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FORMING GENERAL PEDAGOGICAL ICT COMPETENCE OF FUTURE TEACHERS BASED ON THE SYSTEM-ACTIVITY APPROACH

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Abstract: The rapid digitalization of education has changed the requirements for the professional preparation of future teachers. Possession of separate technical skills is no longer sufficient: a prospective teacher needs to understand why, when, and how information and communication technologies (ICT) should be integrated into pedagogical activity. This article examines the formation of general pedagogical ICT competence of future teachers through the system-activity approach. The purpose of the study is to substantiate a pedagogical model in which ICT competence is developed as an integrated result of knowledge, practical activity, reflection, communication, and professional self-development. The study uses theoretical analysis, synthesis, comparison, modelling, and interpretation of international frameworks and pedagogical literature. The analytical results indicate that ICT competence is most productive when it is embedded in authentic professional tasks rather than taught as an isolated computer-skills course. The proposed model includes motivational-value, cognitive, operational-activity, communicative, and reflective components and organizes their development through a cycle of goal setting, planning, action, feedback, reflection, and correction.

Keywords: future teachers; ICT competence; general pedagogical competence; system-activity approach; digital education; teacher education; digital pedagogy; professional development; ICT integration.

INTRODUCTION

Digital transformation has become one of the central factors influencing contemporary teacher education. Digital platforms, learning management systems, multimedia resources, online communication, open educational resources, artificial intelligence, and data-informed assessment have expanded the teacher's professional toolkit. At the same time, the availability of technologies does not automatically improve teaching. The educational value of a digital tool depends on the teacher's ability to connect technological possibilities with pedagogical goals, learners' needs, curriculum content, assessment procedures, and ethical requirements. UNESCO's ICT Competency Framework for Teachers emphasizes that teachers require a structured set of competencies for integrating ICT into professional practice and describes development across policy, curriculum and assessment, pedagogy, digital skills, organization, and professional learning.

This creates a methodological problem for teacher education: how can a university move future teachers from knowing individual digital tools to being able to use technology purposefully in complex pedagogical situations? A narrow skills-based model tends to produce fragmented knowledge. A student may know how to create a presentation, search for information, use a video editor, or operate an online platform, yet still be unable to design a meaningful technology-enhanced lesson. Therefore, ICT competence should be considered not simply as a collection of technical operations, but as an integrated professional capacity expressed in activity.

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The system-activity approach is particularly relevant to this problem because it treats competence as a result of purposeful activity and the interaction of interconnected components. From this perspective, the future teacher is not a passive recipient of digital instructions but an active subject who identifies a pedagogical problem, sets a goal, selects appropriate tools, performs an educational action, evaluates the result, reflects on the process, and adjusts subsequent activity. Such a cycle makes technological knowledge functional and professionally meaningful.

The purpose of this article is to theoretically substantiate a system-activity model for forming general pedagogical ICT competence among future teachers and to identify the pedagogical conditions, structural components, stages, and assessment indicator.

The concept of ICT competence has developed from the earlier idea of computer literacy toward a broader understanding of digital professional competence. Contemporary frameworks emphasize that effective technology use requires pedagogical judgement, critical evaluation of information, collaboration, safe and ethical behaviour, and continuous professional learning. UNESCO ICT CFT Version 3 identifies six broad areas of teacher competence and three developmental levels: knowledge acquisition, knowledge deepening, and knowledge creation. This progression is important because it shows that competence is not achieved when a teacher can operate a tool; the higher level is characterized by the ability to redesign learning and create innovative solutions with technology.

A systematic review of teacher digital competence in higher education likewise indicates that the field does not have one universally accepted definition, but recurrent dimensions include pedagogical-didactic integration and professional development. The review describes digital competence as the capacity to integrate ICT into professional practice using pedagogical, critical, and safe criteria. This interpretation corresponds closely to the needs of future teachers because their competence must be demonstrated in real educational tasks rather than through technical tests alone.

The system-activity approach provides a methodological bridge between competence and professional action. A system is characterized by elements, relationships, structure, functions, and development. Activity, in turn, is organized around a subject, object, motive, goal, means, actions, operations, and result. Applied to teacher education, these categories allow ICT competence to be analysed as a dynamic system. The student-teacher becomes the subject; a pedagogical problem becomes the object; improving learning becomes the professional motive; an instructional outcome becomes the goal; digital and non-digital resources become means; lesson design, communication, assessment, and reflection become actions; and learner achievement together with professional reflection becomes the result.

On this basis, general pedagogical ICT competence can be defined as an integrated capacity of a future teacher to select, combine, create, evaluate, and ethically apply digital technologies in accordance with pedagogical objectives, learners' characteristics, curriculum requirements, and professional responsibilities. The definition intentionally includes both technological and pedagogical dimensions. If technology is considered separately from pedagogy, competence becomes instrumental. If pedagogy is considered without technological literacy, the teacher cannot exploit the possibilities of contemporary educational environments.

The proposed structure contains five interconnected components. The motivational-value component includes the future teacher's awareness of the professional value of ICT, willingness to experiment, responsibility, and ethical orientation. The cognitive component includes knowledge of

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digital tools, educational platforms, information resources, instructional design principles, data protection, copyright, and digital safety. The operational-activity component reflects the ability to perform professional tasks with ICT: prepare learning materials, organize interaction, differentiate instruction, assess learning, and create digital resources. The communicative component concerns collaboration with learners, colleagues, parents, and professional communities through appropriate digital channels. The reflective component includes self-assessment, analysis of learning evidence, recognition of errors, and planning of further development.

These components should not be taught as isolated units. Their relationships are central. For example, knowledge of an online assessment tool becomes competence only when a student can determine the assessment purpose, construct appropriate items, administer the assessment, interpret the results, protect learner data, and use evidence to improve instruction. This is precisely where the system-activity logic becomes useful.

METHODS

The study employed a theoretical and modelling-oriented methodology. The research design was based on analysis and synthesis of scientific and methodological literature concerning teacher ICT competence, digital pedagogy, competence-based education, and system-activity learning. International teacher technology frameworks were examined to identify recurring dimensions of competence and their implications for teacher preparation. In particular, the UNESCO ICT Competency Framework for Teachers was used as a reference point because it explicitly connects technology with pedagogy, curriculum, assessment, organization, and professional learning.

The following methods were used. First, theoretical analysis was applied to clarify the meaning and structural components of general pedagogical ICT competence. Second, comparison was used to identify common features across digital competence frameworks and teacher-education literature. Third, synthesis was used to combine technological, pedagogical, communicative, and reflective dimensions into an integrated structure. Fourth, pedagogical modelling was used to construct a system-activity model for competence formation. Fifth, criteria-based interpretation was used to formulate observable indicators that can be used in future empirical assessment.

The object of the proposed model is the professional preparation of future teachers in higher education. The subject is the pedagogical process of forming their general ICT competence through purposeful educational activity. The model assumes that competence develops through repeated cycles of professionally meaningful tasks. A task is considered meaningful when it requires the student to make a pedagogical decision rather than merely follow a technical instruction.

The main modelling principle is alignment between learning outcomes, activity, technology, and assessment. A digital tool is selected only after the pedagogical objective is defined. For example, if the objective is collaborative problem solving, a collaborative workspace may be appropriate; if the objective is formative assessment, an interactive assessment environment may be selected; if the objective is development of information literacy, students may be asked to compare, verify, and cite digital sources. Thus, the technology is subordinated to the educational purpose rather than becoming the purpose itself.

For practical implementation, competence can be assessed through a portfolio of professional digital tasks. Such a portfolio may include a technology-enhanced lesson plan, a digital learning resource, an online formative assessment, an inclusive learning activity, a collaborative project, a short

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reflection on technology choice, and evidence of information and copyright checks. Rubrics can assess the pedagogical relevance of technology, technical execution, accessibility, communication, information literacy, ethical practice, and reflective improvement.

A four-level diagnostic scale can be used without reducing competence to a single numerical score. At the initial level, the student performs basic operations with substantial guidance and tends to select technology because it is available or attractive. At the functional level, the student independently uses familiar tools for clearly defined instructional purposes. At the integrative level, the student combines several tools with pedagogical strategies, differentiates learning, evaluates evidence, and adapts technology to context. At the transformative level, the student designs innovative learning environments, creates or adapts digital resources, supports peers, and critically evaluates the educational consequences of technology.

Importantly, these levels are developmental descriptors rather than rigid labels. The same student may demonstrate different levels across different tasks. Assessment should therefore be continuous and based on multiple sources of evidence, including performance, products, observation, peer feedback, learner feedback where appropriate, and self-reflection.

RESULTS

The principal result of the theoretical modelling was the development of a system-activity model for forming future teachers' general pedagogical ICT competence. The model consists of five interconnected blocks: target, content, activity-process, assessment, and result. The target block defines the expected professional capacity. The content block organizes technological and pedagogical knowledge. The activity-process block provides authentic tasks and interaction. The assessment block supplies formative feedback and criteria. The result block describes observable changes in the student's professional digital activity.

The first result concerns the logic of competence formation. The analysis indicates that technology should enter teacher preparation through professional problems rather than through a catalogue of applications. A problem-based sequence may begin with a question such as: How can the learning activity be made more accessible to learners with different needs? Students then identify requirements, investigate possible tools, compare alternatives, design a solution, test it, receive feedback, and revise the product. This sequence activates knowledge, skills, communication, and reflection simultaneously.

The second result is a staged system-activity cycle. Stage 1 is orientation and motivation. Students analyse the professional significance of ICT and identify a real or simulated teaching problem. Stage 2 is goal setting and planning. They formulate learning outcomes and define success criteria before choosing technologies. Stage 3 is information and tool selection. Students compare digital resources according to pedagogical fit, accessibility, reliability, privacy, and ethical requirements. Stage 4 is implementation. Students create or conduct a technology-enhanced learning activity. Stage 5 is evaluation and feedback. Evidence of learner activity and achievement is examined. Stage 6 is reflection and correction. Students identify what worked, what failed, why it happened, and what should be changed.

The third result is a set of pedagogical conditions. First, ICT integration should be systematic across the curriculum rather than concentrated in one separate course. Second, teacher educators should model the same digital-pedagogical practices expected from students. Third, students need

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access to authentic tasks and opportunities for repeated practice. Fourth, assessment should value pedagogical decision-making, not only technical accuracy. Fifth, reflective activities should be incorporated after each substantial digital task. Sixth, digital ethics, accessibility, data protection, copyright, and information verification should be treated as integral elements of competence.

The fourth result is a criteria-and-indicator matrix. The motivational-value criterion can be observed through initiative, responsibility, and willingness to use ICT purposefully. The cognitive criterion is indicated by accurate explanation of technologies, pedagogical concepts, information sources, and ethical requirements. The operational criterion is demonstrated by the quality of digital resource creation, platform use, assessment design, and lesson implementation. The communicative criterion is visible in effective online collaboration and professional digital communication. The reflective criterion is demonstrated through evidence-based self-evaluation and improvement of digital products.

The model also clarifies the role of artificial intelligence. AI tools may support planning, generation of draft materials, differentiation, feedback, and idea development, but their use should remain subject to teacher judgement. Future teachers should verify AI-generated information, identify limitations and bias, protect personal data, and maintain responsibility for the final educational decision. This is consistent with the broader direction of contemporary ICT competence frameworks, which address emerging technologies, including AI, alongside inclusive and ethical principles.

DISCUSSION

The results of the conceptual modelling support a shift from a technology-centred interpretation of ICT competence to a pedagogically integrated interpretation. This distinction is important because digital transformation can create a superficial impression of innovation. Replacing a printed worksheet with a digital worksheet, or a board with a presentation, does not necessarily change the quality of learning. The relevant question is whether technology enables a pedagogical function that could not be achieved, or could be achieved less effectively, through the previous design.

The system-activity approach addresses this problem by requiring every technology choice to be connected to motive, goal, action, result, and reflection. It also helps prevent another common weakness: teaching applications without professional transfer. A student may complete a tutorial on a particular platform but fail to use it appropriately in an unfamiliar classroom context. Authentic pedagogical tasks reduce this gap because students must transfer knowledge to situations that contain constraints and competing requirements.

The proposed model is also compatible with the developmental logic of the UNESCO ICT CFT. The framework distinguishes knowledge acquisition, knowledge deepening, and knowledge creation, while organizing competence around curriculum, assessment, pedagogy, digital skills, organization, and professional learning. The system-activity model operationalizes this progression at the level of student activity: first learning the possibilities and limitations of tools, then using them to solve pedagogical problems, and finally designing new solutions and reflecting on their consequences.

Another important issue is the relationship between digital competence and professional identity. Future teachers need to see themselves not merely as users of educational software but as designers of learning environments. This identity develops when students are trusted with meaningful responsibility: they design resources, make decisions, test solutions, explain their choices, respond to

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feedback, and revise their work. Therefore, teacher educators should reduce purely reproductive assignments and increase design, inquiry, collaboration, and reflection.

The communicative dimension deserves special attention. Digital teaching is not only about content delivery; it involves interaction. Teachers communicate through learning management systems, messaging platforms, video conferences, collaborative documents, digital feedback, and professional networks. Competence therefore includes choosing appropriate communication channels, maintaining professional boundaries, ensuring accessibility, and protecting learners' information. Teacher-technology competence frameworks similarly emphasize online teaching, differentiated instruction, assessment technologies, professional networking, responsible use, and leadership.

Assessment is perhaps the most difficult element of implementation. A simple test of terminology cannot adequately measure ICT competence. A student can define blended learning correctly and still design a poor blended lesson. Performance assessment is therefore more suitable. Rubrics should examine alignment between learning outcomes and technology, quality of digital content, learner activity, accessibility, assessment, ethics, and reflection. Portfolio evidence can show development over time and makes the assessment process more transparent.

There are also limitations. The present article is primarily theoretical and modelling-oriented; it does not claim to report results from a completed controlled experiment. Consequently, the proposed criteria, stages, and model require empirical validation with future teachers in real university settings. Subsequent research should compare baseline and post-intervention competence, examine differences across disciplines, test the reliability of assessment rubrics, and investigate which types of authentic tasks produce the strongest transfer from university learning to school practice.

A further research direction is the integration of AI literacy into general pedagogical ICT competence. AI changes the teacher's work not only by introducing new tools but also by creating new questions about authorship, verification, privacy, bias, assessment, and the division of responsibility between human and machine. Teacher education should therefore prepare students to use AI critically and transparently rather than simply teaching them how to generate content.

PRACTICAL IMPLEMENTATION MODEL

For implementation in teacher education, the proposed model can be embedded across one academic semester or distributed across several pedagogical and methodological courses. The starting point should be a diagnostic task in which students independently design a short learning activity using ICT. The task should reveal not only technical ability but also whether the student can identify a pedagogical objective, select an appropriate tool, organize learner activity, assess learning, and reflect on the result.

After diagnosis, the teacher educator can organize a sequence of progressively complex tasks. In the first cycle, students analyse examples of technology-enhanced lessons and identify the relationship between objectives, activities, tools, and assessment. In the second cycle, they redesign an existing lesson using one digital tool and justify the choice. In the third cycle, they develop a learner-centred activity requiring collaboration, inquiry, or problem solving. In the fourth cycle, they create a digital assessment and analyse the evidence it produces. In the fifth cycle, they develop an inclusive or differentiated activity. In the final cycle, students complete a mini-project that integrates several competence dimensions and present a reflective defence of their decisions.

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A practical rubric may contain six dimensions: pedagogical alignment; technological appropriateness; quality of digital resource; learner engagement and inclusion; ethical and information literacy; and reflection. Each dimension can be described by observable indicators. For example, pedagogical alignment is demonstrated when the chosen technology directly supports the intended learning outcome. Technological appropriateness is demonstrated when the student considers usability, access, reliability, and context. Ethical competence is demonstrated through appropriate citation, copyright awareness, privacy protection, and responsible use of AI-generated content.

Teacher educators should also create a feedback-rich environment. One-way grading is insufficient because competence grows through iteration. A useful sequence is draft–peer review–teacher feedback–revision–reflection. Peer review is particularly valuable because students learn to articulate criteria and evaluate technology choices from another teacher's perspective. Digital portfolios can preserve evidence of these cycles and make professional growth visible.

The model can be adapted to different educational contexts. In primary teacher education, tasks may focus on visual literacy, interactive storytelling, digital games, differentiated instruction, and communication with parents. In language education, emphasis may be placed on multimedia input, collaborative writing, pronunciation tools, and online communication. In science education, simulations, data visualization, virtual laboratories, and inquiry platforms may become central. The general principle remains unchanged: technology is selected because it solves a pedagogical problem.

Institutional conditions also matter. UNESCO notes that successful ICT competence development requires adaptation to national and institutional goals, teacher education support, professional development, and appropriate infrastructure. Therefore, responsibility cannot be placed entirely on individual students or teachers. Universities should provide access to digital platforms, stable connectivity, technical support, professional development, and clear policies for ethical technology use.

The implementation model can be summarized as follows: diagnose current competence; define professional outcomes; create authentic pedagogical problems; require purposeful technology selection; organize action and collaboration; collect evidence; provide feedback; require reflection; and repeat the cycle at increasing complexity. This makes competence formation continuous rather than episodic.

The practical significance of the model lies in its ability to connect theoretical preparation with professional performance. Instead of asking future teachers to remember lists of applications, it asks them to demonstrate that they can make sound pedagogical decisions in technology-rich environments. This is a more sustainable basis for teacher professionalism because digital tools will continue to change, whereas the capacity to analyse educational needs, select appropriate means, evaluate evidence, and reflect on practice remains transferable.

CONCLUSION

The formation of general pedagogical ICT competence of future teachers requires a methodological shift from isolated technical training toward integrated professional activity. The system-activity approach provides an appropriate basis for such a shift because it treats competence as a dynamic result of purposeful activity, interaction, feedback, and reflection. The proposed model integrates motivational-value, cognitive, operational-activity, communicative, and reflective

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components and organizes their development through successive cycles of orientation, goal setting, planning, implementation, evaluation, and correction.

The analysis demonstrates that effective ICT competence cannot be reduced to the ability to operate digital tools. It includes the capacity to connect technology with curriculum objectives, pedagogy, assessment, inclusion, communication, information literacy, ethics, and professional development. This interpretation corresponds to the international direction represented by the UNESCO ICT Competency Framework for Teachers, which places digital skills within a wider structure of pedagogical practice and professional learning.

The practical implication is that teacher education programmes should embed ICT-related tasks across pedagogical disciplines, use authentic professional problems, assess performance through portfolios and rubrics, and create repeated opportunities for reflection and revision. Digital ethics, privacy, accessibility, copyright, source verification, and responsible AI use should be treated as integral elements rather than supplementary topics.

At the same time, the model should not be considered empirically validated merely because it is theoretically coherent. Its effectiveness must be tested through systematic research with future teachers. Future studies may employ diagnostic and final assessments, experimental or quasi-experimental designs, portfolio analysis, observation, interviews, and expert evaluation. Such studies can determine whether the proposed stages improve the transfer of ICT knowledge into authentic pedagogical practice and which pedagogical conditions have the greatest effect.

In conclusion, the system-activity approach makes it possible to conceptualize the future teacher as an active designer of digitally enriched learning rather than a passive consumer of technology. The central educational outcome is not the number of applications a student can use, but the quality of professional decisions made with and through technology. Consequently, the development of general pedagogical ICT competence should be understood as a continuous process of purposeful action, critical evaluation, professional communication, and reflective improvement.

REFERENCES

1. Foulger, T. S., Graziano, K. J., Schmidt-Crawford, D., & Slykhuis, D. A. (2017). Teacher educator technology competencies. Journal of Technology and Teacher Education, 25(4), 413–448.
2. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.
3. Redecker, C. (2017). European Framework for the Digital Competence of Educators: DigCompEdu. Publications Office of the European Union.
4. UNESCO. (2018). UNESCO ICT Competency Framework for Teachers (Version 3). Paris: UNESCO.
5. UNESCO Institute for Information Technologies in Education. (2011). UNESCO ICT Competency Framework for Teachers. Moscow: UNESCO IITE.
6. Cabero-Almenara, J., Romero-Tena, R., & Palacios-Rodríguez, A. (2022). Standards of teacher digital competence in higher education: A systematic literature review. Sustainability, 14(21), 13983.
7. European Commission. (2022). Digital Education Action Plan 2021–2027: Resetting education and training for the digital age. European Commission.
8. ISTE. (2017). ISTE Standards for Educators. International Society for Technology in Education.