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A METHODOLOGY FOR DEVELOPING CREATIVE COMPETENCE IN FUTURE MATHEMATICS TEACHERS BASED ON RESEARCH-ORIENTED EDUCATION

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https://doi.org/10.5281/zenodo.22816220

Abstract. This thesis discusses the issue of developing creative competence of future mathematics teachers based on research-oriented education. In modern educational conditions, a mathematics teacher is required not only to have solid subject knowledge, but also to have the competences to independently analyze problem situations, develop non-standard solutions, interpret mathematical ideas in various ways, and organize students' research activities. From this perspective, research-oriented education is considered an effective means of developing future teachers' research activity, critical and creative thinking, innovative approaches to solving mathematical problems, and professional independence. The thesis analyzes the pedagogical possibilities of forming creative competence, methodological aspects of using research tasks and problem situations, and justifies the importance of integrating them into the process of training mathematics teachers.

Keywords: research-oriented education, future mathematics teacher, creative competence, creative thinking, research activity, mathematical problem, problem-based learning, non-standard problems, professional competence, methodological training.

In the modern education system, the process of training a future mathematics teacher is not limited to the acquisition of mathematical knowledge alone. Today's teacher is required to independently identify a problem, analyze mathematical situations from different perspectives, develop several solutions to a problem, put forward new ideas, justify them, and direct students to independent research. Therefore, the development of creative competence in future mathematics teachers is becoming one of the urgent tasks of pedagogical higher education.

The OECD considers creative thinking as the ability to effectively participate in thinking processes that lead to the creation, evaluation, and improvement of effective and original ideas [1]. This approach allows us to interpret creativity not only as an innate ability, but also as a competency that can be developed through education and practical exercises. In mathematics education, creativity is manifested not only in solving a problem using a standard algorithm, but also in searching for alternative solutions, identifying mathematical patterns, putting forward hypotheses, creating mathematical models, and critically evaluating the results obtained.

The relevance of this issue for the Uzbek education system is also clearly reflected in the results of PISA 2022. According to OECD data, the average score of students in Uzbekistan in creative thinking was 14 points on a 60-point scale, while the average score for OECD countries was 33 points. Only 16 percent of students in Uzbekistan achieved at least level 3 in creative thinking, while the average score for OECD countries was 78 percent. The share of Uzbek students who achieved the highest level — 5–6 — was 2 percent [2]. These indicators, along with the development of students' creative thinking skills, also reinforce the need to train mathematics teachers with creative and research competencies who can organize such activities.

Inquiry-Based Learning (IBL) is one of the promising methodological directions for implementing this task. In this approach, the student is not a passive recipient of ready-made knowledge, but participates as an active researcher who identifies the problem, poses questions,

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develops hypotheses, collects information, selects mathematical methods, checks solutions, and justifies his conclusions.

The main feature of inquiry-based mathematical education is that the process of studying the problem is given greater importance than the answer to it. In a traditional task, the student often determines a single answer based on the given conditions and a certain algorithm. In a research task, the problem may have several solutions, the student himself may determine additional conditions, find a mathematical regularity, or prove the existing solution in another way. Such activity creates an opportunity to develop flexibility, originality, and independence of thinking.

From this point of view, it is advisable to organize the methodology for developing the creative competence of future mathematics teachers on the basis of several interconnected stages. The first - at the problem-motivational stage, the student is not given a ready-made solution, but is presented with a mathematical situation that arouses cognitive interest. For example, questions such as "in how many different ways can this problem be solved?", "how can we change the condition of the problem to create a new mathematical problem?" or "is this law applicable in all cases?" activate the student's research motivation.

The second - at the stage of research and hypothesis formation, students analyze the problem, compare existing data and make assumptions about possible solutions. In this process, the teacher's task is not to provide a ready-made answer, but to lead the student to independent research through guiding questions.

The third - the stage of ensuring the multivariateness of solutions is of particular importance in the development of creative competence. Students try to solve one mathematical problem using algebraic, geometric, graphical, analytical or numerical methods. Comparing different solutions to a problem develops flexibility of thinking in students and provides the opportunity to go beyond the standard algorithm.

The fourth is problem posing, that is, the stage of independent formulation of mathematical problems. A study published in the Mathematics Education Research Journal in 2025 found that before a special workshop organized for future mathematics teachers, most of them did not use problem-posing activities in their lesson plans and the level of research independence given to students was low. After the workshop, all participants revised their lesson plans and included problem-posing elements in them [3]. This result shows that teaching problem posing is promising in developing the competence of future teachers in designing research-oriented lessons.

Therefore, in mathematics classes in higher education, it is advisable to regularly give students tasks such as not only solving existing problems, but also changing their conditions, creating new questions, developing more complex or simpler versions of the problem, and formulating mathematical problems from real situations.

Another effective tool for developing creative competence is mathematical modeling. In the modeling process, the student translates the real-life situation into mathematical language, identifies variables and relationships between them, creates a model, obtains mathematical results, and interprets them in terms of a real situation. A study published in 2025 examined the creativity of 141 prospective mathematics teachers from two types of teacher training institutions in China in mathematical modeling. The study showed that the levels of creativity in different modeling tasks differ and that special pedagogical strategies are needed to develop and assess the creative competence of prospective teachers [4].

Open-ended mathematical tasks also play an important role in inquiry-based education. Unlike traditional closed tasks, open-ended tasks may not have a single solution or a single correct path. For example, a task such as “construct different geometric shapes with the same perimeter and compare their areas” encourages the student not only to use formulas, but also to create different options,

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compare them, and identify general patterns. In this case, mathematical knowledge becomes a tool for creative research.

The importance of such an approach is also visible in the OECD PISA 2022 creative thinking system. In assessing creative thinking, PISA pays special attention to students' ability to generate different ideas, develop original ideas, and evaluate and improve existing ideas [1]. Therefore, the creative competence of a future mathematics teacher should be developed not only through “finding original answers”, but also through the ability to create several options, evaluate them based on evidence, and improve the initial solution.

The use of design thinking elements in the development of creative competence is also promising. A study published in the journal Learning and Instruction in 2025 examined the design thinking approach in developing the creativity of future teachers in designing interactive lessons in mathematics. The results showed that the experimental group achieved higher performance than the control group, and design thinking developed future teachers' ability to create interactive lesson plans and solution-oriented thinking [5].

Based on this information, a methodological model based on the sequence “problem — research question — hypothesis — mathematical research — alternative solutions — justification of the result — reflection” can be used to develop the creative competence of future mathematics teachers. In this model, the student does not simply master the educational material, but also experiences how mathematical knowledge is formed through practical activities.

The content of the teacher’s activity also changes. Rather than being the main source of information, he becomes an organizer and facilitator of the research process. The teacher creates a problem situation, encourages students to ask questions, helps determine the direction of research, organizes mathematical discussions between groups, and creates conditions for reflexive evaluation of the results.

Collaborative research is also effective for developing creative competence. In the process of studying a mathematical problem in small groups, students defend their hypotheses, analyze the solutions of others, identify errors, and jointly develop new strategies. Such mathematical discourse develops not only the student's individual thinking, but also the ability to reconstruct their solution using other ideas.

The assessment system should also be consistent with the content of the research-oriented methodology. It also focuses on the connection between creativity and accuracy. In OECD countries, approximately 60–70% of students reported that their teachers valued their creativity, encouraged them to give original answers, and allowed them to express their ideas. Students who reported such pedagogical experiences showed relatively higher results in creative thinking, even after taking into account other factors [6]. This suggests that the training of future mathematics teachers should also develop the competence to create a pedagogical environment that supports creative thinking.

It is also incorrect to contrast creativity with mathematical knowledge. According to the results of PISA 2022, approximately half of the students who showed the highest results in mathematics also fell into the highest quintile in creative thinking. At the same time, very few students who did not reach the basic level in mathematics achieved very high results in creative thinking [6]. Thus, creative competence does not replace subject knowledge; on the contrary, deep mathematical knowledge and creative research should complement each other.

Thus, the development of creative competence of future mathematics teachers on the basis of research-oriented education requires a systematic approach. It is advisable to integrate problem situations, open mathematical tasks, problem posing, mathematical modeling, project and research activities, collaborative research, design thinking, reflection and criterion-based assessment into its structure. Such methodologically organized education serves to form a future teacher not as a

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specialist who transfers ready-made knowledge, but as a creative educator who can see a mathematical problem, put forward new ideas, test them and direct future students to independent research.

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