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Russian Secondary Mathematical Education

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Historical and social context

Before October Revolution (1917) Russian education reflected general European and World trends, for example, the majority of citizens were illiterate. Universal schooling was implemented in 1930-s, high school started to be oriented on technology, science, and ideological indoctrination.

An important event in the early 1960's, was the establishment of a system of specialized mathematical schools, among them four boarding schools to universities. Top-rank professional mathematicians, as well as students and post-graduate students working the leading of these schools.

In the 1970-s a reform of mathematical education was implemented, particularly, elements of mathematical analysis and transformational geometry were introduced. Component of the reform, formatted in the style of the "New Math" was criticized by the public and part of the mathematical community. This has led, inter alia, that until now, most school courses avoid even the basic settheory terminology. "Narrowing" of school mathematics, its orientation to the formal solution of equations, inequalities and their systems, concentration on peculiarities of domains of functions, and so on, was going as well. For weak students this "simplified" the work of the teachers, for strong is consistent with the task of entering universities: each of the leading engineering universities, provided specific type examinations, organized their (paid) preparation courses. However, it contradicted the main general objectives of mathematical education.

Also in 1970-s – 1980-s attempts were made to build new systems of general education (especially primary) from the perspective of modern psychological science, the so-called "developmental systems" of Elkonina – Davydov and of Zankov. In these systems the shift from objectives formulated in terms of "knowledge-and-skills" to meta-cognitive direction (inquiry, reflection...). Learning and teaching materials, as well as educational practice created in the wake of this educational philosophy can be considered as implementing it only partially, the mathematical quality can be criticized.

It is assumed now that all children (excluding children, for whom this is not possible due to the limited capacity of health) to 18 years have 11-years of general education. The high school is profiled (specialized), along with profiles of general education after grade 9 programmes of vocational education embrace up to 50% of student of corresponding age.

In the second half of the 1980-s and in 1990-sthe destruction of scientific and technological capacity and social changes in society have significantly reduced (and in the popular consciousness – demolished) needs for engineering and research (in technology, mathematics and sciences). This led to a sharp decline of motivation of high-school graduates to continue education in engineering and scientific fields, and of the level of graduates who are willing to continue their education in these fields (in conditions of no significant reduction in admission to corresponding universities' departments).

An attempt to keep the level of mathematical education in 9 and 11 grades is introducing compulsory exams (so called Unified State Examination – USE, or Single State Examination) in mathematics. However, in the very beginning of the introduction completely foreign (in any sense) patterns were used. The strengths of the Russian traditions of studying math (development of mathematical thinking and communication) were ignored. The weak features (isolation from life, narrowing towards formal algebraic transformations) were not compensated. Along with universal effect of any change this led to further reduction the overall level of graduates' mathematical competence. Currently, there are indicators of certain improvement of the situation.

Content of Education

The content of mathematical education corresponds at large to the "average" among industrialized economies. It keeps components of algebra and elementary functions (trigonometric, exponential and logarithmic functions), plane and spatial geometry, derivatives and integrals. Around 2000 a successful gradual introduction of elements of data analysis (statistics), and probability theory started. Component of applied mathematics is presented mainly in the course of physics. Real-world

applications connections and projects are presented in most Russian mathematical courses substantially less than those in other economies.

Among the differences, in addition to those mentioned already, you can find a considerable amount of deductive ('axiomatic') geometry (traced back to Euclid), as well as modern mathematical content of Computing Sciences (in course of Informatics). This course has been designed and implemented in the second half of the 1980-s by mathematicians, representatives of the Moscow mathematical school, which as their professional activities, also had programming and teaching programming.

ICT and mathematical education in Russia

As in other economies of the world, information and communication technologies (ICT) are not so popular among teachers of mathematics. Calculators are used in physics in many schools, rather than in mathematics. Geometer's Sketchpad ("Live geometry") and other versions of dynamic geometry are used mainly for illustrative purposes. In the mathematical Informatics computer is used for the design and implementation of programmes, particularly effectively with "Executors" working in visual environments (Robot in maze, Logo turtle, etc.)

Virtual learning environments are spreading in general school practices (including mathematical education). Some of the most widely used are based on an open source environment (Moodle) MODUS.

It is clear that the place of computers in civilization, as well the significant change in the nature of mathematical activities for different categories of people should influence content of mathematical education. The gap between the potential of ICTS and their applications in "adult" life vs. their status in the school is constantly growing. Here is just one example: a group of St. Petersburg mathematicians on the basis of the company "SevernyOchag" ("Northern hearth") has developed and implemented on personal computers a tool to solve any equations and systems of equations from school, so that the most traditional and most crotchety teacher evaluates obtained solutions to "excellent". (In particular, the tool generates all necessary text explanations.) Thus, today an essential component of school mathematics can be completely automated and this should be reflected in school courses. In fact, the reflection is not happening.

Teachers' preparation

The Soviet tradition was to establish teacher training institutions in different regions of the economy. For decades, a trend in preparation of teachers of mathematics (as teachers of other subjects) evolved in the direction of increasing of weight of classical math in teacher preparation, with no direct relation to school math. Simultaneously process of transforming leading pedagogical institutes in the regions to (more prestigious) classical universities was going, with the reduction of actual teaching components in their curricula.

Prestige of the teaching profession, which was not very high throughout the second half of the twentieth century, dramatically fell in 1990, when the State destroyed (in the mentality of teachers and of and general public) the confidence in social guarantees for teaching: in some regions of the economy serving teachers were not paid salaries for months and even years.

So far not the best school graduates enter teacher training institutions, the requirements for admission are low even weaker school graduates are accepted. The number of graduates from teacher training significantly exceeds demand for teachers, but not the best graduates are coming to school.

In recent years we can see a positive trend in this field is.

Directions for the development of mathematical education

Reality of information civilization

The new federal State educational standard for primary education (2009) implies modernization of mathematical education in elementary school to include the basic concepts of modern discrete mathematics, as well as the presence in school of information educational environment and the use of ICT in all subjects.

Modern mathematical content of primary education, including basic topics of mathematical informatics, can be successfully learned by students in a visual form, in the form of mathematical games, in connection with appealing and motivating activities. Going back to primary school "manipulatives" (still there is no entrenched Russian word for these tangible learning objects). The practice of developmental education, critical thinking are implemented in the course of individual and group study and self-discovery. Examples of algorithms are built by students in solving arithmetic problems posed in form of text description of situation, in analysis of linguistic phenomena of Russian language, in building and formulating rules of arithmetic of decimal numbers, as well as in the case of visual environments and games.

In parallel, at various levels of education computer (and other devices, such as projector) are more used as tools for mathematical activities, in particular, for experiment (as mentioned). Interaction between the courses of mathematics and physics will be improved; mathematical data analysis would be more informative. Data automatically collected in natural experiment (using digital measuring devices) will be analyzed in the framework of the statistics (data analysis) learning module

In USE the open (via internet) bank of problems will be developed further. This mechanism allows you to provide a gradual "dosed and addressed" influence on the content of education. In particular, this will help to include into the USE on mathematics more applied tasks. The diversity of examination tasks will grow constantly, including – on geometry. Exam on mathematics with use of computer will be implemented. Exam in mathematics will be divided into base (who are all graduates have to pass) and profile (which is executed those graduates who have chosen to continue their education, including mathematical preparation).

The key issue of improving the quality of teachers of mathematics can be addressed on several fronts. In teacher training institutions the problem-solving component should be extended considerably. Student should practice in solving of elementary math problems (USE including) as well as in checking solutions produced (or pretend-to-be-produced) by graduates. The teaching-in-school practice should be increased considerably. These problem-solving and teaching activity should be proposed to students not from teachers' colleges, but from all institutes that give serious mathematical training. Some of the students will be attracted by teachers work.



Mathematical Education in Russian School

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Math and Math education. Role and structure

- Backbone of information civilization
- Instrument of innovation
- Component of responsible and cultural citizenship



School Math as condition for innovation

- Acquisition of mathematical way of reasoning
- Connection with reality
- More option for discovery in mass primary school
- 21st century Math
- ICT environment
- New Standard adopted in 2009

Teacher development

- Stronger requirements to enter teacher education and come to school
- More problem-solving in teacher education and qualification
- More pedagogical experience in all universities



APEC Survey of Curriculum for Upper Secondary High School Mathematics/Science Teacher Preparation Programs

Dmitry Medvedev



Innovation-based economic development is crucial for stable economic growth... Cooperation in education and developing human capital is vital...

