DEVELOPMENT OF THE PROJECT “EXPERIMENTAL MATHEMATICS” FOR SCHOOLCHILDREN

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Abstract. The aim of the article is to present the history of the “Experimental Mathematics” project implementation for schoolchildren on the basis of the Higher School of Information Technologies and Automated Systems of the Northern (Arctic) Federal University named after M.V. Lomonosov.

Key Words: *experimental mathematics, an inquiry-based mathematics education, dynamical geometry software.*

Mathematics and Technology

The educational project for schoolchildren “Experimental Mathematics” is one of the directions of the international project “Methodology and Information Technologies in Education” – MITE. Professor Sava Grozdev is the head of the project from the Bulgarian side and Professor Tatiana Sergeeva from Russian Federation side.

This direction had appeared during the experimental work on the inquiry-based mathematics learning technology approbation for the secondary schoolchildren after hours using dynamical geometry systems (DGS). Learn more about this here [1-4].

The main purpose of the “Experimental Mathematics” project is to attract pupils to study Mathematic additionally; to participate in mathematical competitions, to develop their creative abilities and research skills by involving them in research tasks formulation and solution by means and methods typical for the field of experimental mathematics.

The project started in 2014 on the basis of the Northern (Arctic) Federal University named after M.V. Lomonosov (hereinafter NArFU) Institute of

Mathematics, Information and Space Technologies with grant support from the Contemporary Natural Science Foundation.

The objectives of the project are the following:

1. To make pupils acquaint with the capabilities of dynamical geometry software (using GeoGebra as an example) to support the research tasks formulation and solution practice, to form pupils' commitment to use this software class products for creating dynamic models of research objects and conducting computer experiments.
2. To involve schoolchildren in didactic games aimed at including them in formulation, solution and development of an idea of the research tasks with the help of practice-oriented and fantastic plots by the experimental mathematics means and methods.
3. To lead pupils to the choice of directions for further research work, to consult pupils and teachers on the questions of the research work, to draw up the report on the study, to present research results at the student conferences and competitions.
4. To prepare students participate in academic competition and contests on experimental mathematics.

The project has been implemented to solve these tasks through a system of contests and educational events: "Experimental mathematics" club; popular science lectures on experimental mathematics; experimental mathematics annual tournament.

Let us present the results of work over the past 6 years for each event.

"Experimental mathematics" club is organized for 7-9 grades pupils. Currently, the club is being held at several venues:

1. Arkhangelsk (on the basis of NArFU Higher School of Information Technologies and Automated Systems);
2. Severodvinsk (on the basis of the Municipal budgetary educational institution "Secondary School № 24 in Severodvinsk");
3. Velsk (on the basis of the Municipal budgetary educational institution "Secondary School № 92 in Velsk");
4. Podolsk, Moscow Region (on the basis of the Municipal Budgetary Educational Institution "Secondary School № 1");
5. Republic of Kazakhstan (on the basis of the State Institution "Lakeside Secondary School" of the Kostanay area, Kostanay region);
6. Innopolis, Republic of Tatarstan (on the basis of the State Autonomous General Educational Institution "Lyceum Innopolis").

During the lessons of the club, pupils get acquainted with the capabilities of dynamical geometry software that can be used for solving research tasks and conducting individual research work using experimental mathematics. The program of the club is presented on the website: http://itprojects.narfu.ru/kruzhok-exp-mat/program.php. Pupils' research works are annually presented to district, city and regional competitions, as well as the international competition "Mathematics and Projecting", organized in within the MITE project.

The reading of popular science lectures on experimental mathematics by scientists with experience in this field was organized on the basis of the NArFU Higher School of Information Technologies and Automated Systems, supported by the Foundation "Contemporary Natural Science". Video materials of the lectures are posted on the official website of the project: http://itprojects.narfu.ru/kruzhok-exp-mat/index.php.

On October 24, 2015, a popular science lecture by Honorary Doctor of NArFU Sava Grozdev (Institute of Mathematics and Informatics of the Bulgarian Academy of Sciences, Sofia, Bulgaria) was presented. The title of the lecture was "Can a computer generate problems?" Formulation of new and fascinating, mathematical problems is a real art, accessible just for a small number of people. At the lecture, the principles of using computer programs were presented, the use of which allows to obtain new tasks that develop the idea of solved ones. The problems of the international Olympiads of the past years were taken as a basis, the development of ideas of which led the lecturer – the head of the Bulgarian national team in mathematics – to achieve new results in the study of second-order curves.

On December 12, 2015, the Head of the Department of Theory and Methods of Teaching Mathematics, Professor Alexander Yastrebov from the Yaroslavl State Pedagogical University named after K.D. Ushinsky, held a popular science lecture titled "Computer help in solving problems". As conceived by the author, the lecture makes the student think about the interaction of two components of mathematics, experimental and theoretical, about which the scientific community has not reached a consensus yet. "Serious" and "humorous" plots are developed in the lecture. One of the "serious" plots relates to a comparative analysis of experimental solutions and theoretical solutions of several seemingly similar, but, in fact, deeply different equations. Another plot relates to the comparative analysis of experimental and theoretical solutions to construction problems. The third plot reveals the role of experiment in the process of generalizing mathematical theorems. In the serious" plots developing process, the following mutually additional statements are revealed. 1) In a number of cases, the experimental solution is simpler and easier than the theoretical one. 2) Any experimental solution needs theoretical understanding. The "playful" plots complements the above statements by demonstrating some of the paradoxical properties that the GeoGebra dynamical geometry software possesses.

On January 30, 2016, a popular science lecture was held by the Associate Professor of the Department of Mathematics of AESC MSU Kolmogorov Boarding School, the scientific leader of the project “Mathematical Designer” Vladimir Dubrovsky: “Pythagorean pants and Napoleon's cocked hat”. The famous “Pythagorean pants” is a construction of three squares built on the sides of a triangle, with the help of which Euclid proved the Pythagorean theorem in his grand book “Beginnings”. They have a number of remarkable geometric properties. The lecture describes how, using a dynamic computer model, these properties can be discovered and come up with their proof. If we replace the squares with regular triangles, then we get another wonderful construction, which is usually associated with the name of Napoleon. And this is the topic for the second part of the lecture. Finally, generalizations of both of these constructions are presented.

The experimental mathematics tournament among 7-9 grades pupils is annually held in February on the basis of the NArFU Higher School of Information Technologies and Automated Systems, The tournament is also held remotely on the basis of secondary schools in Arkhangelsk and the Arkhangelsk region, in Krasnoyarsk, in Moscow (School “Intellectual”), Podolsk, as well as in the Republic of Kazakhstan. The total number of participants is over 250 people annually. Students are offered tasks in the field of experimental mathematics, for the solution of which is necessary to use a mental, natural or computer experiment. In 2019, the tournament was also held among 5-6 grades pupils. The tournament tasks, solutions and results are posted on the official website of the experimental mathematics tournament: http://itprojects.narfu.ru/turnir/index.php.

The data presented here on the progress of the “Experimental Mathematics” project prove its viability. The ability to experiment with mathematical objects, to create their computer visualization stirs up pupils’ interest in research for searching new discoveries, as well as the interest for studying of mathematics at more advanced level. We also believe that it is efficient to resume the work of a popular science lecture hall for students. It would be interesting to introduce students to the authors of the tournament tasks in experimental mathematics, as well as to make then acquaint with those scientists who made experimental mathematics the sphere of their scientific interests.

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