

Organizing the Process of Educating Future Teachers in Mathematics at a University

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Abstract : The article deals with the organization of project-based training in the preparation of teachers of mathematics at the Orel State University named after I. S. Turgenev and the implementation of the project of a full life cycle entitled “We write the methodology together.” A method of organizing the process of training in a Master’s program in the direction of training No. 44.04.01 “Pedagogical education” with a focus on Mathematical education. Based on the experience of the Russian education system, in terms of the preparation of teachers for secondary schools, the principles of the basic educational program for preparing teachers of mathematics are formulated, the main stages of the project are presented, and their brief content and purpose are given.

1. Introduction

In the passport of the priority project “Universities as centers of the space for creating innovations” (approved by the Presidium of the Presidential Council for Strategic Development and Priority Projects / 10.25.16), the task was to develop a model for implementing project-oriented educational programs, including a pedagogical profile of complete life cycle projects. The program is one of the priority measures aimed at implementing the Concept for the Development of Mathematical Education in the Russian Federation. This Concept establishes the fact that “in the Russian Federation there are not enough teachers and lecturers of educational institutions of higher education who can qualitatively teach mathematics, taking into account, developing, and shaping the educational and vital interests of various groups of students”. It is important to develop a basic educational program for the training of teachers of mathematics, focusing on solving the problem of teacher training that has been posed by the state. A program that meets the modern requirements of the Federal State Educational Standards of Higher Education and a professional standard Teacher has been developed and is being tested at the Oryol State University named after I. S. Turgenev. Due to the implementation of this program, specialized training of bachelors and masters in the field of content and technology of mathematical education is carried out. The content of the educational program provides for the formation of readiness of future teachers of mathematics to the study of problems of mathematical education, modeling, and forecasting educational processes.

2. Methodology

In the pedagogical science, there were certain theoretical prerequisites for solving the problem of professional training of future university teachers. At present, the process of developing pedagogical abilities and pedagogical skills is considered (A. V. Mudrik, A. A. Sokhor, etc.). The basis for the formation of the teacher’s pedagogical orientation has been developed (A. A. Orlov, I. Ya. Fastovets, etc.), taking in account professionally important qualities (N. V. Kuzmina, M. N. Skatkin, etc.). The psychological foundations of the teachers’ activities are analyzed (L. S. Vygotsky, S. L. Rubinstein, etc.); the ways of formation of teachers’ personality are shown (N. M. Brytko, V. A. Slastenin, etc.). However, the potential of the methodological component of vocational training has not been fully considered.

The formation of professional competencies is one of the pressing problems of both pedagogy and methodology. The final solution of the problem posed is hardly possible, since the issue of scientific and

methodological development of the content of the mathematical training of future teachers is interconnected with the continuous development of society, changing social situations, thinking paradigms.

The multidimensionality of the problem posed is confirmed by the diversity of opinions, judgments, and conclusions. The problem of improving the methodological and mathematical training of future teachers of mathematics, the formation of professional competencies are addressed in the works by T. K. Avdeeva [3], Yu. A. Drobyshev [4], L. V. Zhuk [5], Yu. M. Kolyagin [6], V. I. Krupich [7], Z. A. Magomeddibirova [8], O. N. Orlyanskaya [10], S. A. Samsonov [12], and others.

So, T. K. Avdeeva outlined the method of preparing a teacher of mathematics, organically linking the teaching and upbringing, drawing on the example of the life and work of classical teachers. Yu. A. Drobyshev developed theoretical foundations and formulated conditions for implementing a multi-level historical and mathematical training of future teachers of mathematics. L. V. Zhuk identified the theoretical and methodological aspects of the application of computer modeling methods in the system of training future teachers of mathematics. In the methodological works by Yu. M. Kolyagin, various methods of studying leading mathematical concepts at school are presented, Russian and foreign experience is highlighted; a method of teaching mathematics on “problems” was developed, which formed the basis for the development of textbooks designed to prepare future teachers of mathematics in high school. V. I. Krupich outlined the theoretical foundations of teaching how to solve school math problems and defined the basic principles of methodical preparation of a teacher of mathematics. Z. A. Magomeddibirova identified and substantiated the conceptual approach and the construction on its basis of a methodological system for the implementation of continuity in teaching mathematics. O. N. Orlyanskaya’s technique has been developed for future teachers of mathematics to address a system of problems. S. A. Samsonova provided the scientific and methodological substantiation of ways to improve the effectiveness of professional training of mathematics teachers in a pedagogical university based on the use of stochastics.

Analysis of professional tasks that need to be addressed by a teacher, taking into account the demands of tomorrow, led us to the conclusion that it is necessary to make additions and changes to the organization of students’ methodological work, which is determined by the main educational program.

3. Study

The purpose of the paper is to search for means and methods of organizing the process of teaching future mathematics teachers at a university. On the basis of the Faculty of Physics and Mathematics of the Orel State University named after I. S. Turgenev, “... the study is conducted from 2017 to the present. The study consists in the development and testing of a mathematics teacher training program.”

In developing the structure, principles for constructing the main educational program for training teachers of mathematics, we relied on the experience of the Russian education system [1]. The following principles formed the basis for building the program: 1) strengthening the role of project-research activities while maintaining the leading role of fundamental education; 2) the possibility of using modular technology; 3) strengthening the role of practice in cognition; 4) the development of e-learning; 5) the development of network forms of cooperation; 6) high requirements for material and technical (including laboratory) support.

As a result of historical experience and analysis of the requirements of the Federal State Educational Standards of Higher Education, we came to the assumption that the most rational would be the implementation of a project-oriented educational program of the pedagogical profile, involving the team execution of a full life cycle project. The goal of the project “Writing Methods Together” is the development of a methodical system for teaching mathematics in the process of preparing a final qualifying work, demonstrating the level of professional training of mathematics teachers in accordance with the requirements of the federal state educational standard of higher education.

The central place in the program is occupied by the organization of students’ project activities, the preparation of full life cycle projects. As you know, every project from the emergence of an idea to its full completion goes through a series of successive stages of its development. The complete set of project development stages forms the project life cycle. The project life cycle consists of a complete set of consecutive phases. We are of the opinion that there should be four: the initial phase (concept), the

development phase, the implementation phase and the completion phase [11].

We have formulated the goal of the project, based on a clear conviction that the teacher's task is, from existing technologies and taking into account students' abilities, to choose what helps to acquire a specific ability to create one's own methodical teaching system. Such a system should be owned by every highly professional teacher, and each one should have their own.

A graduation qualification work of each individual student is an integral part of teamwork that meets the requirements of fundamentality, the depth of theoretical development of the problem, and relies on in-depth specialized knowledge and free choice of theories and methods in solving research problems. The choice of the topic of research work is carried out in the first month of study. Of course, undergraduate students have the opportunity to continue the problem they are studying at a higher scientific and methodological level, but it is possible to change the direction of research.

The full life cycle of a project consists of the implementation of four phases: 1) the initial phase involves the study of the experience of teachers, methodologists and mathematicians, special literature, and fellow students' experience; 2) the development phase is intended to identify the problem of the study, justify the relevance of the research, develop conceptual provisions, and prepare for its implementation. In the group of masters, as a rule, there are students of different ages. Among them are those who have just completed the undergraduate program, as well as teachers with work experience; therefore, it is necessary to use this feature – a group of different age groups – to share experiences, discuss methodological and mathematical research; 3) the phase of the project is to perform the basic work necessary to achieve the project goal. For example, the development of methods of teaching a specific topic is successfully carried out according to the technology proposed by the authors' collective Russian State Pedagogical University named after A. I. Herzen under the supervision of V. V. Orlov [9]. Using the analytical framework of a colleague, we consider the following sequence of work to be rational.

The main objective of the work: to reveal the methodological features of the organization of work on teaching the topic; to develop a comprehensive planning study of the topic and methods of work on the formation of the theoretical apparatus; and to learn how to build systems of tasks in the implementation of a differentiated approach to learning.

1. *Choosing a topic in mathematics.* A student together with a supervisor, taking into account the specificity of the category, chooses a specific topic of the course of mathematics.
2. *Determining the range of textbooks containing the study of the selected research topic.*
3. *Tutorials.* Indicating the teaching aids for students, educational and methodical literature for the teacher, designed to study the chosen topic.
4. *Conducting a logical-mathematical, logical-didactic analysis, a methodical analysis of the problem material of the chosen topic.*

A logical and mathematical analysis of the topic (theoretical content) suggests:

- setting learning objectives and main learning outcomes;
- knowledge of what objects and concepts are given as definitions, knowledge of definition formulations;
- knowledge of what mathematical propositions (statements), other than definitions, are in the subject; determining the type of these sentences (statements) – theorems, laws, rules, formulas; knowledge of how they are introduced (disclosed) in the textbook; knowledge of their content;
- knowledge of the functions of geometric and algebraic material in the textbook and features of using this material in this topic;
- an ability to solve the main (typical) tasks of the topic; knowledge of the decision methods used in the school; knowledge of recommendations for the design of solving problems posed by the school program.

A logical and didactic analysis is performed on the basis of logical and mathematical analysis and

includes:

- formulating basic learning tasks and selecting appropriate cognitive actions;
- selecting the main methods, means, and methods of teaching the topic;
- defining forms of control and assessment of the results of students' activities.

A methodical analysis of the problem material suggests:

- 1) A definition of the functions of the task material, which means selecting the following cycles of tasks:
 - on the actualization of knowledge, including the tasks of concurrent repetition;
 - on motivation;
 - to study the new material (with the allocation of tasks intended for introducing this new material; as well as tasks for developing the theory at the primary level);
 - to consolidate the studied theory, including tasks that require an integrated application of knowledge, i.e. performing the functions of the current repetition;
 - tasks of concurrent repetition (securing the previously studied material out of touch with the new material);
 - propaedeutic tasks (tasks that prepare for the perception of a new (next) topic).
- 2) Determining forms of students' activity in which a specific task material is implemented, which means the allocation of tasks:
 - Working out the actions to be formed in the classroom and done collectively (group forms, work in groups of steam-shift personnel, the whole class, etc.);
 - Practicing the actions to be formed in conditions of independent work in the classroom (and here you can talk about the independent work of a training, testing, control character) and at home.

The result of the three types of analysis mentioned above is the development of *a comprehensive methodological planning*, made in the form of a table, which indicates:

- subject, number of hours;
- subtheme (topic of paragraph, paragraph), the number of hours (lessons);
- for each lesson:
 - a) formulated goals;
 - b) theoretical material to be considered, as well as the repetition material, are recorded;
 - c) task materials are allocated for work in the classroom (collective and independent forms of work) and at home;
 - d) forms of control are determined;
 - e) it is planned to use the educational and methodological complex (TCO, visibility, tables, etc.).
- 5. *Preparation and testing in practice of the notes of the lessons of various types.* For example, a lesson is the study of a new material; a lesson is the consolidation of the material studied; lesson - control knowledge.
- 6. *Preparation of control and evaluation materials on the selected topic.*
- 7. *Preparation and testing in practice of summaries of extracurricular activities in mathematics using theoretical and practical information from the chosen topic.*

At all stages there is a discussion on the lessons of the scientific and methodical seminar of masters.

- 1) The completion phase corresponds to the defense of the final qualifying work, the definition of further possibilities for the implementation in practice of the methodological and mathematical results obtained.

Each undergraduate develops his own topic of the mathematics course, carries out approbation during the period of practice, but does this not only contacting the supervisor but makes his own conclusions, results, and achievements obtained for discussion in the group. At the same time, unilateral “reporting of results” also does not take place. The task assigned to students from the standpoint of their research studies is to provide an expert assessment of the teaching methods proposed by the undergraduate, the forms of control, the conclusions and proposals made on organizational and substantive methodological issues.

A prerequisite for a project is a special structure of the educational process. At the first stage, the fundamentals of fundamental mathematical disciplines are studied (projective geometry, functional analysis, functional ways of solving problems of elementary mathematics, non-Euclidean geometry, history and methodology of mathematics, etc.) along with psychological-pedagogical courses with a professional orientation. At the second stage, there is a cycle of methodological and mathematical disciplines, including the use of information and communication technologies. The completion phase corresponds to the protection of final qualifying work, the definition of further possibilities for the implementation in practice of the obtained methodological and mathematical results.

We recommend monitoring students’ knowledge on the basis of adaptive semantic models. The method of knowledge control is described in detail in the studies conducted by T. Sh. Shikhnabiyeva [2; 4].

4. Conclusion

As a result of the project “Writing Methods Together,” students develop systematized knowledge of all the main components of a methodological system of teaching mathematics; the ability to determine specific goals of studying mathematics according to the steps of learning, the themes of lessons; they can structure the content of the subject in accordance with student’ goals and cognitive abilities; develop the most rational methods and organizational forms of training aimed at achieving the goals set; skills in the use of training tools and the development of recommendations for their use in teachers’ practice.

In the period of the whole process of student’s learning, project methodological and mathematical activities are carried out, which are both individual and collective. In the process of vocational training, a future teacher should not only become a participant of the project being prepared for his training, but also he needs to learn how to carry out the process of organizing project activities. The project effectiveness is an assessment of the final product and reflection on students’ intermediate results. Reflection contributes to the conscious performance of activities and the development of such personal qualities as responsibility, perseverance, initiative, and interpersonal skills.

References

- [1] Gerasimova E.N., Shcherbatykh S.V., Savvina O.A., Simonovskaya G.A., Masina O.N., Trofimova E.I., Tarasova O.V. (2017). Coexistence of theory and practice in training the future mathematics teacher: the experience of the Russian education system. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(12), pp. 7695-7705.
- [2] Shikhnabiyeva, T., & Beshenkov, S. (2016). Intelligent system of training and control of knowledge, based on adaptive semantic models. In *Smart Education and e-Learning* (pp. 595-603). Berlin, Germany: Springer International Publishing.
- [3] Avdeeva, T. K. (2004). *The classics of teacher education in the system of vocational training of teachers of mathematics*. Orel, Russia: Trud.
- [4] Drobyshev, Yu. A. (2004). *Historical and mathematical aspect in the teacher’s methodical preparation*. Kaluga, Russia: KSPU named after K. E. Tsiolkovsky.
- [5] Zhuk, L. V. (2007). *Informatics and education*, 3, pp. 56-63.

- [6] Kolyagin, Yu. M. (1975). *Methods of teaching mathematics in high school. General method*. Moscow, USSR: Education.
- [7] Krupich, V. I. (1992). *Theoretical bases of teaching how to solve school math problems: author's abstract dis. ... doctor of pedagogical sciences: 13.00.02*. Moscow, Russia: Mosk. ped. state uni. named after V. I. Lenin.
- [8] Magomeddibirova, Z. A. (2003). *Methodical system for the implementation of continuity in teaching mathematics*. Moscow, Russia: MGOU.
- [9] Orlova, V.V. (Ed.) (2007). *Methods and technology of teaching mathematics. Laboratory workshop: a study guide for students of mat. faculties at ped. universities*. Moscow, Russia: Drofa.
- [10] Orlyanskaya, O. N. (2004). *The method of formation of the future teachers of mathematics ability to construct systems of problems. Thesis ... Cand. ped. sciences (p. 165)*. Volgograd, Russia.
- [11] (2010). *Guide to the body of knowledge on project management (p. 464)*. Moscow, Russia: Guide PMVOK.
- [12] Samsonova, S. A. (2005). *Methodical system of using information technology in teaching stochastics of university students: author's abstract dis. ... doctors of pedagogical sciences: 13.00.02 (p. 33)*. Moscow, Russia: Mosk. ped. state un-t.
- [13] Tarasova, O. V. (2017). Implementation of the educational program in the direction of training "44.04.01 Pedagogical education", the profile of mathematical education at the Faculty of Physics and Mathematics of the Orel State University named after I. S. Turgenev. In T. N. Mozharova (Ed.), *Modern problems of physical and mathematical sciences. Proceedings of the III International Scientific and Practical Conference, November 23-26, 2017* (p. 547-552). Orel, Russia: OGU.
- [14] Shikhnabiyeva, T. Sh. (2017). *Methodology of formalization and representation of knowledge in intelligent tutoring systems*. Moscow, Russia: Institute of Education Management of the Russian Academy of Education.