ABOUT PREPARATION OF PUPILS OF THE ARKHANGELSK REGION FOR OLYMPIADS AND COMPETITIONS IN MATHEMATICS

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Abstract. One of the tasks set by the state for the education system is to identify and develop younger generation talents and abilities. Traditionally, the main way to identify mathematically gifted students is through multi-stage Olympiads and competitions. The main among them is the all-Russian Olympiad for schoolchildren. It allows you to select the best of the best, as its participants go through a four-stage selection process.

One of the problems of such a system of talent identification is the low success rate in multi-stage Olympiads of students living in small towns and villages. They do not have specialists and opportunities to organize additional education for the preparation of Olympiads.

The purpose of the article is to present the experience of solving this problem in the Arkhangelsk region of the Russian Federation. The article describes the work of the regional intellectual school “Constellation”. The directions of its further development are determined based on the analysis of international experience.

Key Words: *olympiads and competitions in mathematics, model of training talented students in mathematics, preparing students.*

One of the main tasks of General education in the Russian Federation is to reveal and develop the abilities of each student, helping them to self-determination. This is enshrined in the Concept of a nationwide system for identifying and developing young talents [1].

Olympiads and competitions in mathematics are the means to identify the students' talents in this field.

Today, on average, about 70 Olympiads of various scales and levels are held in Russia every year [2]. The main one is the all-Russian school Olympiad (Vsosh) [3]. Today, more than six million students from various educational institutions take part in this Olympiad every year [4].

Participants of the all-Russian Olympiad must overcome four stages: school, municipal, regional and all-Russian (final). The distinctive feature of Vsosh is the consistent selection of participants of the next stage among the winners and prize-winners of the previous one. This imposes serious requirements on the participants' training both from a substantive and psychological point of view.

Students begin to participate in the all-Russian math Olympiad from the 4th grade. At the same time, only the school stage is currently held for 4-6 grades, and only the school and municipal stages are held for 7 and 8 grades. In the eighth grade, the role of the regional and final stages of the Vsosh is played by the Olympiad named after Leonhard Euler [5].

In 9-11grades, the format of the all-Russian Olympiad becomes complete – all four stages are present. The municipal stage takes place on a single day set in advance by local authorities. Five or six tasks of different degrees of complexity are proposed. Tasks are developed by municipal subject-methodical commissions, based on the content of educational programs of basic General and secondary General education at the advanced level and the corresponding orientation (profile). In their content, these tasks are not much different from the tasks present in school textbooks.

Example of tasks for the municipal stage of the Vsosh:

1) Two cyclists ride along the circular road of the velodrome at constant speeds. When they go in opposite directions, they meet every 10 seconds; when they go in the same direction, one overtakes the other every 170 seconds. What is the speed of each cyclist if the circular road is 170 meters long? (9th grade, 2016)

Solution: if the speed of the first rider is x, then in 10 seconds he passes 10x meters. The second, moving to it, goes from meeting to meeting the rest of the circle, that is 170-10x meters. If the speed of the second y, then it is 10u meters; thus, $170 – 10x = 10y$.

If cyclists ride one after the other, the first one passes 170x meters in 170 seconds, and the second one passes 170x meters. If the first moves faster than the second, then from one meeting to another passes one circle more than the second, that is, $170x - 170y = 170$. After simplifying these equations, we get: $x + y = 17$, $x-y = 1$, where $x = 9$, $Y = 8$ (meters per second).

2) The arithmetic mean of ten different natural numbers is 15. Find the largest possible amount of the largest of these numbers (10th grade, 2014)

Solution: the sum of these numbers is 150. As all numbers are different, the sum of the nine smallest ones is not less than 1 + 2 + ... + 9 = 45. Therefore, the largest number cannot be more than 105.

For example: (1 + 2 + ... + 9 + 105): 10 = 15.

There is enough solid knowledge of the program material to advance in the problem at these stages: properties of linear and quadratic functions; the basics of number theory; techniques and methods for solving equations and inequalities; theorems of planimetry and stereometry, the basics of mathematical analysis and combinatorics formulas.

The regional and final stages follow the same scheme: the first day and the second day. Tasks are developed by the Central subject-methodical commissions. Despite the fact that their proposed tasks are also based on the content of educational programs of basic General and secondary General education at an advanced level and the corresponding orientation (profile), their solution requires students to attract a sufficiently large number of original ideas and possess a sufficiently large Arsenal of heuristic techniques and methods.

Example of tasks for the regional stage of the Vsosh:

1) Let's call the distance between two squares of the checkered Board the smallest number of moves that a chess king can get from one of them to the other. Find the largest number of cells that can be marked on the Board 100x100 so that among them there are no two cells whose distance is 15 (11th grade, first day, 2019).
2) The two reduced square trinomials f(x) and q(x) are such that each of them has two roots, and the equations f(1) = q (2) and q (1) = f (2) hold. Find the sum of all four roots of these trinomials.(9th grade, first day, 2019)

On each of these days, five tasks are proposed (regional stage) or four tasks (final stage).

Practice shows that the participants of the regional and all-Russian stages are most often students who live in well-known cultural centers: Moscow, St. Petersburg, Novosibirsk, etc.

Students of small towns and villages who won the municipal stages do not get enough points to pass to the next stages. The fact is that they are trained by school teachers, many of whom have never taken part in Olympiads and do not have a sufficient level of mathematical and methodological training to prepare for Olympiads.

All of this more common for Arkhangelsk region, whose territory is 5 times larger than Bulgaria. To solve this problem, the Ministry of education and science of the Arkhangelsk region in December 2017 initiated the creation of the regional intellectual school "Constellation" (School) in which the winners and prize-winners of the school and municipal stages are trained using the Digital educational ring of the Arkhangelsk region. The project "Digital educational ring of the Arkhangelsk region" was implemented with the assistance of the Ministry of education and science of the Arkhangelsk region in order to improve the efficiency of communications using modern technical means and technologies.

This resource has made available high-quality training for Olympiads and competitions for students from the most remote corners of the Arkhangelsk region. Teaching at the remote intellectual school is conducted by trainers from the Northern (Arctic) Federal University named after M. V. Lomonosov, they also check students' work. Almost anyone can take part in the work of this remote school, on teacher's recommendation. To do this, the school only needs to submit applications for enrollment.

Classes are held once a week after school. The main forms of organization of the educational process are: lectures in videoconferencing mode (VC); homework; final control work. It should be noted that all lectures are also available on the record. As part of the lecture sessions, teachers also give an analysis of homework and final control work. Students of 8 and 10 grades who have successfully completed the courses of the Remote intellectual school and have experience of successful participation in various stages of the Vsosh are invited to continue their studies at the full-time on-campus Summer school. Travelling to the venue of the school, accommodation of students and training in are carried out at the expense of the regional budget.

For the winners and prize-winners of the regional stage (students of 9-11 grades), spring training camps are additionally organized, which are also held on-campus in full-time format.

Coaches working with Olympiad participants at the Constellation school have received special training at the Sirius Federal educational center. They are also constantly improving their knowledge by studying the experience of working with participants of Olympiads in other regions and countries.

The appearance of the "Constellation" school and the development of Russian-Bulgarian relations between NArFU opened the way for the construction of education in accordance with the model of training talented students in mathematics, proposed by the Bulgarian Professor, doctor of pedagogical sciences, Grozdev Savva Ivanovich [6].

Professor Gruzdev offers to divide all students participating in mathematical Olympiads and competitions into 5 groups, depending on their abilities, and then work in groups, increasing their level of training. At the same

time, such an organization of the developing environment is carried out, which stimulates the curiosity of schoolchildren. Such techniques as intellectual competitions, games, independent construction of Olympiad tasks by students, etc. allow us to conduct such classes most effectively.

In the intellectual school “Constellation” teachers also work with different groups of students. The first group includes students of Distance School, who are mostly just interested in mathematics children and have not shown themselves anywhere. As a rule, up to 300-400 students study at a Distance School at the same time. The second group includes students of the Summer intellectual school, these are children who have a positive experience of participating in various stages of the all-Russian school Olympiad and/or have successfully completed courses of the Remote intellectual school “Constellation”. Usually, there are 20-30 such children. The third group includes students of the Spring school who were the part of the Arkhangelsk region team for the final stage of the Vsosh. There are usually up to 20 participants. When organizing classes in the Spring and Summer intellectual schools, we use techniques: competitions in teams to solve problems, solving a series of problems, mathematical games and puzzles, brainstorming to solve complex, non-standard problems. Thanks to this organization of the preparation process for the math Olympiads, students in Arkhangelsk and the Arkhangelsk region are successful at all stages of the Vsosh.

When developing a curriculum for preparing for Olympiads and competitions in mathematics, developers focus on the structure of Olympiad tasks from previous years.

Here is an example of a fragment of the program of the Summer intellectual school for the 10th grade in 2019:

№	Content	Number of hours
1	“Rating + example”. The construction of examples and counterexamples	2
2	Method of mathematical induction	3
3	Elements of combinatorics.	3
4	Dirichlet principle	3
5	Diophantine equations (equations in integers)	2
6	Inscribed and circumscribed circles	4
7	Extreme geometry problems.	2

The proposed approach to the organization of preparation for Olympiads and competitions in mathematics allows you to manage the learning process, allows you to clarify the activities of students to achieve results and achieve the set educational goals.

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