

# Mathematics in Kolmogorov's School

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More and more activities aimed at high school students are being organised by universities in Europe and all over the world. The reason of this trend is twofold: to raise interest in scientific education and to increase the level of students eventually passing entrance exams or other forms of selection to enter higher educational institutions. Russian experience of more than 50 years can be useful to create an operational model of a specialised school connected with a higher educational institution.

The first school specialising in mathematics and physics was created in 1963 in collaboration with Moscow State University through the initiative of the world famous mathematician and member of the Soviet Academy of Sciences, Andrei Kolmogorov. Almost at the same time, similar schools were created in Novosibirsk and then in Leningrad, Kiev and Alma-Ata, and later – right before the dissolution of the Soviet Union – in Minsk and Sverdlovsk. Together with Kolmogorov, the initial idea belonged to academician Isaak Kikoin, Rector of Moscow University Ivan Petrovskiy and President of SAS Mstislav Keldysh.

The creation of specialised high schools at prominent universities has allowed the training of students of higher grades who have shown interest in mathematics and physics; professors from these universities have participated in the development of the programmes for the students and the realisation of the programmes. On top of that, students of such schools have had access to scientific research at a very early stage of their “careers”. University professors have acted as their scientific advisors – this approach has been applied since then and it has produced promising results.

Traditionally, these specialised schools welcome students who pass entrance examinations after the 9th grade (at an age of 15–16). These students are selected from all over the country, with the possibility of being lodged at the school's dormitory. At this age, they already have some ideas about their professional orientation and specific talents start showing up – one just needs to help the students acquire the necessary level of specialised knowledge. They are also autonomous enough to be able to live away from their families. So, another important aim has been in allowing them to socialise with other talented teenagers – in such schools they are surrounded by their peers. They not only study together but also interact in their spare time. In a specialised school, all students are offered advanced learning programmes, complicated optional and special courses, and projects and research activities but also various leisure activities coherent with their high intellectual potential.

In 1988, the school at MSU was transformed into the Advanced Education and Science Centre (AESC) – Kolmogorov's boarding school – which obtained the status of a department of MSU. This was a unique pedagogi-

cal experiment aimed at carrying out concrete work with talented children – a practical realisation of the ideas of Kolmogorov about selection, instruction and upbringing of gifted students.

Nowadays, AESC MSU works with students from the 10th and 11th grades (the last two grades in the Russian system), specialising in physics and mathematics, information technology, chemistry and biology. Regardless of the chosen specialisation, a very high level of mathematical education is maintained.

The school consists of six departments, five of them related to the specialisations of mathematics, physics, chemistry, informatics and biology; there is also a department of humanities. The classes follow the university scheme: lectures and exercise classes, optional and special courses, and exam sessions at the end of each semester – precisely like first and second year university students.

Concerning mathematics, three disciplines are taught at the school: mathematical analysis (calculus), geometry and algebra. The programmes of these disciplines are not precisely fixed; they reflect the personal tastes and experiences of each lecturer. The course of mathematical analysis is traditional and resembles a first year at university. The general goals of the geometry course are rather close to a high school programme, studying the properties of geometric shapes on a plane and in space but using more advanced techniques and results. The course of algebra is supposed to establish the foundations necessary for related disciplines. The advanced level means solving more complicated problems, considering some chapters not presented in classical programmes and addressing various topics usually discussed at university. All this arouses an interest for mathematics in general and its applications to other fields. It should also provide a basis for applying mathematical and computer modelling in science.



Andrei Kolmogorov with students at his school.

An important supplement to general mathematics courses is the programme of mathematical practicum. Within this framework, students solve computational and constructive geometric problems and conduct data analysis in order to classify mathematical objects and their properties. Sometimes this leads to the possibility of realising a project and even getting engaged in research activities; in these cases, the university professors act as scientific advisors. Results of such projects are then presented at various contests and even scientific conferences; sometimes they give rise to serious publications.

Let us stress again that special courses are delivered by university professors and actual researchers. This provides students with up-to-date information on recent scientific advances and allows them to make well-founded choices in deciding upon their own directions of research and education.

Amongst recent trends, let us mention that professors from AESC MSU also participate in educational projects for other students. Various evening, weekend and Summer courses are held and the distance learning platform is up and running. The school organises internet Olympiads, the "Mathematical multiathlon" tournament<sup>1</sup> and the "Kolmogorov's readings" conference.<sup>2</sup> This allows future students of AESC MSU and MSU to be addressed directly (including students of lower ages) whilst not forcing them to change their usual school and family atmosphere. With-

<sup>1</sup> <http://internat.msu.ru/doc/mathematical-multiathlon-2015-en.pdf>.

<sup>2</sup> <http://internat.msu.ru/16th-kolmogorov-readings/>.

in the framework of these activities, the profile subjects are taught clearly with an important emphasis on mathematics.

To conclude, let us stress again that during the years of its existence, the pedagogical team of Kolmogorov's school have obtained enormous experience of working with talented and highly motivated students. This experience may be interesting for those looking to start similar initiatives.



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