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THEORETICAL AND METHODOLOGICAL FOUNDATIONS OF DEVELOPING PRE-SERVICE TEACHERS' DIGITAL COMPETENCE

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Abstract. The article examines the theoretical and methodological foundations of developing pre-service teachers' digital competence. The concept of "digital competence" is analysed on the basis of international frameworks (DigComp, DigCompEdu, UNESCO ICT CFT), the TPACK model, and doctoral dissertations by scholars from Uzbekistan and the CIS. Systems, competence-based, activity-based, student-centred, and integrative approaches are substantiated as methodological foundations. The study proposes a four-component structure of pre-service teachers' digital competence (motivational-value, cognitive, activity-technological, and reflective-evaluative), the pedagogical conditions for its development, a four-block methodological model with implementation stages, and assessment criteria and levels.

Keywords: digital competence, pre-service teacher, DigCompEdu, TPACK, competence-based approach, pedagogical conditions, methodological model, digital learning environment.

INTRODUCTION. The ongoing digital transformation across all spheres of social life poses new requirements for the education system. Today's educators are expected not only to utilize digital tools, but also to address complex professional challenges, such as creating digital educational resources, developing students' digital literacy, managing instructional processes in an online environment, and cultivating a culture of digital safety. Therefore, an educator's digital competence has become one of the primary indicators of the quality of contemporary teacher training.

In the Republic of Uzbekistan, this issue has been elevated to the level of state policy. In the "Digital Uzbekistan – 2030" Strategy, the digitalization of education and improving the digital skills of pedagogical personnel are designated as priority areas [1]. Furthermore, the Concept for the Development of the Higher Education System until 2030 sets objectives to widely introduce digital technologies and distance learning formats into the educational process, aligning the content of personnel training with international standards [2].

At the international level, several framework documents defining educators' digital competence have been developed: the European Framework for the Digital Competence of Educators (DigCompEdu) [3], the Digital Competence Framework for Citizens DigComp 2.2 [4], and the UNESCO ICT Competency Framework for Teachers [5]. However, these frameworks are primarily targeted at in-service teachers, and the theoretical and methodological foundations for systematically developing pre-service teachers' digital competence tailored to national educational conditions in pedagogical higher education institutions (HEIs) have not been sufficiently elaborated.

The aim of this study is to identify the theoretical and methodological foundations of developing pre-service teachers' digital competence, and to devise its structure, pedagogical conditions, and methodological model.

LITERATURE REVIEW. The issue of teacher digital competence has been examined within various conceptual approaches in foreign scholarship. The TPACK (Technological Pedagogical

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Content Knowledge) model proposed by P. Mishra and M. Koehler interprets teacher knowledge as an integration of technological, pedagogical, and content knowledge, demonstrating that teaching technology in isolation from instructional content and methodology is ineffective [6]. R. Krumsvik conceptualizes teacher digital competence as a multi-layered phenomenon encompassing basic ICT skills, didactic ICT competence, learning strategies, and "digital Bildung" (digital culture), substantiating the significance of situated (practice-based) learning in its formation [7].

G.Falloon emphasizes the necessity of transitioning from "digital literacy" to "digital competence", delineating personal-ethical and professional dimensions within the Teacher Digital Competency (TDC) framework; according to Falloon, digital citizenship, safety, and ethical responsibility are just as vital as technical skills in preparing pre-service teachers [8]. E.Instefjord and E.Munthe examined the integration of professional digital competence into curricula within the Norwegian teacher education system, pointing out that it frequently remains confined to isolated subjects and highlighting the decisive role of pedagogical practicum and teacher-educator role modeling [9]. A systematic review by M.Spante et al. confirmed that "digital competence" and "digital literacy" are defined diversely in the scientific literature, thereby reinforcing the need to establish a unified conceptual framework [10].

Doctoral dissertations by Russian scholars hold an important place in establishing the theoretical foundation for educational informatization. I.V.Robert developed the theoretical foundations for the design and application of educational informatization tools, systematizing the requirements for teachers' information activities [11]. In his doctoral dissertation, V.V.Grinshkun substantiated integrative approaches to developing educational informatization tools and illuminated methodological aspects of preparing educators to utilize such tools [12].

Research by Uzbek scholars provides a crucial foundation for incorporating the national context. U.Sh.Begimkulov, in his doctoral dissertation, developed the theory and practice of organizing and managing the informatization of pedagogical education processes, establishing an organizational and methodological system for preparing prospective teachers to employ information and communication technologies [13]. N.A.Muslimov investigated the theoretical and methodological foundations of professional development for vocational education teachers, uncovering the structure of professional competence and regularities of its gradual formation [14]. N.I.Taylokov's doctoral dissertation formulated the scientific and methodological foundations of teaching computer science within the continuous education system [15]. Moreover, studies by A.A.Abdukodirov and A.Kh.Pardaev on the theory and practice of distance education are of significant value for organizing instruction in digital learning environments [16].

General pedagogical interpretations of the competence concept have been thoroughly expounded in the works of I.A.Zimnyaya and A.V.Khutorskoy: I.A.Zimnyaya views key competencies as a new paradigm of educational outcomes [17], whereas A.V.Khutorskoy distinguishes between competence (social requirement, standard) and competency (personal quality, achieved outcome) [18]. J.From describes "pedagogical digital competence" as a unity of values, knowledge, and skills [19]. A systematic review by J.Tondeur et al. shows a bidirectional relationship between teachers' pedagogical beliefs and their technology use practices [20]. J.Cabero-Almenara et al. compared existing teacher digital competence frameworks using expert evaluations and rated the DigCompEdu framework highest [21].

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This review demonstrates that while the essence of digital competence has been broadly investigated, a comprehensive methodological system ensuring its step-by-step development among pre-service teachers within pedagogical higher education, alongside its pedagogical conditions and assessment criteria tailored to national curricula, remains insufficiently developed. This contradiction defines the core research problem.

RESEARCH METHODOLOGY. The study employed methods of theoretical analysis (review of philosophical, psychological-pedagogical, and methodological literature, normative-legal acts, and doctoral dissertations), comparative analysis (comparing DigComp 2.2, DigCompEdu, UNESCO ICT CFT, and TPACK frameworks), systematization and generalization, as well as pedagogical modeling. Systems, competence-based, activity-based, student-centred, and integrative approaches were adopted as the methodological foundation.

ANALYSIS AND RESULTS

1. The Essence of the Concept of "Digital Competence"

In the DigComp 2.2 framework, digital competence is characterized through 21 competencies across 5 competence areas: information and data literacy; communication and collaboration; digital content creation; safety; and problem solving [4]. The DigCompEdu framework details 22 educator-specific competencies organized into 6 areas (professional engagement, digital resources, teaching and learning, assessment, empowering learners, facilitating learners' digital competence) and delineates six proficiency stages from A1 to C2 [3]. The UNESCO ICT CFT framework examines six aspects of teacher practice across knowledge acquisition, knowledge deepening, and knowledge creation levels [5].

Synthesizing these frameworks and definitions from literature [7, 8, 17–19], we propose the following working definition: pre-service teachers' digital competence is an integrative personal-professional quality encompassing motivation, knowledge, skills, experience, and reflection, which manifests in their readiness to apply digital technologies purposefully, safely, and ethically in professional-pedagogical activities, create and evaluate digital learning resources, foster students' digital literacy, and continuously improve their own digital expertise.

2. Methodological Approaches

The systems approach requires designing the digital competence development process as a holistic pedagogical system in which goals, content, forms, methods, tools, and outcomes are interlinked [13].

The competence-based approach enables formulating educational outcomes in terms of observable and measurable competencies harmonized with international frameworks [17, 18].

The activity-based approach substantiates that digital competence is formed exclusively through the execution of authentic professional tasks — designing lessons, developing digital resources, and organizing online assessment [7, 14].

The student-centred approach involves determining individual developmental pathways by taking into account differences in students' initial digital proficiency, interests, and learning trajectories [20].

The integrative approach, in alignment with the TPACK model, demands teaching digital technologies in close connection with subject-matter teaching methodologies, meaning that digital

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competence should be developed across the entire curriculum rather than within an isolated course [6, 9, 12].

3. Structure of Digital Competence

Based on the literature review [3, 7, 8, 14, 19], a four-component structure of pre-service teachers' digital competence was developed (Table 1).

Table 1. Structure of Pre-Service Teachers' Digital Competence

Component	Content / Essence	Key Indicators
Motivational-value	Internal need to utilize digital technologies in professional activities; values of digital ethics and responsibility.	Interest in digital innovations; adherence to digital ethics and copyright; aspiration for continuous self-development.
Cognitive	System of knowledge regarding digital technologies, digital didactics, information security, and regulatory requirements.	Knowledge of digital tool capabilities; TPACK-based knowledge; understanding data privacy and protection regulations.
Activity-technological	Skills to select and create digital educational resources, organize instruction in online/blended formats, and conduct assessment.	Creating digital content; managing courses within LMS; utilizing digital assessment tools; fostering students' digital literacy.
Reflective-evaluative	Ability to analyze one's own digital performance, evaluate its efficiency, and implement continuous enhancement.	Maintaining a digital portfolio; self-assessing proficiency against standard frameworks; sharing experiences in professional communities.

4. Pedagogical Conditions

The effective development of digital competence is ensured through the realization of the following pedagogical conditions:

- Embedding digital competence development objectives across general professional disciplines, specialized subject methodologies, and pedagogical practicum on an interdisciplinary integration basis [9, 13];
- Creating an enriched digital educational environment (LMS, cloud services, digital repositories) combining blended and distance learning modalities [16];
- Organizing learning through professionally oriented project assignments and real-world cases (digital lesson designs, interactive resources, online assessments) [7, 14];
- Educators themselves serving as role models of digital competence and undergoing continuous professional development [9, 20];

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- Conducting diagnostics based on criteria aligned with the DigCompEdu framework and organizing reflective assessment via e-portfolios [3, 21].

5. Methodological Model and Implementation Stages

Based on the aforementioned approaches and conditions, a four-block methodological model was constructed. The target-methodological block encompasses the social demand (state programs [1, 2]), international frameworks [3–5], and methodological approaches. The content block delineates curricular modules aligned with competence components (fundamentals of digital literacy, digital didactics, digital content creation, digital assessment, digital security and ethics). The organizational-technological block covers learning modalities (blended learning, flipped classroom, project-based learning), pedagogical methods, and digital instruments. The outcome-evaluative block comprises assessment criteria, levels, diagnostic tools, and expected learning outcomes. The implementation stages of the model are presented in Table 2.

Table 2. Stages of Developing Digital Competence

Stage	Year / Course	Primary Objectives	Forms of Activity
Adaptive-motivational	Year I	Ensuring baseline digital literacy, shaping professional motivation and attitudes.	Baseline entry diagnostics, hands-on workshops with digital tools.
Knowledge-operational	Year II	Acquiring knowledge of digital didactics and TPACK; developing digital tool selection skills.	Case analysis, mini-projects, specialized online training modules.
Project-practical	Year III	Designing subject-specific digital educational resources and multimedia lesson plans.	Project-based learning, flipped classroom sessions, microteaching.
Reflective-creative	Year IV	Applying digital competence during school practicum; digital portfolio and self-evaluation.	Teaching practicum, e-portfolio defense, comprehensive exit diagnostics.

6. Assessment Criteria and Proficiency Levels

To evaluate the level of digital competence development, four criteria corresponding to each component were identified: motivational (interest in digital activity and value-oriented attitude), cognitive (breadth, depth, and systematicity of knowledge), operational (autonomy and quality in executing digital pedagogical tasks), and reflective (ability to analyze and refine one's professional practice). In accordance with DigCompEdu levels [3], four proficiency stages are designated: Elementary (A1–A2; operates digital tools based on given models), Basic (B1; independently selects digital tools for professional tasks), Advanced (B2; customizes and evaluates digital solutions according to instructional goals), and Creative (C1–C2; creates novel digital learning resources, establishes methodological innovations, and disseminates expertise). A comprehensive assessment

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methodology integrating objective testing, practical performance tasks, expert reviews of project outputs, self-assessment questionnaires, and e-portfolio evaluation is recommended.

DISCUSSION

The proposed framework preserves the core principles of international frameworks [3–5] while adapting them to the four-year undergraduate teacher education curriculum. Singling out motivational-value and reflective components aligns with the theoretical views of J. From [19] and G. Falloon [8], preventing the reduction of digital competence to a mere collection of technical proficiencies. The distribution of stages across academic years is congruent with the staged professional development principles substantiated by N. A. Muslimov [14], while the integrative approach relies on conclusions drawn by U. Sh. Begimkulov [13] as well as E. Instefjord and E. Munthe [9]. To validate the model's empirical efficacy, conducting pedagogical experiment trials and analyzing outcomes using mathematical-statistical methods is anticipated in the subsequent phase of research.

CONCLUSION AND RECOMMENDATIONS

1. Pre-service teachers' digital competence is an integrative personal-professional attribute uniting motivation, knowledge, skills, practical experience, and reflection; its conceptualization is most effective when anchored in DigComp, DigCompEdu, UNESCO ICT CFT frameworks, and the TPACK model.

2. The methodological foundation for fostering digital competence comprises a harmonized synthesis of systems, competence-based, activity-based, student-centred, and integrative approaches.

3. Digital competence encompasses motivational-value, cognitive, activity-technological, and reflective-evaluative components, with concrete measurable indicators defined for each dimension.

4. The developed four-block methodological model and four-stage implementation pathway (adaptive-motivational, knowledge-operational, project-practical, and reflective-creative) facilitate the interdisciplinary integration of digital competence across pedagogical university curricula.

5. It is recommended that pedagogical HEIs formulate a national framework for teacher digital competence grounded in DigCompEdu, establish professional development programs in digital pedagogy for teacher educators, and integrate students' digital portfolios into state graduation and certification procedures.

REFERENCES

1. Decree of the President of the Republic of Uzbekistan No. UP-6079 dated October 5, 2020 "On Approval of the Strategy 'Digital Uzbekistan – 2030' and Measures for Its Effective Implementation". – Available at: www.lex.uz.
2. Decree of the President of the Republic of Uzbekistan No. UP-5847 dated October 8, 2019 "On Approval of the Concept for the Development of the Higher Education System of the Republic of Uzbekistan until 2030". – Available at: www.lex.uz.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

3. Redecker, C. (2017). European Framework for the Digital Competence of Educators: DigCompEdu (Y. Punie, Ed.). Luxembourg: Publications Office of the European Union. – 95 p. – DOI: 10.2760/159770.
4. Vuorikari, R., Kluzer, S., & Punie, Y. (2022). DigComp 2.2: The Digital Competence Framework for Citizens – With new examples of knowledge, skills and attitudes. Luxembourg: Publications Office of the European Union. – (JRC128415).
5. UNESCO. (2018). UNESCO ICT Competency Framework for Teachers. Version 3. Paris: UNESCO. – 68 p.
6. Mishra, P., & Koehler, M. J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108(6), 1017–1054.
7. Krumsvik, R. J. (2008). Situated learning and teachers' digital competence. Education and Information Technologies, 13(4), 279–290. – DOI: 10.1007/s10639-008-9069-5.
8. Falloon, G. (2020). From digital literacy to digital competence: the teacher digital competency (TDC) framework. Educational Technology Research and Development, 68, 2449–2472. – DOI: 10.1007/s11423-020-09767-4.
9. Instefjord, E. J., & Munthe, E. (2017). Educating digitally competent teachers: A study of integration of professional digital competence in teacher education. Teaching and Teacher Education, 67, 37–45.
10. Spante, M., Hashemi, S. S., Lundin, M., & Algers, A. (2018). Digital competence and digital literacy in higher education research: Systematic review of concept use. Cogent Education, 5(1), Article 1519143. – DOI: 10.1080/2331186X.2018.1519143.
11. Robert, I. V. (1994). Theoretical foundations for the creation and use of tools for the informatization of education [Teoreticheskie osnovy sozdaniya i ispolzovaniya sredstv informatizatsii obrazovaniya]. Doctoral dissertation in Pedagogical Sciences. Moscow.
12. Grinshkun, V. V. (2004). Development of integrative approaches to the creation of tools for educational informatization [Razvitie integrativnykh podkhodov k sozdaniyu sredstv informatizatsii obrazovaniya]. Doctoral dissertation in Pedagogical Sciences. Moscow.
13. Begimkulov, U. Sh. (2007). Theory and practice of organization and management of informatization of pedagogical education processes [Pedagogik ta'lim jarayonlarini axborotlashtirishni tashkil etish va boshqarish nazariyasi va amaliyoti]. Doctoral dissertation in Pedagogical Sciences. Tashkent.
14. Muslimov, N. A. (2007). Theoretical and methodological foundations of professional formation of vocational education teachers [Kasb ta'limi o'qituvchisini kasbiy shakllantirishning nazariy-metodik asoslari]. Doctoral dissertation in Pedagogical Sciences. Tashkent.
15. Taylokov, N. I. (2006). Scientific and methodological foundations of teaching informatics in the continuous education system [Uzluksiz ta'lim tizimida informatika fanini o'qitishning ilmiy-metodik asoslari]. Doctoral dissertation in Pedagogical Sciences. Tashkent.
16. Abdukodirov, A. A., & Pardaev, A. Kh. (2009). Theory and practice of distance learning [Masofali o'qitish nazariyasi va amaliyoti]. Tashkent: Fan.

HSR (LONDON),
HOUGHTON STREET REVIEW JOURNAL
ISSN: 2058-5519|Impact factor-15.9
http://houghtonstreetreview.com/index.php/hsr

17. Zimnyaya, I. A. (2003). Key competencies – a new paradigm of educational results [Klyuchevye kompetentsii – novaya paradigma rezultata obrazovaniya]. Vysshee Obrazovanie Segodnya, (5), 34–42.
18. Khutorskoy, A. V. (2003). Key competencies as a component of the personality-oriented paradigm of education [Klyuchevye kompetentsii kak komponent lichnostno-orientirovannoy paradigmy obrazovaniya]. Narodnoe Obrazovanie, (2), 58–64.
19. From, J. (2017). Pedagogical digital competence – between values, knowledge and skills. Higher Education Studies, 7(2), 43–50.
20. Tondeur, J., van Braak, J., Ertmer, P. A., & Ottenbreit-Leftwich, A. (2017). Understanding the relationship between teachers' pedagogical beliefs and technology use in education: a systematic review of qualitative evidence. Educational Technology Research and Development, 65(3), 555–575. – DOI: 10.1007/s11423-016-9481-2.
21. Cabero-Almenara, J., Romero-Tena, R., & Palacios-Rodríguez, A. (2020). Evaluation of teacher digital competence frameworks through expert judgement: the use of the expert competence coefficient. Journal of New Approaches in Educational Research, 9(2), 275–293. – DOI: 10.7821/naer.2020.7.578.