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Professional Deficiencies in Mathematics Teachers: An Analysis of Regional Research Results

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Abstract: Purpose: to describe the results of a regional study of subject and methodological skills of teachers of mathematics in the Krasnoyarsk Territory; highlight the professional difficulties of teachers in the subject area "Mathematics"; determine a list of corrective measures to eliminate the identified problems. Methods: theoretical (analysis of scientific literature on the problem of research, systematization and generalization of the results of scientific research) and empirical (ascertaining pedagogical experiment, analysis and interpretation of the results). Results: a program for diagnosing the subject and methodological skills of the professional activity of a mathematics teacher was developed. A diagnostic toolkit has been developed, which is based on the following principles: orientation to current educational results and modern require ments for the labor actions of a teacher, a system activity approach for determining deficiencies in the field of methods of teaching mathematics, the possibility of designing an individual trajectory of a teacher's professional development based on the results of diagnostics. The analysis of the research results and recommendations for eliminating the identified professional deficiencies are presented. Scientific novelty: developed and substantiated an approach to the formation of control and measuring materials for the diagnosis of professional deficiencies in mathematics teachers. Practical significance: the main results and conclusions of the article can be used to create a regional system for monitoring professional deficits of mathematics teachers, as well as

to develop modular training programs for teachers that provide personalized assistance to teachers in eliminating professional difficulties

Keywords: diagnostics of subject and methodological skills, advanced training of mathematics teachers, readiness to solve professional problems.

One of the priority tasks of modern Russian education, formulated at the federal level, is to improve the quality of general education and to become one of the 10 leading countries in the world by this indicator by 2024. Today many scientists and

Experts in the field of education quality agree that reaching a new qualitative level is impossible without improving the mechanisms for staffing the educational sector. The quality of education, including general education, largely depends on those who teach. This conclusion is also confirmed by an analysis of the educational practice of countries that are recognized leaders in the field of education.

Thus, in China, teachers are called the key to the success of students. The significant role of teaching staff in providing human resources for strategic government reforms is noted. Constantly improving the level of professionalism of teachers is a priority in the reforms of China's educational system. In the Finnish education system, responsibility for the educational results of students is also placed on the teacher, who is required to demonstrate a high level of pedagogical competence. The country has created conditions for continuous professional development, mastering by teachers the latest achievements in the field of the subject taught, as well as familiarization with modern research in the field of teaching methods. This is due to the need to overcome teachers' professional difficulties when solving new professional problems.

According to the international PISA study, Russian students have been demonstrating rather average results for a long time, which indicates systemic problems in Russian general education, among which shortcomings in staffing are not the least important. In the context of the new educational situation, the

questions have become particularly relevant: are Russian teachers ready for the new reality? Are they ready to ensure that students achieve relevant educational results? Do they have enough cognitive and technological resources to do this? The search for answers to the questions raised led to the need to diagnose the professional competence of teaching staff in modern Russian secondary schools in order to identify their professional difficulties. Recently, a number of studies have appeared devoted to assessing the readiness of teachers to implement labor functions in the modern educational situation. The authors note that currently a significant percentage of Russian school teachers have significant professional difficulties. This, in turn, requires the development of conditions for professional growth, mechanisms for targeted, personalized assistance to practicing teachers. The development of such mechanisms at the regional level is possible only if we understand the objective picture of the existing professional deficits of specific teachers. This circumstance served as the basis for conducting a study in a test format to identify professional deficiencies of mathematics teachers in the Tashkent region.

The purpose of the article is to describe the procedure for a pilot study of professional deficiencies of mathematics teachers in the Krasnoyarsk Territory, present diagnostic results and recommendations for eliminating the identified deficiencies.

In accordance with the goal, theoretical (analysis of scientific literature on the research problem, systematization and generalization of the results of scientific research) and empirical (ascertaining pedagogical experiment, analysis and interpretation of results) research methods were used.

The basis of the study was the teaching of the works of authors involved in the study of the professional competence of a secondary school teacher and the problems of the readiness of modern teachers to work in the new Russian school (S. M. Begeldieva [15], S. A. Pisareva, M. Yu. Puchkov, S. V. Rivkina, A. P. Tryapitsyna [16], G. A. Ragozina, E. S. Panskaya, I. V. Manzhosova [17], S. A. Uskova [18]). An analysis of the results presented in these works showed that most authors identify competencies in the subject area and in the field of

teaching methods as the main components of a teacher's professional competence. This allowed the subject of the study to determine the professional deficits of mathematics teachers in the field of the subject taught and methods of teaching mathematics.

Diagnosed skills in the subject area "Mathematics" were selected taking into account the existing problematic components of mathematical training of students in the region based on the results of the final state certification in the region over the past 3 years [19, 20]. A set of methodological skills was determined based on an analysis of the problems of real educational practice in the region, as well as the skills formulated in the Professional Teacher Standard.

Of some interest in the context of the study were also works devoted to the study of teachers' professional deficits [22-25]. A review of these publications allowed us to draw conclusions about the need to develop a tool for assessing professional deficits, allowing us to diagnose a teacher's ability to apply certain skills in solving specific professional problems, and not his level of formal theoretical training, awareness of how this should be.

248 mathematics teachers took part in the pilot study. When conducting diagnostics, the following were taken into account:

1) each teacher took part in the study only once;

2) the research participant had at least 1 year of experience teaching the subject "Mathematics";

3) the involvement of teachers in the study was carried out on a voluntary basis;

4) the confidentiality of the information received was ensured

The development of the content of control measurement materials (CMM), intended to identify professional deficiencies of mathematics teachers, was based on the following principles:

focus on current educational results and modern requirements for the teacher's work activities: the content of the tasks allows the teacher to demonstrate the ability to perform current tasks in the subject area (including tasks in mathematics, as well as tasks to demonstrate the existing level of

functional literacy) and the ability to design components of the educational process, aimed at achieving current educational results by students in the modern educational situation;

systemic activity approach for identifying deficits in the field of mathematics teaching methods: shifting the emphasis from identifying the teacher's awareness of how the educational process should be designed and organized in a modern school to determining his ability to systematically apply existing knowledge and skills in solving specific professional problems;

the possibility of designing an individual trajectory of a teacher's professional development based on diagnostic results: the developed content is aimed at helping the teacher understand his personal professional difficulties and allows him to develop recommendations for designing individual trajectories of professional development and develop regional "custom-made" professional development programs.

When developing the test format for diagnostic work, it was also taken into account that many teachers are very wary of various diagnostics. The situation worsened after the testing of unified federal assessment materials (EFOM) in 2018. In this connection, when compiling CMM tasks, the possibility of completing them without additional preparation in the allotted period of time (120 minutes) was taken into account. As a result, a diagnostic work was developed, which consisted of 16 tasks, divided into two modules: subject and methodological, differing in content and purpose.

The subject module included 10 subject-specific tasks requiring a short answer that must be written down as a number or a sequence of numbers. The format of the tasks was close to the content of the tasks for the final certification of secondary school graduates. The tasks included in the CMM allowed us to assess the level of development of the following skills in the subject area: perform calculations and transformations of algebraic expressions (PU 1); simulate real situations in the language of algebra; create expressions, equations and inequalities based on the conditions of the problem; explore the constructed models using algebra (PU 2); perform actions with geometric

shapes (PU 3); perform actions with functions (PU 4); use acquired knowledge and skills in practical activities and everyday life, build and explore simple mathematical models (PU 5); solve mathematical tasks of an increased level of complexity (PU 6). Completion of tasks in this module was checked automatically.

Examples of subject module tasks:

1) Find the meaning of the expression:

$$\sqrt{(6\sqrt{3}-11)^2}-6\sqrt{3}$$

2) The straight line passing through the origin touches the graph of the function y = f(x) at point C (–2; 7). Find the value of f'(–2).

The methodological module contained 4 tasks in a case format, the answer to which was expected in the form of a brief description of an opinion (judgment), and 2 tasks (cases), to which it was necessary to give a detailed, complete answer (explanation, description or justification, expression of a reasoned opinion). The tasks contained descriptions of educational situations typical for the region. Open assignments made it possible to avoid the teacher guessing the correct answers. The tasks of this part of the work tested the formation of methodological skills, indicating the ability to solve professional problems in the field of mathematics teaching methods: design a fragment of an educational lesson in accordance with the goals and objectives of training and the individual characteristics of students (MU 1); select and adjust the content, forms and methods of teaching, taking into account the educational results of students and their individual characteristics (MU 2); objectively evaluate the results of students' activities based on the proposed criteria, argue their position and analyze the reasons for the mistakes made (MU 3).

Tasks with a detailed answer (methodological module) were checked using the method of expert assessment. Specific criteria were used for each task (an example of criteria for a specific task is presented in Table 1).

An example of a methodological module task: When completing the task "Write down the sequence of your actions that must be performed to find the length of a country road if 4/9 of it is 36 km," a 5th grade student suggested the following option: 1) 36:4 = 9 (km) - one part; 2) 9×9=81 (km) – length of the road. Answer: 81 km

a) Determine which skill has been developed and which has not been developed in this student? The answer is about scurry

b) Offer another task focused on developing a skill that this student has not developed.

c) Without changing the subject component, change the wording of the proposed task, focusing on the student ionophone.

The level of development of each skill was determined by the success rate, which is calculated as the ratio of the points received by the respondent for completing tasks that determine a specific skill to the maximum possible score for these tasks, expressed as a percentage. A skill is considered developed if the success rate is more than 80%, partially developed - in the range from 60 to 80%, undeveloped - less than 60%. The results of the diagnostic work are presented in Figure 1.

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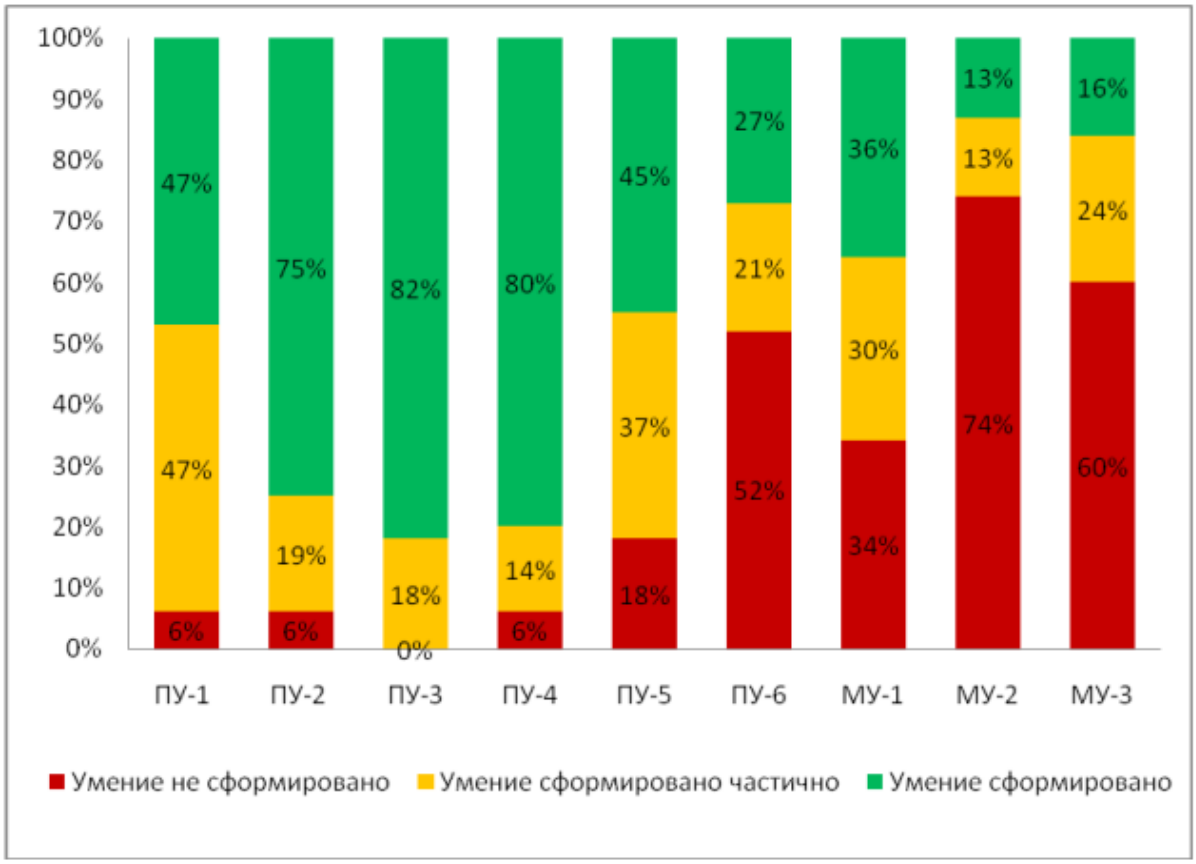

Figure 1 – Results of diagnostics of subject and methodological skills

The diagnostic results, in a sense, explain the regional results of the final certification of students - less than 50% of respondents demonstrated the ability to solve high-level tasks (prototype of task 13 of the Unified State Exam). In addition, with a fairly high percentage of solved subject tasks of a basic level of complexity, teachers demonstrated a certain pattern of thinking and the development of special skills in solving "Unified State Examination of similar tasks." Such skills have been developing in recent years among students and, as it turns out, among teachers. For example, when developing KIM, data was specially selected so that in some tasks the answer was expressed as an irrational number, while most teachers, seeing the familiar "Unified State Exam formulation", wrote down an integer in response. Which, again, to some extent explains the results of students in the region and indicates certain subject deficiencies. The diagnostics showed that, in general, the level of subject

training of the studied group of teachers does not fully correspond to modern educational demands, as evidenced by the teachers' difficulties in solving economic problems (recently included in the content of the Unified State Exam KIM in mathematics at the profile level), as well as PISA tasks.

The results of diagnosing professional deficits in the field of mathematics teaching methods turned out to be quite low: none of the diagnosed skills was developed in at least half of the teachers (Figure 1). In particular, the ability to select and adjust the content, forms and methods of teaching taking into account the educational results of students and their individual characteristics (MU 2) has not been developed in 74% of mathematics teachers. Most teachers, when performing the above diagnostic task, focused on the subject skills of the students, which they demonstrated when solving the problem. While this task implies the fact of manifestation of meta-subject skills (planning one's activities when solving educational problems), which was left unattended. Most of the answers were very short, incomplete, and there were no suggestions for adjusting assignments taking into account the individual characteristics of students. The main reasons for such low results in diagnosing the methodological skills of mathematics teachers include either the low degree of teachers' readiness to solve new professional problems, or the use of traditional approaches for this without adapting them to the conditions of the changed Russian school. Perhaps these results are also related to the sample of respondents, but they are also very indicative and make one think: teachers who have demonstrated this level are teaching children today.

Based on the diagnostic results, expert opinions were drawn up for each educational institution that took part in the study. The conclusion includes recommendations for designing individual professional development trajectories for each teacher and a recommended version of the personalized content of the professional development program.

The feedback received after the diagnosis from the participating teachers indicates its usefulness. Many teachers have changed their attitude towards such procedures for the better. The study participants expressed their readiness

for further cooperation; they noted that this should not be a one-time event, such diagnostics should be carried out systematically. There is a real need in the region to conduct constant monitoring of teachers' professional deficiencies; this stimulates reflection on professional activities and motivates teachers for professional development.

Conclusions

The conducted research allowed us to draw the following conclusions. The group of teachers under study experiences certain difficulties in solving new professional problems in the field of mathematics and methods of teaching mathematics, dictated by modern realities. The professional deficits of mathematics teachers identified during the pilot study can be divided into two groups: knowledge deficits and activity deficits. The first group includes deficits associated with a lack of cognitive resources: insufficient subject knowledge; misunderstanding and/or rejection of changes in the educational situation; lack of knowledge of modern professional terminology; insufficient knowledge of the features of design and organization of educational activities of students in modern realities. The second group consists of deficits caused by the presence of stereotypes regarding the activities of a general education school mathematics teacher; insufficient experience in implementing the requirements of new standards, applying existing subject and methodological knowledge in new conditions.

Correcting the current situation in the region will be facilitated by solving the following tasks: creating a regional system for monitoring professional deficits; creation of regional mechanisms for motivating professional development that will encourage teachers to eliminate professional deficits and to develop their own in the subject and methodological areas; development of modular programs for advanced training of teaching staff, providing personalized assistance to teachers in eliminating professional difficulties. The implementation of the identified tasks will ensure the improvement of staffing for mathematics education in the region, the professional growth of

mathematics teachers, which in turn will have a positive impact on the quality of students' mathematical training.

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