Mathematical Education in Universities in the Soviet Union and Modern Russia

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Traditions of mathematical education in Russia on both school and university level, research done by Russian scientists and its impact on the development of mathematics is considered by many a unique and valuable part of the world cultural heritage. In the present paper, we describe the development of mathematical education in Russian universities after 1955 — a period that proved to be most fruitful.

1. University Education in 1955-1988

In contrast to most Western countries, especially North American ones, high-level university education in the Soviet Union was concentrated in very few centers, and even among these centers, the Faculty of Mathematics and Mechanics of Moscow State University (widely known as Mechmat) was distinguished due to its unique cluster of outstanding mathematicians. The state of Mechmat mathematics determined the general situation in the country. The golden period of Soviet mathematics lasted for less than 20 years between approximately the mid-50s and the mid-70s. Both its beginning and its end were caused by political events in the country. The fall of the iron curtain and the exodus of Soviet mathematicians in the late 1980s marked the beginning of a new period.

The Golden Years of Soviet Mathematics

Outstanding Soviet mathematicians have always worked for Mechmat. However, at the end of the 1950s their concentration became incredible. In addition to the representatives of older generations, like Andrei Kolmogorov, Izrail Gelfand, Ivan Petrovskii, Igor Shafarevich, during a short period of time Mechmat hired such recent PhD students as Dmitrii Anosov, Vladimir Arnold, Felix Berezin, Alexander Kirillov, Yuri Manin, Sergei Novikov, Yakov Sinai, and several others, who determined the development of mathematics in the Soviet Union and affected the world mathematics over the next few decades. Mechmat classrooms were full of young students not only in the mornings and afternoons during obligatory classes but also in the evenings when popular research seminars were overcrowded. It wasn't only Mechmat students or professors took part in the seminars: people working for other Moscow universities and research centers or even in other Russian cities would regularly come to the seminars too. Seminar participants would either present their own research or explore the most recent results from abroad considered to be important by seminar leaders. Soviet mathematicians, as well as the rest of the Soviet people, were typically not allowed to leave the country; Western mathematicians came to Russia very rarely, and only a part of Western journals was available even in the best libraries, often after a serious time gap. Nevertheless, most of the important research results and theories reached the target audience. Practically all quickly developing domains of mathematics were well represented at Mechmat in those years.

During that period several Soviet mathematical journals that published quality papers were widely read all around the world, and many Western mathematicians decided to study Russian in order to be able to read the Russian versions of the papers before their translations appear (which could take some time). Publications in these journals were considered to be very honorable, and it was not an easy task to achieve such a publication.

Low mobility inside the Soviet Union, caused both by economic reasons and various restrictions, gave birth to many stable research schools, where dozens of people communicated regularly with one another for decades, developing rich theories. The atmosphere of mathematical enthusiasm and the obvious quality of the faculty made Mechmat attractive to strong mathematically-oriented high-school graduates, and they got probably the best possible education in the world. Of course, not all of Mechmat graduates stayed there to work, and many other universities all over the country had a chance to hire world-level faculty of a very high quality. Leningrad State University, which is the oldest Russian university, had several high-quality research schools of its own. Mathematicians were among the founders of Novosibirsk State University in 1959, which shortly after that became a leader in several research areas, while there were one or two research schools in a specific domain in many other universities. Flexibility and high quality of education in these leading universities allowed their graduates to play crucial roles in the years to follow in the development of computer science and information technology in the Soviet Union.

At the beginning of the 1960s, 4 leading universities established boarding schools for talented high-school students. University professors, as well as specially selected teachers, gave lectures in these schools. Best pupils from all over the country, especially from small towns and villages, were agglomerated in these schools in order to prepare them for future research careers. In a few years, this network of boarding schools extended and was supplied by specialized schools in big cities. Kvant monthly magazine, which started in 1970 and explained deep notions in mathematics and physics to high-school students, reached 300 thousand subscribers [1]. Each year the Correspond-

ence school (school of distanced education) founded and ruled by Gelfand taught hundreds of high school students all over the country. As a result, in subsequent years universities got a lot of well-prepared freshmen.

The Period of 1970–1988

Since late Stalin period (early 1950s), people of Jewish background were considered by authorities as suspicious (although this was not officially admitted). For many years, this was not a serious problem in physics and mathematics, since leading physicists managed to explain to the government that developing new kinds of weapons and space program required attracting all capable people, no matter what their ethnicity was.

The situation had changed by the end of the 1960s after several public political manifests by leading scientists. Mechmat top administration was replaced, and the local Communist Party group started to play an important role in the student admission process (to both undergraduate and graduate programs), as well as in the faculty hiring process. Similar problems arose in other top universities. As a result, strong students who were suspected of having Jewish roots were no longer accepted to leading universities. In some cases, even line-up of the Soviet team for the International Academic Olympics was affected by the same tendency [2]. Local efforts to improve the situation (for example, for several years such students could study at the Department of Applied Mathematics of Moscow Institute of Gas and Oil) could not lead to principal solutions.

Taking into account that many leading physicists and mathematicians were of Jewish origin (it suffices to recall that five out of eleven Russian Nobel prize winners in physics have Jewish roots), and a traditional Jewish affection for natural science studies, one may conclude that Soviet universities and, later, Soviet science lost a good deal of talented people.

The period between 1970–1988 can be considered a period of stagnation, without serious exceptions. Higher education faculty, especially in leading universities, did not improve since political loyalty was valued much higher in the process of hiring people than professional qualities. When Soviet citizens of Jewish origin were finally granted a restricted right to emigrate to Israel, it became even more difficult for them to enter a university or find a decent job. Many of those affected by the situation chose to leave the country.

Mathematical Societies in Russian Cities

Nowadays mathematical societies play an important role in organizing the social life of mathematical communities all over the world. It suffices to mention the American Mathematical Society, the London Mathematical society, the European Mathematical society, and so on. They advertize vacancies, publish books and journals, discuss school and university curricula, organize regular meetings. There is no national-level association of comparable status in Russia. The Soviet Mathematical Association, established in 1934, did not succeed in becoming a serious organization that would unite the community, and was dissolved by 1960.

In contrast, mathematical societies of certain cities were active and, for certain periods, flourishing. The oldest one, the Moscow Mathematical Society, was established in 1867 and has been active without serious interruptions till now. In 1960-1990, it was headed by Aleksandrov, Kolmogorov, Gelfand, Shafarevich, Novikov. Its regular weekly meetings at Mechmat were attended by dozens of Moscow mathematicians. The Society published several respectable journals. Other pre-revolutionary societies like Kharkov and Leningrad ones were active too, as well as newly established societies in other cities. Being non-governmental organizations, these societies defined the community's moral and academic standards.

2. Current State of Mathematical Education at University Level

Several processes that began around 1988 have seriously affected mathematical education in Russia. Among them:

- disintegration of the Soviet Union;
- fall of the iron curtain, which gave Soviet mathematicians an opportunity to leave freely for the West;
- quick growth of both the number of universities and student enrolment in Russia;
- introduction of the obligatory state exam for high-school graduates;
- splitting of university education into two stages: 4-year bachelor programs and 2-year master's program, instead of the traditional 5-year "specialist" education.

Some aspects of mathematical education have survived these processes but the very necessity to survive weakened them a lot. Thus, the Kvant journal, as well as Correspondence School, still exist but they do not affect mathematical education anymore due to the small number of participants. Nevertheless, this does not mean that mathematical education in Russia is in crisis, as Russian knowledge of how to teach and do mathematics is still highly demanded in the world.

Impact of the Post-1988 Period on Mathematical Education

Simultaneously with the disintegration of the Soviet Union, Russian economy collapsed. The country's financial system was in a poor state, and for about ten years in a row universities got very small financial support from the government compared to the preceding years. At the same time, state control over education and its outcomes weakened dramatically.

An increase in the number of universities led to more corruption in the university admissions process (which in those times relied on the system of entrance exams).

In many cases, corruption part of the educational process at later stages too: students were expected to pay for passing exams. Although mathematical departments were affected by this problem less than, for example, those of medicine, economics, or Law, they experienced certain negative effects as well. The introduction of the Unified State Examination in 2002 was aimed at improving education at high-school level and tackling corruption at university entrance exams. Unified State Examination in mathematics is obligatory for all high-school graduates. It has been highly criticized by many experts because of a standardized approach to problems, which cover only a part of high-school mathematics. Criticism became less concentrated after 2010 when multiple-choice questions were excluded from the exam but corruption accusations against the system of Unified State Examinations on the whole remained high till 2014.

Most of good, specialized high schools all over the country survived the complicated period of 1988–2000 without serious loss of quality. In contrast, the average level of education decreased dramatically. Despite the lack of comparable data, practically all experts agree that most university freshmen's mathematical background is much lower now than in the 1980s.

University Education Centers

Emigration of many leading Russian mathematicians, which reached its heights after 1988, dramatically weakened both higher education and research in Russia. For example, all the Fields medalists of Russian origin have permanent positions in the West (the only exception, till recently, being Grigori Perelman, who does not work for Russian institutions anymore anyway). Thus, it is estimated [3] that more than 300 active Russian mathematicians found permanent positions in American universities after the disintegration of the Soviet Union, while more than 1000 in total left Russia and moved to the USA. The former's combined scientific productivity was greater than that of their American colleagues: during the period 1992–2008, each of them published on average 20 papers more, and got 143 references more.

Nowadays Russian public universities have about 130 departments teaching math majors [4]. Leading scientists teach at only few of them. As a result, the average level of research in most of the universities is lower than that in the US, Canadian or Western European universities. Teaching level is low too: professors who don't do research teach badly prepared students.

Academic inbreeding is wide-spread. There is no real competition in the process of hiring. With few exceptions, regional universities admit only high-school graduates from the same region. Regional universities do not compete for mathematics students, and they are not attractive for young people interested in math.

While there were more than 30 out of the 80 invited speakers at the International Congress of Mathematicians in Berkeley (USA) in 1986 came from the Soviet Union (most of them from Russia), only 5 Russians (among 170 speakers) were invited to give talks at the Congress in Hayderabad (India) in 2010. When compared to European and North-American countries, Russia hosts much fewer conferences, and with fewer foreign participants.

Nevertheless, new centers of mathematical education have been established in Russia in the recent years, and they have already gained world-wide recognition, namely:

The Independent University of Moscow (founded in 1991)

- and (closely related to it) Faculty of Mathematics at National Research University Higher School of Economics (founded in 2008).

In September 2015, a new bachelor program was launched at St. Petersburg State University.

The Principles of Developing Mathematical Education in Russia

The government realizes the importance of mathematical education for national economic development and the need to improve it. On December 24, 2013, the government approved The Principles of Developing Mathematical Education in Russia. However, its practical implementation is planned to start in 2016, and for now, the results are difficult to predict.

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[1] For example, the running data of Kvant issue no.10, 1974 at the website ***http://kvant.ras.ru/oblozhka_djvu.htm*** *indicates the number of published copies as 361,090*

[2] See, e.g., the interview with Grigory Perelman's teacher Sergei Rukshin: ***http://polit.ru/article/2012/12/18/rukshin2/***

[3] George J. Borjas, Kirk B. Doran THE COLLAPSE OF THE SOVIET UNION AND THE PRODUCTIVITY OF AMERICAN MATHEMATICIANS, The Quarterly Journal of Economics (2012), 1143–1203. doi:10.1093/qje/qjs015.

[4] See the list in the 2014 rating ***http://www.hse.ru/ege/second_section2014/rating/2014/53497441/gos/***

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