COMPETENCY MODEL OF PROFESSIONAL TRAINING OF TEACHERS OF MATHEMATICS SUBJECTS IN THE POSTGRADUATE PEDAGOGICAL EDUCATION SYSTEM OF UKRAINE

КОМПЕТЕНТНІСНА МОДЕЛЬ ПІДВИЩЕННЯ КВАЛІФІКАЦІЇ ВЧИТЕЛІВ ПРЕДМЕТІВ МАТЕМАТИЧНОЇ ГАЛУЗІ В СИСТЕМІ ПІСЛЯДИПЛОМНОЇ ПЕДАГОГІЧНОЇ ОСВІТИ УКРАЇНИ

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The article reveals the organization of professional development of teachers of mathematical subjects in the system of postgraduate pedagogical education of Ukraine. The issue of modeling the educational process in the system of advanced training of teachers on the basis of competency-based and andragogical approaches according to the programmes of advanced training of specialists is considered. Using the example of implementing an author's advanced training course for teachers of mathematical subjects «Professional Culture of a Mathematics Teacher», the features of building a competency-based model of teacher training are revealed, the structure and content of the curriculum are presented, the goal and objectives of teacher training are determined, and the forms and methods of interaction with course participants are described. The feasibility of modeling the educational process is substantiated, taking into account the provisions of current regulatory documents regulating the structure and content of teachers' professional competencies, as well as the results of modern scientific research in the field of pedagogy, in particular adult education and professional development of pedagogical personnel. It is characterized that the model of the educational process in postgraduate education has target, content, operational, methodological and effective components. It has been analyzed that the effectiveness of training in the context of teacher professional development is significantly influenced by adherence to the principles of educational design, namely ensuring the accessibility of educational content for all participants in the educational process, flexibility in choosing methods of perception, expression and assimilation of information, and the creation of a variable educational environment that takes into account different learning styles, levels of training and individual educational needs of specialists.

Key words: *mathematics teachers, teacher training, educational process, modeling, competency-based approach, adult education, postgraduate pedagogical education, Ukraine.*

Стаття присвячена організації професійного вдосконалення вчителів предметів математичної освітньої галузі в системі післядипломної педагогічної освіти України. Розглянуто питання моделювання освітнього процесу в системі підвищення кваліфікації вчителів на засадах компетентнісного й андрагогічного підходів за програмами курсового підвищення кваліфікації фахівців. На прикладі реалізації авторського курсу підвищення кваліфікації для вчителів предметів математичної галузі «Професійна культура вчителя математики» розкрито особливості побудови компетентнісної моделі навчання вчителів, подається структура та зміст навчальної програми, визначаються мета й завдання навчання вчителів, описуються форми та методи взаємодії зі слухачами курсів. Обґрунтовано доцільність моделювання освітнього процесу з урахуванням положень чинних нормативно-правових документів, що регламентують структуру та зміст професійних компетентностей вчителів, а також результатів сучасних наукових досліджень у галузі педагогіки, зокрема освіти дорослих і професійного розвитку педагогічних кадрів. Схарактеризовано, що модель освітнього процесу у післядипломній освіті має цільовий, змістовий, операційний, методичний та результативний складники. Проаналізовано, що на ефективність навчання в контексті підвищення кваліфікації вчителів суттєво впливає дотримання принципів освітнього дизайну – забезпечення доступності навчального контенту для всіх учасників освітнього процесу, гнучкість у виборі способів сприйняття, вираження і засвоєння інформації, створення варіативного освітнього середовища, яке враховує різні стилі навчання, рівень підготовки та індивідуальні освітні потреби фахівців.

Ключові слова: *вчителі математики, підвищення кваліфікації вчителів, освітній процес, моделювання, компетентнісний підхід, освіта дорослих, післядипломна педагогічна освіта, Україна.*

Formulation of the problem in a general form. The modern system of advanced training of teachers in postgraduate education is characterized by deep systemic reformation, the purpose of which is to improve the system of pedagogical education for the training of pedagogical workers and the formation and development of modern alternative models of continuous professional and personal development of specialists. In state documents, it is noted that the functioning of the new system of advanced training for teachers should be focused on «increasing and expanding the opportunities of teaching staff to improve their teaching skills and lifelong professional growth» [12].

Changes in the organization of advanced training of teachers in the postgraduate period, namely, the choice of content, forms and methods of teaching, are caused by the implementation of the state policy in the field of reforming basic secondary education «New Ukrainian School» (NUS), which is aimed at creating a modern school that educates creative, responsible, active and enterprising citizens [6]. Such

steps on the part of the state are intended to further promote European integration processes in the country's education and be aimed at ensuring the sustainable development of Ukrainian society.

The concept of the New Ukrainian School provides for competency-based learning, centered on the student's personality. The role of the teacher is to create a favorable educational environment that supports the formation of soft skills and readiness for lifelong learning. Fulfilling this role is possible only if the teacher is constantly growing professionally, that is improving pedagogical skills, digital competence and emotional intelligence, as well as organizational and communication skills. Such development becomes real under the condition of purposeful organization of teacher training based on a competency-based approach, which involves building an appropriate model of the educational process focused on the development of professional competencies of specialists.

It should be noted that the educational process in institutions of postgraduate pedagogical education, where teachers' advanced training is carried out, has its own characteristics, determined by the specifics of teaching adults with higher education and experience in their professional teaching. All this makes the issue of developing new technologies, teacher training methods, and finding new approaches to organizing the educational process in the system of teacher in-service training relevant.

Analysis of recent research and publications. Research into theoretical and practical aspects of organizing the educational process for teachers in the context of a competency-based approach is highlighted in scientific studies related to the development of the following teacher competencies: professional (A. Voievoda, V. Saiuk), methodological (V. Zabolotnyi), informatics (E. Smirnova-Trybulska), informational (P. Grabovskyi), research (L. Burchak, O. Norkina), mathematical (S. Rakov), and psychological and pedagogical (N. Lisova) competencies of teachers.

Thus, in the research of M. Byrk [2], the system of professional development of teachers in postgraduate education is defined as «a single complex of structural and functional components (forms, methods, means, conditions and content)», and he considers the professional development of teachers to be its system-forming factor [2, p. 136]. The structural model of the development of information competence of teachers in postgraduate education developed by P. Grabovskyi [4] contains such components as: target, diagnostic-motivational, content, procedural, evaluation-design, and effective. According to the scientist, the development of competence is carried out using modern information and communication tools [4].

In her scientific work, O. Norkina [8] notes that information and communication technologies are an important means of increasing the effectiveness of the development of research competence of mathematics teachers in postgraduate education. The researcher has developed an author's model of developing research competence of a modern teacher, which consists of the following blocks: target (goal, objectives, methodological approaches and principles), operational-technological (types of information and communication technologies and methods of their application), evaluative-resultative (criteria, indicators and levels of development of research competence of mathematics teachers) that require the implementation of a number of organizational and pedagogical conditions for effective implementation.

The problematic tasks of postgraduate education, which ensures the improvement of professional knowledge, skills, and abilities of specialists, in accordance with innovation processes, are presented in the study of O. Babkova [1]. The researcher believes that the improvement of the teacher's professional characteristics is determined by the leading provisions of the competence approach, on which the State Standard of Basic and Secondary Education is based (that is assessment of key, general educational and branch competencies of schoolchildren), as well as the need for constant updating of knowledge regarding modern international assessment standards and skills in organizing assessment procedures [1].

An important problem of modeling learning in the system of advanced training of teachers is revealed by researcher N. Bilyk [3], who considers the main strategic direction of development of the system of teachers' advanced training to be consistent integration into the European educational space, achieving a balance between the demand and supply of specialists in the labor market, constant work with scientific and pedagogical and pedagogical workers, and the introduction of new concepts and technologies, alongside with a significant improvement in the scientific and methodological support of the learning process [3, p. 3].

Having analyzed the studies devoted to improving the qualifications of teachers in postgraduate pedagogical education in Ukraine, we come to the conclusion that they have sufficiently thoroughly developed theoretical and practical principles of improving the qualifications of teachers (goals, content, organization, principles, forms and methods), there are also attempts to create models for the development of teachers' professional competence. Individual issues of the development of teachers' personal qualities have been investigated. The psychological and pedagogical principles of professional development and improving the qualifications of specialists have been considered.

Highlighting previously unresolved parts of the overall problem. In the context of the above material, there is a need to develop a competency-based model of teacher training that would meet

modern requirements for a teacher's professional activity. Such a model should be based on the provisions of current regulatory and legal documents that determine the structure and content of professional competencies of specialists and take into account the results of scientific research in the field of pedagogy, which reflect the latest approaches to adult education, continuous professional development, and educational design in the system of postgraduate pedagogical education.

The purpose of the article. The purpose of the study is to familiarize with the features of building a competency-based model of advanced training for teachers of mathematics subjects in postgraduate education in Ukraine, to highlight the experience of implementing an author's course aimed at developing a teacher's professional competence.

Presentation of the main research material. Modeling is a characteristic method of studying pedagogical processes, which in the scientific literature are considered as a «system of immeasurable complexity» [10]. At the same time, any modeling involves the use of abstraction and idealization and allows us to operate with objects about which we do not have complete knowledge. This is especially true for modeling complex pedagogical processes, the effect of which depends on a large number of interrelated factors of various origins.

The essence of the modeling method is the creation and study of a scientific model, which is understood as «a semantically presented and materially realized system that adequately reflects the subject of research (namely, it models the structures of the educational process or the management of this process, etc.)» [11, p. 35]. To substantiate the competency model of teacher professional development in postgraduate education, we will use the prognostic type of model for optimal resource allocation and specification of the goals of the educational process.

The construction of the model requires taking into account the fact that training at advanced training courses should be considered through the prism of the andragogical approach, since it is an educational activity focused on adult learners. Adult students, as a rule, have different levels of awareness of their own professional needs and already have some practical experience. Therefore, there is a need to satisfy the personal requests of experienced and qualified specialists regarding their implementation of pedagogical activities. Therefore, let us turn to the basic concepts of the study («competence», «professional and general competencies of a teacher», «competences of teachers of mathematics subjects», etc.), taking into consideration the peculiarities of implementing educational activities in postgraduate pedagogical education and adult education.

By personality competence we mean «a dynamic combination of knowledge, abilities, skills, ways of thinking, views, values, and other personal qualities that determine a person's ability to successfully socialize, conduct professional and/or further educational activities» [9]. At the level of Ukrainian legislation, professional competencies are defined as «a set of knowledge, skills and abilities, as well as professionally significant personal qualities that ensure the ability to perform at a certain level labor functions defined by the professional standard» [9].

Of direct importance for building a competency model are the provisions laid down in the professional standard, which serve as the basis for the formation and development of professional qualifications of specialists, in particular, the document contains requirements for the competencies of pedagogical workers approved in accordance with the established procedure [9]. According to current legislation, the use of a competency-based approach for the professional development of Ukrainian teachers involves the development of a whole complex of teacher competencies, namely: general (civic, social, cultural, leadership, entrepreneurial) and professional (linguistic-communicative, subject-methodical, informational and digital, psychological, emotional and ethical, pedagogical partnership, inclusive, health-preserving, design, prognostic, organizational, evaluative and analytical, innovative, reflective competencies, as well as the ability to learn throughout life) competencies [7].

The purpose of the proposed model is to improve the process of advanced training of teachers of mathematical subjects in the system of postgraduate pedagogical education in accordance with the current requirements of the development of Ukrainian society, defined by the current Professional Standard [7]. The implementation of this model involves ensuring continuous professional development of teachers, focusing on a competency-based approach, as well as taking into account modern challenges caused by the reform of school education, alongside with the introduction of innovative technologies, and the need to improve professional and cross-disciplinary competencies in accordance with European guidelines for the quality of education.

The model contains the following components: target, content, operational, methodological and effective. The target component includes the goal and objectives of training. The content component is determined by the content and types of exercises aimed at developing teachers' competence, the ratio of their types in different topics of training. The operational component combines forms (face-to-face, distance, mixed) and methods (practical, problem-based teaching, research, partial-search, problem-based), which are proposed to be used in the educational process of improving teachers' qualifications, as well as forms and types of student activities, and types of tools that are presented in information and communication support. Since the result must correspond to

the set goal, the effective component is directly consistent with the target and contains a description of the achieved results in the development of teacher competences.

An example of the implementation of such a model in practice is training under the course programme for advanced training of teachers of mathematical subjects «Professional Culture of a Mathematics Teacher» (course duration: 30 hours (1 ECTAS credit), form of study: full-time / full-time-distance / distance / mixed), organized on the basis of the Chernihiv Regional Institute of Postgraduate Pedagogical Education named after K.D. Ushinskyi [5]. Training under this program is as competency-based as possible and focused on the requests and needs of education seekers. The goal of the program is to develop general and professional competencies, deepen pedagogical and methodological knowledge, as well as knowledge of the subject, the history of mathematics as a component of the teacher's general culture, alongside with familiarization with new teaching methods and their practical application in the educational process.

The content of this curriculum includes such important topics as: «Development of the teacher's professional culture in the context of the requirements of the pedagogy of success» (2 hours), «Development of the general cultural competence of a mathematics teacher» (2 hours), «Modern approaches to the content and methodology of developing the logical-mathematical competence of a teacher» (4 hours), «Algorithmic competence of a mathematics teacher: algorithmic knowledge, algorithmic thinking, algorithmic culture» (4 hours), «Information and digital competence of a mathematics teacher» (4 hours), «Geometric component of mathematical competence of a mathematics teacher» (4 hours), «Methodological competence of a mathematics teacher» (4 hours), «International mathematical competitions and educational measurements TIMSS, PISA» (2 hours).

The expected learning outcomes of this program include deepening the professional, pedagogical, mathematical, informational, general culture and erudition of pedagogical workers, which is achieved through the development of general (GC.01, GC.02) and professional (A2.1, A2.4, A3.2, D3.1, D3.2, E1.2, E1.3, E2.1, E3.1) competencies of the teacher and provides training for specialists to implement the provisions of the concept of the New Ukrainian School. In the practical aspect, there is an appeal to the best examples of teacher training experience aimed at meeting the needs of Ukrainian society in the professional training of high-level specialists who will have innovative thinking and motivation for self-improvement and lifelong self-learning.

Thus, subject-methodological competence (A2.1 – modeling of learning content according to mandatory results) is developed in Topic 3 (4 hours) «Modern approaches to the content and methods of developing logical-mathematical competence». The topic includes the following issues: the teacher's logical competence as the level of mastery of the deductive method of proving and disproving statements (concepts, statements, axioms, theorems and their proofs, counterexamples to theorems, etc.), finding a logical error, using mathematical and logical symbols. The practical part is the formation of students' logical competence on the example of studying the following topics: 3.1 «Planimetry – Properties of the simplest geometric shapes», 3.2 «Steriometry – Lines and planes in space».

Improving subject-methodological competence (A2.4 – the ability to acquire and develop current and effective methods and technologies in order to train and develop students' abilities) occurs during the development of Topic 6 – "Methodological competence of a mathematics teacher" (4 hours). It is intended to develop the teacher's ability to evaluate the appropriateness of choosing mathematical methods, analyze the effectiveness of their use for solving competency-based problems, and the ability to reflect on their own experience on these issues. The workshop includes an analysis of the following topics: topic 6.1 – "Elements of combinatorics, the beginnings of probability theory and elements of statistics"; topic 6.2 – "Two-person games: Finding a strategy for success".

The development of information and digital competence (topic A3.2 – the ability to effectively use existing and create (if necessary) new electronic (digital) resources) occurs, for example, when working on the questions «Mathematical statistics at mathematics lessons: how artificial intelligence helps analyze the data (ChatGPT, Excel with AI functions, Google Sheets, Canva)», «Geometric transformations using the Cabri Express program».

Innovative, in our opinion, is the experience of using training methods during the study by students of the topic «Development of general cultural competence of a mathematics teacher» (2 hours) in the following areas: general cultural competence as an indicator of the general and pedagogical culture of a mathematics teacher, general-cultural potential of the history of mathematics; conducting a questionnaire survey of teachers to identify the teacher's ability to self-development as well as testing «Intellectual characteristics» according to Kettler and performing exercises of «Science of deduction», «Identifying correspondence» and «Achievements of great mathematicians».

Organizational competence (D2) is an important component of a teacher's professional competence. The development of this personal characteristic of specialists (D2.1 – the ability to organize the process of learning, upbringing and development of education recipients, D2.2 – the ability to organize various types and forms of educational and cognitive activity

of education seekers) is integrated with the improvement of another equally important competence for teachers of mathematical subjects, algorithmic. The program provides for the study of Topic 3. «Algorithmic competence of a mathematics teacher: algorithmic knowledge, algorithmic thinking, and algorithmic culture» (4 hours) and is considered in the context of illuminating such issues as: algorithmic competence of a mathematics teacher as the ability to solve typical mathematical problems, the practical use of algorithms for solving typical problems, systematization of typical problems; finding criteria for reducing problems to typical ones and using various information sources to find procedures for solving typical problems (textbook, reference book, Internet resources). Practical sessions include the following: topic 3.1 – Using algorithms for typical tasks on the topic: «Equations, inequalities and their systems», topic 3.2 – The importance of building algorithms for tasks on the topic «Functions».

The teacher's evaluative and analytical competence (D3.1 – the ability to assess the learning outcomes of education seekers, D3.2 – the ability to analyze the learning outcomes of education recipients, D3.3 – the ability to form the capacity of education seekers to self-assess and peer-assess learning outcomes) is developed on the materials of topic 8 «International mathematical competitions and educational measurements» (4 hours), which includes the following questions: 8.1: International studies TIMSS, PISA. Features of implementation. Statistical data. 8.2: Specificity of mathematical problems in test notebooks. 8.3: Analysis of the level of complexity and compliance with the mathematics programmes of Ukrainian schools.

The ability to learn throughout life, namely: to carry out professional development and receive support from colleagues (E1.1) develops during the consideration of all the topics, including ones in the final discussion session, where feedback is maintained with the students and an exchange of views between colleagues is carried out. During the class, students provide answers to the questions of the initial questionnaire: «During the educational process, I found out/understood/learned…»; «I was most interested in…»; «I had the greatest difficulties with…»; «What changes have occurred in me (in my knowledge of mathematics/computer science/in my ability to receive new information/in my reflective skills)?»: «I wish I…». The survey is carried out with the aim of providing self-assessment by students on the knowledge gained during their studies and reflection on their activities on the courses. The teachers' workload is taken into account, so it is completed at a convenient time using Google Forms (https://forms.gle/vcyT-8JADY9BfmMu6A).

So, we have developed and are implementing a competency-based model of advanced training for mathematics teachers in the system of postgraduate pedagogical education in Ukraine, which is realized through training students according to the author's course programme «Professional Culture of a Mathematics Teacher». In practice, we ensure the integration of the development of general and professional competencies with subject-specific competencies – mathematical, algorithmic, logical-mathematical, methodological, and research, which are crucial for specialists in this educational field. The content of the course is practice-oriented, its relevance and applied nature are confirmed by the adaptation of the educational content to the real professional needs of teachers. The course programme includes various active forms of work: workshops on solving competency-based tasks, analysis of pedagogical situations, case methods, mini-projects, and interactive trainings.

Conclusions. The proposed competency-based model of advanced training for mathematics teachers in postgraduate pedagogical education in Ukraine is focused on the systematic development of general and professional competencies, which meets the modern needs of teachers' personal growth and the demands of Ukrainian society. The effectiveness of the developed methodology is confirmed by the successful experience of its approbation at the Chernihiv Regional Institute of Postgraduate Pedagogical Education named after K.D. Ushinskyi, which gives grounds to recommend it for wider implementation in the educational process of postgraduate pedagogical education institutions in the country.

Promising areas of further research in this context are improving the content of teacher training programmes on the basis of competence and andragogical approaches, implementing effective methods for forming general and professional competencies, optimally combining innovative and traditional teaching technologies, as well as adapting modern didactic approaches, digital tools, and practice-oriented forms of learning. It is advisable to place special emphasis on workshops aimed at forming professional motivation and developing subject-methodical skills of teachers, which is a key prerequisite for achieving high learning outcomes and ensuring high-quality teaching of mathematics in secondary education institutions.

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