

NEW APPROACHES IN MATHEMATICS EDUCATION: THE REGIONAL DEVELOPMENT CONCEPT OF MATHEMATICS EDUCATION

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Abstract. *This project focuses on development of Maths' popularity among students. The aim of the research is to preserve and improve the traditions in Mathematics education in the Samara region. The article then extends different methods and strategies of gaining popularity in mathematical knowledge in the region. The methodology of the research was held of using secondary data, also the results of several projects, which were launched in this field, were used. As a result, this approach offers continued support and ultimately increases students' achievements, engagement and retention. In addition, the authors made a comparison between the previous and future projects in order to show the gap in methodologies in Mathematics education.*

Keywords: *education, development, institutions, knowledge, Mathematics, method, motivation, project, research, students, teaching, technologies, training.*

Introduction

*“Mathematics is one of the oldest of sciences;
it is also one of the most active;
for its strength is the vigour of perpetual youth.”
Andrew Russell Forsyth (1858-1942)*

Throughout mankind's history Mathematics has been an integral part of human culture, a key to understanding the world around us, a base of scientific and technological progress. The study of Mathematics plays a system-forming role in education, developing the cognitive abilities of a person, as well as logical thinking, and influencing the process of teaching other disciplines. The reason for the penetration of Mathematics into various branches of knowledge is that it offers precise models for studying the surrounding reality, in contrast to the less general and more diffuse models offered by other sciences. Without modern Mathematics and its logical and computing apparatus, progress in various areas of human activity would not be possible (de Lange, 2003). A high

level of Mathematics education is necessary in order to fulfil the task of creating an innovative economy, providing long-term goals and objectives for social and economic development of the Samara region.

Proficiency in Mathematics is as an essential precursor to success in modern society necessary to ensure highly qualified specialists for the knowledge-based, skill and technology-intensive industries.

Mathematics education researchers seek answers to important questions that will ultimately result in the enhancement of Mathematics teaching, learning, curriculum, and assessment, working towards “ensuring that all students attain Mathematics proficiency and increasing the numbers of students from all racial, ethnic, gender, and socioeconomic groups who attain the highest levels of mathematics achievement” (National Council of Teachers of Mathematics, 2014). However social changes exacerbate the problems of development in this field. In order to simplify their consideration, the challenges are divided into the following groups: motivational problems, meaningful problems, teacher-related challenges.

Lower learning motivation of pupils and students is intricately linked to the social underestimation of the importance of mathematics education, the congested curriculum in schools and higher educational establishments, as well as appraisal and training materials with outdated content and the lack of training programs to meet the needs of students and the actual level of their training (Gould, 2010). All this leads to a larger mismatch between the tasks of the intermediate and state final certification and the students' actual knowledge base.

The choice of the content of Mathematics education is outdated and becomes detached from life, from reality. The needs of future specialists in mathematical knowledge and methods are not sufficiently taken into account. The lack of differences in curricula, appraisal and training materials, in the requirements of intermediate and state final certification for different groups of students leads to a low efficiency of the educational process, substitution of training by exam preparation. The level of Mathematics education in the institutions declines, due to the absence of an update mechanism of the content of Mathematics education.

Teachers are the key to the positive and sustainable development of education system. They now constitute the principal challenge to quality Mathematics education for all. The problems are manifold, quantitative and qualitative (UNESCO, 2012).

The quantitative teacher recruitment and retention problem is a major issue and, if it is to be solved, the problems of Mathematics education after basic education must be examined. To overcoming this challenge, the real importance of the profession must be recognized socially and teachers' working conditions

must be improved. Furthermore systematic efforts must be made to give all teachers access to networks, resources, in-service training, exchanges and collaboration with others (UNESCO, 2012).

The other problem is quality. Today there are not enough teachers in the region who can teach mathematics in a qualitative way, taking into account interests of different groups of students. The existing system of training, professional retraining and regular in-service training of teachers does not meet modern requirements. The graduates of higher educational pedagogical institutions, in their majority, do not meet the qualification requirements, professional standards, have little experience of teaching and applying of pedagogical knowledge. The system of additional professional education of teachers is not effective enough and is often formal in terms of improving Mathematics education.

Trying to solve all these issues, the authors of the present paper developed the Regional Concept of Mathematics education in the Samara region.

The Regional Concept of Mathematics Education of the Supporting University in the Samara Region

The aim of the Regional Development Concept of the supporting university is to raise the regional Mathematics education to the leading position in the country. Mathematics in the Samara region should become an advanced and attractive area of knowledge and activity, while the acquisition of mathematical knowledge – a conscious and internally motivated process.

The objectives of the development of Mathematics education in the Samara region on the basis of the supporting university are:

- modernization of the curricula of Mathematics education at all levels (ensuring their continuity), based on the needs of students and society in general mathematical literacy, in specialists of various profiles and levels of mathematical training, in the high achievements of science and practice;
- ensuring that there are no gaps in basic knowledge for each trainee, because there are “no children incapable of Mathematics”, ensuring confidence in the adequate tasks of the state final certification, providing teachers with diagnostic tools (including automated ones) and overcoming individual difficulties;
- ensuring the availability of information resources necessary for the implementation of educational programs in mathematics education, among them the electronic records and the use of modern technologies in the educational process;

- improving the quality of teachers' work, enhancing the schemes of their financial and social support, providing them with opportunities to access the best models of Russian and world mathematics education, the achievements of pedagogical science and modern educational technologies, creating and implementing their own pedagogical approaches and author programmes;
- supporting the leaders of Mathematics education (teachers and scientists, as well as the structures around the leaders), the identification of new leaders;
- providing students with high motivation and showing outstanding mathematical abilities, all conditions for the development and application of these abilities.

To achieve all these objectives, we implied Mathematics education in different levels of education: in secondary education, vocational education, professional education and additional education.

At the level of secondary education, Mathematics education should provide each student the opportunity to achieve the level of mathematical knowledge necessary for further successful life in society and provide each student with intellectual activity at an affordable level, using the beauty and fascination inherent in Mathematics.

In the secondary education, it is necessary to provide training for students in accordance with their requests to the level of training in the field of Mathematics education.

It is crucial to provide each student an opportunity to achieve any level of training, taking into account his individual needs and abilities and regardless of the place and conditions of residence. The ability to achieve the required level of Mathematics education should be supported by the individualization of teaching, the use of e-learning and distance education technologies (Medvedeva, 2015). The possibility of achieving a high level of training should be provided by the development of a system of specialized educational organizations and specialized classes, a system of additional education in mathematics, a system of Mathematics competitions (Mathematical Olympiads, etc.). Appropriate programs can be implemented by higher educational establishments (within existing and established educational and research centres of universities, as well as network forms of educational programmes).

Achieving any level of training should not hamper the individualization of teaching and keep open the option of further education or changing the profile.

It is necessary to stimulate an individual approach and individual forms of work with trainees lagging behind, involving educators with extensive experience.

Improvement of the content of Mathematics education should be provided through advanced training and additional professional education of teachers based on leadership practices of Mathematics education formed in educational organizations.

At the level of vocational education, system should provide the necessary level of mathematical training for the needs of mathematical science, economics, scientific and technological progress, security and medicine. Thus, it is required to develop modern educational programmes, to include basic mathematical directions in the relevant priority areas of modernization and technological development of the Russian economy (Pavlova & Pitt, 2003).

Students who study Mathematics and Information Technology and their teachers should participate in mathematical research and projects. Teachers of the Faculties of Mathematics at classical universities need to conduct fundamental research recognized by the professional community, and their students should devote much more time than at present to solving creative and research tasks. Teachers of Mathematics departments at technical universities should conduct research in fundamental mathematics or in applied fields, carry out the orders of different organizations with their students (similarly for economic and other educational organizations of higher education). Teachers of Mathematics departments at pedagogical universities should work with schoolchildren; participate in the development of attestation materials, textbooks for schoolchildren. Students (including those who are preparing to become teachers and educators in educational institutions) need to solve the problems of elementary Mathematics in the area of their development, to practice at school much more than today, using this activity as a basis and motivating factor for obtaining psychological and pedagogical knowledge.

The interaction of the bodies that carry out management in the field of education, educational organizations of higher education and general education organizations should be aimed at supporting the best graduates of Mathematics faculties of pedagogical universities, and graduates of profile specialties of classical universities. It is necessary to provide the best graduates, who have studied the mathematical orientations of educational institutions of higher education and who have propensities and abilities for pedagogical work, the opportunity to work at higher education institutions.

In order to achieve each objective in sequence, it is planned to refine the system of labour evaluation taking into account the specifics of the activity and international practice of assessing the work of teachers of Mathematics, scientific and pedagogical workers of higher educational establishments and scientific workers of scientific organizations engaged in the field of Mathematics.

At the level of higher education, institutions and research centres should provide an advanced level of fundamental and applied research in the field of Mathematics and its use in Mathematics education. It is necessary to strengthen the integration of Russian mathematical research work into the world science, to ensure the achievement of high positions in the world rankings by the Mathematics faculties of leading Russian universities, as well as the quality, quantity and quoting of Russian mathematicians, the attractiveness of Russian Mathematics education for foreign students and professors (Igoshin, 2012). The mobility of students, post-graduate students and young candidates of science should improve cooperation between educational institutions and research institutes should develop.

Higher education institutions and research centres should participate in the work on the Mathematics education and popularization of mathematical knowledge in Russia.

Successful teachers are provided the opportunity for their professional growth in the form of scientific and applied work, additional professional education, including training in various organizations – leaders in fundamental and applied research in the field of Mathematics and Mathematics education.

At the level of additional education system, including mathematical centres, clubs and competitions is an important part of the Russian tradition of Mathematics education that should be state-supported. At the same time, new forms such as obtaining Mathematics education in distance form, interactive museums of Mathematics, mathematical projects on the Internet portals and social networks, professional mathematical Internet communities should be developed.

All possible opportunities are taken to promote Mathematics and to stress its importance:

- providing state-supported and accessible Mathematics for people of all ages and able to provide anyone with unexpected aids to understanding and action (UNESCO, 2012);
- creation of conditions for a positive attitude towards the achievements of mathematical science and research in this field, understanding the importance of Mathematics education for the future of our country, being proud of Russian scientists' achievements;
- providing continuous support and raising the level of mathematical knowledge to satisfy the person's curiosity, his cultural needs, the acquisition of knowledge and skills used in daily life and professional activities.

The Best Pedagogical Practices of Samara State Technical University (Supporting University) in the Field of Popularization of Mathematics Education

In order to engage in productive mathematical conversations, teachers tried to create and orchestrate discourse and structure learning environments to deepen engagement and support learning. Effective practices at the Samara State Technical University support students as they learn to participate in mathematical discourse. They are Interregional Olympiad of schoolchildren in Mathematics, SAMMAT (see <http://samm.ru/>), the program “VZLET” (see <http://vzletsamara.ru/>), Mathematical School «TALENT» (see <http://talant.samgtu.ru/>), Mathematics Public Lectures (see <https://www.samgtu.ru/node/7263>). All mentioned events promote mathematical thinking and discourse in the Samara region.

Interregional Olympiad of schoolchildren in Mathematics “SAMMAT” is an annual Olympiad in Mathematics for schoolchildren of 6-11 grade. The history of «SAMMAT» began to be written in 1993 by the teachers of Samara universities, Professor Andreev A. A. (Chairman of the Organizing Committee of the Olympiad), Professor Radchenko V. P., Associate Professor Alyakin V. A., with the support of the Samara regional branch of the Russian Academy of Natural Sciences (Chairman - academician Astafyev V. I.).

Annually, approximately 20 000 pupils from the schools of Samara, Ulyanovsk, Orenburg, Penza, Saratov regions, the Republic of Bashkortostan, Mordovia, Belgorod region take part in SAMMAT. Since 2009, all exchange information between participants and the organizing committee of the Olympiad (registration of participants, placement of tasks, information on the results and results of the Olympiad) is conducted using the latest information technologies.

The main goals and objectives of the Olympiad are to identify and develop the creative abilities and interest in scientific activity of students from various regions of the Russian Federation, create conditions for intellectual development, support gifted children, including their assistance in professional orientation and continuing education. All universities participating in the organization of the Olympiad have specialized schools within their Alma Mater, which try to involve students in an intensive process of studying Mathematics. The winners of the Olympiad enrol in various faculties of the leading universities of the country, actively participate in research work.

It should be mentioned that the winners of the Olympiads of the previous years are engaged in Mathematics research. Many of them are the candidates of science (S. A. Beilin, D. V. Dmitriev, K. V. Lykov, M. V. Ignatyev, V. Sevostyanova, M. N. Saushkin, I. Saushkin, E. A. Kozlova and many others) and even have PhD degree (I. V. Minakov, A. A. Yudashkin).

By order of the Ministry of Education and Science of the Russian Federation No. R-727 of October 24, 2017 Interregional Olympiad of schoolchildren SAMMAT is included in the list of international schoolchildren's Olympiads with the allocation of quotas for training in Russian universities for winners of the Olympiad among foreign citizens (see [http://minobrnauki.rf / documents / 11773](http://minobrnauki.rf/documents/11773)).

A unified regional scientific and educational environment for creatively gifted youth in the field of science, technology and technology has been created in the Samara region. A key role in the formation of the Governor's Register of creatively gifted youth in the field of science and technology, as well as in further coordination of professional and personal development of its participants, is the inter-departmental chair "Informational Developing and Educational Systems and Technologies" of Samara State Technical University. On the basis of the developed information and communication system, the department forms youth research micro-collectives "pupil-teacher-scientist" at the school level and different-aged youth research teams at the level of the university-enterprise in accordance with the chosen scientific topic, monitors and supports the projects: projects of schoolchildren (the "VZLET" Program) and student projects (the "POLET" Program).

The most numerous projects for schoolchildren are the "Mathematics" section. Currently, there are 10 794 users registered in the scientific and educational programme "VZLET". These are students of secondary schools, teachers, university professors, representatives of the territorial offices of the Ministry of Education and Science of the Samara region and partner organizations.

In total, 1564 themes of research projects proposed by scientists from 15 universities of the Samara Region were introduced into the system. At the moment, there are 1501 projects under implementation: projects on Mathematics - 167, Physics - 123, Biology and Medicine - 113, Chemistry - 96, Computer Science and ICT - 88, Economics and Management - 74, etc.

94 of 167 projects performed in Mathematics, are carried out under the supervision of high school teachers, the rest of the projects are under the guidance of school teachers. Table 1 shows the distribution of projects management by scientific advisers on Mathematics at the universities of the Samara region. Table 2 shows the distribution by classes. The greatest activity is shown by pupils of the 8th and the 10th grades.

Table 1 A set of projects on Mathematics at higher education institutions

№	University	Number of projects
1.	Samara State University	23
2.	Samara State Technical University	40
3.	Volga State University of Telecommunication and Informatics	14
4.	Togliatti State University	17
	Total:	94

Table 2 A set of projects on Mathematics by age of the trainees

№	Grade	Number of projects
1.	5 Grade	1
2.	6 Grade	1
3.	7 Grade	1
4.	8 Grade	28
5.	9 Grade	17
6.	10 Grade	24
7.	11 Grade	21
8.	1 course of pre-higher education	1
	Total:	94

Another important project of Samara State Technical University is mathematical School «TALENT» opened in October 14, 2016. It was attended by more than 100 people from 20 schools of Samara. The head of the school is the founder and the permanent head of «SAMMAT Olympiad», the candidate of physical and mathematical sciences, Professor A. A. Andreev. «With the students of the Mathematical School, we will meet once a week to study complex and interesting problems and the theory of the subject», Andreev explained. Classes are free of charge and are aimed primarily at pupils of the 10-11th grade.

In addition, on the official site of Samara State Technical University provides Mathematics Public Lectures of scientists. Among others, Olga V. Yusupova, Ph.D., the Head of the Department of Higher Mathematics talks about Mathematics in engineering education. The lecture is addressed to schoolchildren and students-future engineers with the aim of forming motivation for studying Mathematics. Public lectures were recorded as part of the implementation of the section “Popular Science” of the strategic project “Technology Polygon” of the supporting university.

Conclusions

Realization of the Regional Concept of the Supporting University will provide a new level of development of Mathematics education in the Samara region, which will improve teaching of other subjects and accelerate the development not only of Mathematics but also of other sciences and technologies. This will allow our region to take the leading position in the country as well as to increase students' motivation and popularize Mathematics education among young generation.

These mathematical events described in the article help students to express themselves through projects. The participants can appreciate and remember mathematical facts more clearly. Mathematical events are also effective in bringing desired changes in average or even slow learners. Preparing and demonstrating mathematical knowledge help them to participate in the learning process more actively. The students, who have lost interest in Mathematics due to its abstract nature, change their attitude after understanding the concepts in a concrete way. There is also a chance of getting appreciation from teachers, parents and other participants, which in turn inspires them to think and work with self-confidence. They own much and show interest in Mathematics.

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