stage.

Table 2. Stages of the model and their practical products

Stage	Main activity	Practical product
Diagnostics	Identifying knowledge, practical skills, and needs	Individual competence profile
Individual design	Setting goals, tasks, deadlines, and forms of support	Professional development plan
Practical activity	Adapting technology and applying it in the lesson	Lesson plan, resources, and student work
Reflection	Comparing planned and observed results	Evidence-based analytical note
Correction	Reworking the methodological solution	Improved lesson plan
Updated trajectory	Defining new needs and goals	Plan for the next development cycle

The cyclical nature of the model is aimed at ensuring the educator continues to develop even after a single training course. The updated trajectory is linked to new diagnostics. Collaboration and organizational support apply at all stages.

The transition between stages is determined not by the expiration of time, but by the sufficiency of the product for further activity. After diagnostics, there must be a clear need; after designing, an actionable plan; and after practical activity, evidence suitable for analysis. If sufficient evidence is not collected, a definitive conclusion on effectiveness is not drawn at the reflection stage; the observation or task is reorganized. Thus, the cycle is repeated in accordance with the educator's needs.

Evaluation criteria. The following criteria are proposed for assessing competence:

- **Pedagogical validity:** the technology is selected to match the educational goal and subject content.
- **Adaptation:** tasks are suited to the students' level of preparation, needs, and existing conditions.
- **Organization of activity:** the emergence of meaningful educational activity through technology.
- **Assessment alignment:** alignment of tasks and assessment criteria with expected results.
- **Quality of reflection:** substantiation of subsequent methodological decisions using collected evidence.

A descriptive rubric consisting of initial, independent application, and adaptive design levels can be developed for these criteria. At the initial level, the educator relies on examples and assistance; at the independent application level, they select and implement appropriate technology; and at the adaptive design level, they modify the solution, analyze the results, and explain the conditions for transferring it to other situations. These levels are suggestive and require validation.

In the practical rubric, three descriptive levels can be used for each criterion:

- 1 - execution with assistance;
- 2 - independent and justified application;
- 3 - situational redesign and evidence-based improvement.

These numbers are conventional ordinal markers and should not be interpreted as a normative boundary or interval measure without validation. If there is insufficient evidence for observation, a note stating "insufficient evidence" is entered instead of an assessment.

For example, regarding the reflection quality criterion, the first level means limiting oneself to a general impression; the second level means justifying the problem through student work or observation; and the third level means comparing several facts, considering alternative explanations, and drafting a verifiable correction plan. It is recommended that the portfolio includes a baseline lesson plan, an assessment rubric, anonymized student work, an observation record, and a revised project.

4. Discussion

The main feature of the proposed model is the organization of competence development through the integration of knowledge transfer, practical activity, and feedback. Mastering knowledge about technology is a prerequisite for professional development. Its practical expression is manifested in the teacher's purposeful lesson design and the refinement of their decisions based on the results.

The connection between the model and the technological-pedagogical content knowledge approach is evident in the selection of technology without separating it from the subject content and teaching method [1]. DigCompEdu, on the other hand, serves as a foundation for clarifying assessment and professional development directions [2]. However, the six mechanisms proposed in this article are not a repetition of the ready-made classifications from these sources; they are a conceptual synthesis developed in accordance with the research objective.

The individual design mechanism allows the differences in educators' needs to be taken into account. For one educator, the primary task may be creating resources, while for another, managing student activities or using assessment results may be more relevant. Therefore, it is recommended to link the development content with diagnostic results.

Guskey discusses the connections between an educator's professional development, practices, beliefs, and student outcomes through a model of change [9]. The resulting interpretation for this article is that the motivational-

value component should not be evaluated solely as an initial desire: reliable evidence obtained from practical activities can also influence the educator's subsequent choices. Therefore, motivation and reflection are observed again at different stages of the cycle.

The practical application of the model can be explained using the example of working with mathematical problems in primary school. The teacher identifies that the students can solve the problem but struggle to explain the solution. Following this, the teacher develops a lesson plan based on collaborative work and the discussion of various solutions. During assessment, along with the correctness of the answer, the logic of the explanation is also observed. After the lesson, the students' work is analyzed, and subsequent assignments are revised. This example illustrates how the model operates and is not interpreted as an experimentally verified result.

To implement the model in an educational organization, the activities of the methodological association can be directed toward analyzing practical outputs. In doing so, alongside the presentation, the educator provides the lesson plan, student work, assessment criteria, and a reflective note. The discussion is based on this evidence.

When adapting the model to Uzbekistan's schools and professional development practices, it is recommended to consider the subject curriculum, language of instruction, class composition, teacher workload, and available resources. Initially, the model can be piloted in a single methodological association, tasks can be linked to local educational content, and necessary forms of support can be agreed upon. These recommendations are provided not as outcomes confirmed by local empirical data, but as testable organizational proposals for implementing the model.

If generative artificial intelligence tools are selected, the educator must verify the generated text or task for accuracy, age-appropriateness, and alignment with the assessment objectives. UNESCO's recommendations focus on considering the human role in decision-making, inclusivity, and data privacy [11]. Within the framework of the model, these requirements are incorporated into the criteria for selecting and adapting resources; it is recommended that students' personal data not be entered into external tools and that original sources be cited.

The limitations of the research are determined by its theoretical nature, the targeted selection of sources, and

incomplete coverage. The effectiveness of the proposed mechanisms across various disciplines, educational stages, and resource conditions has not yet been tested. For the empirical evaluation of the model, initial and final diagnostics, a comparison group, independent expert evaluation, and lesson observation can be used. It is also necessary to verify consistency among evaluators and the reliability of the tools.

Changes in teacher competence and student outcomes should be measured separately. A teacher's creation of a high-quality lesson plan does not automatically mean an improvement in student performance. This correlation must be verified with additional evidence.

In a future empirical study, the first stage may consist of an expert assessment of the rubric's content suitability and testing the tasks on a small pilot group. Subsequently, the same initial and final practical tasks will be applied to teachers under the model-based program and the comparison conditions. Group selection, the number of participants, program duration, and key outcome indicators are to be determined prior to data collection; if possible, the assignment and evaluation of participants should be organized independently.

An independently evaluated lesson plan and observation profile can be taken as the main indicators of a teacher's competence. Student outcomes are measured separately through tasks aligned with the learning objectives. The analysis takes into account baseline differences, participation, consistency of application, and attrition. For the rubric, providing inter-rater reliability is recommended, while for the results, effect size and confidence intervals should be reported. Informed consent for participation and data anonymization are ensured. This procedure represents a research design, not a description of a completed experiment.

5. Conclusion

Based on theoretical analysis and pedagogical modeling, a conceptual model for developing the competence of teaching staff in the use of innovative educational technologies was proposed.

Competence combines the abilities to select, adapt, and implement technology in practice, evaluate the results, and improve professional activities. Its motivational-value, cognitive, practical-technological, and reflexive-evaluative components were identified.

The development of these components can be organized through mechanisms of diagnostics, individual design, practical integration, collaboration and mentoring, reflexive-correctional activities, and organizational support. These mechanisms were integrated into a continuous cycle from diagnostics to an updated development trajectory.

In practice, it is recommended to tailor the content of professional development to the individual needs of educators, work with real lesson plans, utilize peer feedback, and track progress through an evidence-based portfolio.

The proposed model can serve as a foundation for designing methodological programs. Conclusions regarding its effectiveness, however, should be based on the results of empirical research.

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