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Research Work with the Gifted Children at Kolmogorov School

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I. Introduction

The creation of the system of work with the gifted in the second half of 20th century. Historical and social preconditions. The place of boarding schools within this system. The principles of education created by the boarding schools founders: experimental, creative attitude to the educational programmes; attraction of every student (no exceptions) to the creative, research work; dependence of the curricula and educational programmes from the trend of the science and society development; democratic level of the interrelations at the boarding school. Moscow physics and mathematics boarding school was created in 1963 on the initiative by the famous scientists in the field of physics and mathematics. At that time in the USSR the tempos of industrial development was very high, especially in the field of military and space exploration. The demand of high qualified specialists in the field of sciences was very high as well. The system of advanced day time education was coming to its end in the field of sciences for the gifted senior school pupils. By 1963 this system had covered the inhabitants of big cities. In those cities, as a rule, there was a sufficient number of high qualified university lectures. So the boarding school established in Moscow, Leningrad, Novosibirsk

and Kiev were oriented for the selection of the distant country regions. The founders of Moscow boarding school were the prominent scientists Andrei N. Kolmogorov, the most outstanding mathematician, as his contemporaries said; Isaac K. Kikoin, academician in physics; Ivan G. Petrovsky, Moscow University rector and other.

The most important question for the professors and teachers of the boarding school is the selection of the profile subjects contents, especially in mathematics. It would be a serious mistake to limit educational programmes just by University programmes. Such approach leads to delletantish exposition of the advanced parts of science. The repetition of these courses at universities may lead to the loss of interest in subjects studied. At the boarding school all attention is aimed at the elementary mathematics and other profile disciplines profound study. The creative efforts of pupils are not limited by anything because the same problem often can be solved by means of both elementary and advanced mathematics. The limitation in methods demand deeper thinking. The structure of Moscow boarding school consists of 5 Departments: mathematics, physics, chemistry, computer science, humanities. There are also the department for education and research technical support, the department for pupils leisure time. Such structure formed within time. The chemistry and computer science departments were established in the beginning of 1990s. It was a result of progressive development of those fields of science. Nowadays a new direction - biology is adding to the boarding school profile subjects and the department of biology has been established. It's a result of genes engineering and the initiative of the new Moscow University faculty administration - the Faculty of Bioengineering and Bioinformatics.

II. Research Work Begins from the Lessons

Superposition of different types of the giftedness and different levels of preparation at the example of computer science. What should be taught at the boarding school? Combination of the teachers and the professors of University faculties. Succession: former students become teachers. Who can be a teacher at

school? The upbringing of the need to perfect oneself. What is the need of the teachers who can work out the course of their own? The collective of the like-minded men but not of the prominent one-aloners. The samples of the working out of computer science and algebra courses. The right combination of the profile and non-profile (science and humanities) subjects. The choice of the future major shouldn't be limited. Yu. Kim - a teacher of history and social science, a famous bard. D. Gordeyev - a teacher of mathematics and a famous painter. I. Korovin - the boarding school graduate, a graduate of the Gnesinys Musical Institute, a singer, an actor, our boarding school associate.

Lectures, seminars and practical laboratory lessons. Their peculiarity at the boarding school. The lectures should be interesting. Towards logical formality through examples. The problems done at the seminars are not the ones where standard algorithms are used. They create some preconditions for the creativity. The using of the Moscow University laboratory equipment. Adaptation of the students at University. The basis of the system of education at boarding school is the same as at University - the pupils attend lectures, work at seminars and laboratories. That provides the adaptation for the University environment directly from the school bench. The education is given for two last forms of secondary school (10th and 11th forms). The applicants are admitted to 2-year and 1-year programme.

A week educational programme consists of 42-44 academic hours. More than half time is allocated for the profile subjects study. The diagram shows the education hours for the pupils of 10th form who major in physics and mathematics. As one can see from the diagram, mathematics, physics and computer science occupy 53% of all time. The rest is devoted to the compulsory school subjects which are taught at our boarding school at a very high University level. There are authors' methodical works in Russian, English and other humanities.

III. The System of Extra Curriculum research Work

Special course as a result of the teacher's scientific and methodical work. What courses should be selected? An example of the working out of algebra

annual course. What should be studied at special seminars?

A special seminar - a practical continuation of a special course. Assignment. The students' reports. A stimulus for the independent research. Search and independent studying of the literature. It's impossible to ask a neighbour - one should find the answer by him/herself.

The studying of the new methods of the problems solving. Drilling of the techniques. Practical usage of the knowledge collected.

The pupils are broken to the research work not only during their lessons. In the afternoon some special courses are delivered, special seminars are held for those pupils who are interested in some special science direction. The diagram shows some themes of special courses. These lessons are taught not only by school teachers but also by the University professors. Such lessons are interesting not only for the pupils but also for the teachers because sometimes one can hear from a professor that the way of solving a problem suggested by a pupil is quite new and is of interest for future research.

From the time of its establishment the school teachers pay a lot attention to the methodical work. The school founders attitude to the educational programmes in an experimental, creative way. This tradition lasts till nowadays. Each teacher of our school is able to work out his or her own programme for the gifted pupils. So at school our own courses of lectures, manuals, books of problems and other methodical materials are being worked out.

The results of the methodical work for the last 5 years are represented at the diagram. The methodical material worked out at our school are often used by other schools and are recommended by the Ministry of Education for the specialized schools.

The complete course of school physics for forms 7th-11th compiled by Professor Pavlenko is represented at the front side of the slide.

Watch a funny clip about the physics lesson. The clip was made by our pupils. Our pupils can not only appreciate the depth of scientific thought but also to feel a creative rise.

IV. Individual Research Work

Why there should exist individual research work of students? Examples of the students' research results.

The peculiarities of the research problems for students. Individuality at work. Attraction of the highly qualified university teachers. Mutual interests of a teacher and a student.

How the students' individual research activities are stimulated. The system of scientific conferences in Russia and its connection with the conferences abroad. Should one take part in all conferences?

Kolmogorov Readings - the result of scientific work of students for a year. The main goal and peculiarities of Kolmogorov Readings. How are the best works published? Preliminary work. The Readings programme. The acquaintance with the best scientists of Moscow University and their creative works. Some words about previous academic year. One of the main principles of the school work is the attraction of all the pupils to the creative, research work. Both individual and collective activities are encouraged. The system of practical work at laboratories is aimed at the solving the problems by the groups of pupils. Mutual consulting, study of the literature, talks with the teacher. Each profile subject programmes are included into the school educational programmes. There also exist less creative forms of work. They are connected with the individual work of a teacher and a pupil. The teacher as a rule poses an unsolved problem. The pupil tries to solve this problem during some long time, usually some months. The results are delivered at a school scientific conference.

The system of school conferences has come into being in Russia. The most popular of them is the Russian round of the INTEL company. The Russian winners of the conference go to the USA to present their reports. The other important conferences are Chebyshev Readings held by Saint-Petersburg University, Chariton Readings at Sarov, Young physicists tournament. I'd like to say some more words about Young physicists tournament. It's a team competition, the essence of which is as follows: some teams take place in the competition, the

competition consists of some battles. Before each battle the teams are given the assignment and get some time for solving the problems. Then each team presents the solving of the problem and answers the question of the opposite team. The aim of the opposite team is to express the weak points of their rivals. The results of each competition are judged by jury, the winner is selected. The competitions are very interesting and the result in deepening the pupils knowledge of the subject. The Young physisists tournament was born within our school premises and now it has become a famous International competition to host the teams of different continents. Some countries pupils success who have recently become the competitors amaze. The representatives Of the Republic of Korea won in 2002 when they took part in the competition only for 2nd time. Unfortunately our school team due to the finance difficulties couldn't take part in the competitions for some years. Last year we could overcome the difficulties and took part in the final round that was held in Sweden, in Stockholm. This year this competition is held in Australia. We hope for the success for our team which have won the right to take part in the final round. Our team is a participant of the International conference of young scientists. This year it is held in the Netherlands, at Nijmegen. Last year it was held in Prague. From 2001 our school hosts International School conference - Kolmogorov Readings. Some 200 participants take part in it. Mostly they are the pupils of different regions of Russia.

The differences of the collective research work from an individual one. Who can be a member of the collective team? Grants. Examples

Practical lessons - an opportunity to check one's knowledge. Practical lessons on mathematics. A problem sample. Practical lessons on physics. How one can work out his/her own device? The development of the practical lessons idea. Transfiguration of the practical lessons on mathematics to those of computer science.

The role distribution in the team. What is the difference between a strong team and a team of strong members. The boarding school successes in the team Olympiads on programming. The work at a team and future research activities.

The work at a team stimulates individual activities.

Something about the mathematical battle rules. Traditional rivalry with school #54. Critical perception and its role in science.

V. Olympiads.

Is sport necessary for the science? Mass number and individuality in Olympiads. The history of the Olympiads development in Russia. The Olympiads and the boarding school founders. Unlike the individual creative work already solved problems are offered. A sample of the Computer science Olympiad problem. From the solving of an Olympiad problem to its composition. The teachers are the members of the Olympiads judge board. The connection of the Olympiads participants generations.

We understand that the creativity forms are different. A lot depends of the speed of thinking, the possibility of deep study of a subject, some special, universal abilities and other factors. The participants of school conferences, as a rule, are the pupils who penetrate deeply into the theme they research, spending a lot of time for that. Olympiads demand the speed of reaction, the quick understanding of the problem and the finding of the ways of its solving. Traditionally the pupils of Kolmogorov school win at Olympiads of very high levels including both Russian and International ones. The victories at Olympiads are not the main goal of the pupils. Now one can hear an opinion that one can win at Olympiad only being a professional in this field. We don't support that opinion. We think that exxagerative efforts for preparing for the Olympiad could be harmful for the teaching process. In spite of that in each of profile subjects every year our school sends its pupils for the final round of the All Russia Olympiad. Our pupils win prizes in mathematics, computer science, chemistry, physics, astronomy. One of the school's main task is to provide high general education level. Here the results of Moscow Olympiad are more characteristic. In spite of high rivalry in the field of mathematics and physics with the other schools the Kolmogorov schools holds the leading positions. The results of leading schools of Moscow are compared at the diagram: besides Kolmogorov schools the

schools 57 and 2, in a special column the results of other schools are shown.

It is remarkable that the results of the pupils of 11th form at the Olympiad in physics are better than the results of schools 57 and 2 but the results of 10th form pupils are still not.

VI. The Role of Extra Curriculum Work at Organising Leisure Time, Sports and Tourism.

The boarding school founders attitude to physical culture and tourism. Not only training a highly-qualified specialist but also bringing up a citizen. Modern time, moral and science. Contemporary science: a broad outlook, connection between the directions.

Dedication to creative activities. Communication with scientists at extra curriculum time.

The process of education at school is inseparably connected with the process of upbringing. So the whole life at school is aimed at not only at the profile education but also at making a member of society. The daily routine at school has been preserved since Kolmogorov time. The main idea of it is to combine intensive study with some physical exercises and regular nutrition and recreation. Leisure time could be used for both home assignment and for sports competitions and walks which often are held with the teachers participation. So the process of creative communication between teachers and pupils goes on till late in the evening.

Our pupils have the opportunity to visit all Moscow theatres including the famous Bolshoi Theatre, Maly theatre and other. For 2 years spent at school every pupil has the opportunity to visit Moscow theatres. The most favourite hobby of pupils during vacations are the hikes and excursions to different part of our great country. Here the character, real friendship is *и́стина* the sense of beautiful is developed.

Watch a short clip about *походе* by canoes along a river. For 40 years of its existence at the boarding school its own traditional festivals have appeared. It's the festival of Initiation, School Birthday, Kolmogorov Birthday.

Initiation is a festival that lasts two days. It includes an endless number of competitions which are held by the 2nd year pupils for the novice. It is here the boarding school atmosphere is so visible. School Birthday is celebrated on the first Saturday of December. Traditionally the graduates of different years meet and share their thoughts. Kolmogorov Birthday is celebrated on 25th of April. On that day every pupil thinks about his or her scientific career. The traditional Farewell festival to the Russian winter is also very popular.

VII. Relations with Moscow University. Gymnasium under University Auspices

Summing up abovementioned ...The Rector of Moscow University tutors personally the boarding school. Strategic guidance by the School Council. Instruction by scheme school-university is an example of continuous profile education.

From 65% to 85% of our graduates enter Moscow State University. The role of Moscow University for the boarding school is very important. Till 1988 the help of University was in sending its teachers from Mechanic and Mathematic and Physics Faculties to work at the boarding school. Besides, Moscow University carried out all methodical work on profile subjects. In 1988 a special Governmental decree was issued which incorporated Moscow boarding school into the structure of Moscow University. Only due to that the school has been preserved during the times of trouble for the country and the system of education. It still fulfills the tasks that were put by its founders. It hasn't become the preparatory courses but selects the gifted senior pupils. For many years the rector of Moscow University himself Victor Sadovnichy leads the school process. Besides the compulsory expenses for the education and accommodation the rector allocates the money that made it possible to reconstruct two buildings of hostels, to repair pipe system and technical equipment of educational process. In spite of high expenses for the education at boarding school University covers them. In their turn the school graduates are the basis of the staff of Moscow University science faculties. The strategy of Kolmogorov school development is worked out by Scientific Council which consists of 5 deans, some academicians, other leading University professors.

The Kolmogorov School is the only secondary educational establishment the

graduates of which are admitted to University without taking entrance exams. Their final exams at school are taken into consideration. So the pupils proudly bear the title of Moscow University pupils. Moscow University prepares teachers for schools and nowadays when other school are short of highly qualified teachers Kolmogorov school doesn't have any difficulty in having such staff.

The University teachers who work at Kolmogorov school get the invaluable training that gives an additional impulse in their research work. It should be stressed that in recent years the number of graduates entering other Moscow Universities have decreased.

VIII. Selection of the Gifted Children.

The goal of the selection. The role of the founders of the boarding school. The system of selection.

The knowledge of the manual material or ability to think? Who does the boarding school need?

The goals of the round by correspondence. It attracts by the handsomeness of the problems, demonstrates the necessary level. The problems samples.

The changing of the system of the relations with the regions. Competition or cooperation? The argument between P. Kapitsa and A. Kolmogorov and how time arbitrated them.

Summer school - a predecessor of the boarding schools. The goals of the summer school. Programmes samples.

The broadening of the competition field. The advantages of Moscow boarding school and the relations with the regional schools. The place of the boarding school in the system of work with the gifted. What do the students evaluate?

The unique admittance system was set up by the founders of Kolmogorov School. That time the whole country was divided into four regions by the numbers of boarding schools. Moscow school is responsible for the central and southern parts of European Russia. Gradually the conditional borders lost their significance and now the school admits the pupils from more than 40 regions of Russia. Every year to those regions the school sends its examination board that

consists of the Kolmogorov school teachers and other Moscow University faculties. After the independent states on the former USSR territory appeared the admittance system has been tolerated. In former time this system was regulated by the Minister of Education decrees. Those decrees envisaged some compulsory actions in the regions. The local bodies of education were obliged to receive, accomodate the representatives of the examination board, select the most gifted senior pupils and provide the conditions for the examinations procedure. Now the administartive system is lost, so to support the admittance system the existing links with the regions are used as well as the authority of Moscow University.

The system of entrance examinations consists of three parts. The first one is by correspondence. It is to attract the attention of the gifted pupils. The problems of that part are published in the central editions for the school pupils, for example in QUANTUM magazine. The problems are composed by high qualified specialists and the solution contains some element of creativity. The second one is supposes that an applicant meets the examination board. It is held in the regions and collects the participants of regional Olympiads and the pupils who took part in the correspondence.

The special role in the selection system is played by summer schools. The pupils who successfully passed the second round are invited for the summer school. During two weeks the experienced teachers have classes with these pupils on the most interesting problems of physics and mathematics. During the training process tests and exams are held that allow to evaluate the pupils' giftedness and the speed of their development. The summer school not only helps to select pupils but also give a good impulse for their future education. It is necessary to point out that the Kolmogorov school itself was born from summer schools that were held by its founders.

IX. Additional Programmes

The school brand. Attraction of scientists, teachers from other educational establishments.

The exchange programmes of school children, the meetings of the Olympiad

participants of the highest levels, seminars for the teachers.

International cooperation. Summer school for the foreign students and teachers, participation at international symposiums.

For a long time school developed as a elitary educational establishment. The information about school were not available in media and was not the subject of discussion of broad scientific circles. Some years ago the negative features of that way of development appeared in the aspect of the increasing competition in the field of training the gifted. So the department of additional educational programmes was established the main task of which is the establishing the links with other educational establishments in Russia and abroad. The most tight contacts are established with Busan Science Academy (Republic of Korea) which was opened in 2002. In the Republic of Korea the educational programme for the gifted is developing very rapidly. The opening of the school working on the principles like ours is the prove of the correctness of the way which was chosen by academician Kolmogorov. In summer 2003 Kolmogorov school received a group of 130 Korean pupils and teachers for the educational and cultural programme. To work at this summer school the leading teachers of Kolmogorov school in mathematics, physics, chemistry, computer science and English were invited. All lessons were given in English. The programmes for pupils and teachers were given simultaneously. After classes the teachers and pupils were able to see the Moscow sights and take part in sports competitions. The both sides were very content of how this summer school was held. The Korean side suggested to go on with this programme in 2004.

Now the Council of Kolmogorov school and the administration research the question of the long term education of foreign pupils at Kolmogorov school.

X. Results for 40 years of Work. Perspectives

About some school prominent graduates. The school is a provisioner of applicants for Moscow University. Surveys. Perspectives and conditions for future development.

In December 2003 our school celebrated its 40th anniversary. Some results were

summarized. The main of them are:

- more than 7,000 graduates;
- many of them have become famous scientists, professors at higher educational establishments, leaders of different enterprises, banks, political leaders;
- among the boarding school graduates is the world famous programmer, the author of computer anti-virus programme Yevgeni Kaspersky, academician in computer science Gennady Savin, corresponding members for Russia Academy of Sciences Matiyasevich, Abramov and other outstanding scientists.

The graduates of boarding school form the whole corporation in the leading Moscow higher educational establishments. At the boarding school the psychology service works. One of its task is the evaluation of the characteristics of personalities of the pupils, the possibility of their constant presence in the collective of pupils. Not every gifted in science pupil can be an organic part of the collective of pupils. A lot of cases are known when future prominent scientists couldn't bear the life at boarding school. The psychology service should predict such cases. The order is as follows: first a special test is held. Then by its results, a group of risk is found for the systematic individual work in the future. In the process of taking a survey some important questions also appear. At the slide the motives for entering to the boarding school are shown. According to the spirit of time the most expressed motives are connected with pragmatic reasons: entering Moscow University, study at a prestigious school, study at Moscow and other. Among 250 graduates a survey was held to find out if they liked their life. The majority have found their place in life and are content that they studied at Kolmogorov school. The results are shown at the diagrams. It is interesting that the most of the pupils would like to have their children studying at Kolmogorov school. This answer is the most characteristic for the pupils attitude to the school. Lets' mark that almost all graduates after getting higher education take an active life position.