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A Soviet Experiment in Science Education

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ON A visit in April 1967 to the USSR,[1] I was given the opportunity to visit a new experimental high school of science, the Physics-Mathematics-Chemistry Boarding School (Fiz-Mat School) attached to the Novosibirsk State University. Although the visit to this school lasted only part of a day, mimeographed source material on the high school was provided,[2] and there were also later opportunities to discuss with scientists of the USSR Academy of Sciences the operation and philosophy of the school. The existence and significance of this and other, similar experimental schools in Moscow, Kiev, and Leningrad warrant the attention of the science teaching profession in the United States. The following report is intended to sketch the organization, operation, and philosophy of these schools and to comment briefly upon their significance to secondary-school science education in the USSR.

The Fiz-Mat School in Novosibirsk began operating in 1962 as a two-year boarding school specializing in teaching physics, chemistry, and mathematics to students in their last two years of the public school system. Students are chosen through a series of competitive examinations (the All-Siberian Science Olympiad). In the first round of this competition, problems in chemistry, physics, and mathematics are published in local Komsomol (Communist Youth Organization) newspapers. Interested students send in answers to their problems, and the answers are graded by scientists from the Siberian Division of the Academy of Sciences and by students from Novosibirsk State University. Winners of that competition are invited to participate in a second round held in major cities of various districts. This event is supervised directly by special commissions from Novosibirsk. Participating students hear lectures telling about the program at Novosibirsk and compete in a problem-solving session. Winners of round two are invited to attend a three-week summer camp at the new Academic City (Akademgorodok) located about 30 kilometers outside of Novosibirsk. Here they listen to daily lectures given by outstanding scientists and participate in daily two-hour practical work sessions in mathematics, physics, or chemistry. In addition, there are organized social and athletic events designed to keep high school students happy. The summer camp ends with a last competitive examination. Students with the best papers are invited to attend the Fiz-Mat School to finish their high school training.

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Normally students attend the school for their ninth and tenth years of schooling (equivalent in level of work to our last two years of high school), and at the end of the course they receive a certificate of secondary education. Some especially worthy students are brought in for three years, and others who are "discovered" late may spend only their last year (tenth) at the school.

Lists describing the make-up in 1964 of the student body show the following:

(a) There were 607 students, 540 of whom were boys and 67 girls.

(b) Students had parents employed in a wide range of professions and trades, but grouping of the categories listed shows that:
- 26 percent were children of teachers, scientists, and doctors.
- 20 percent were children of engineers.
- 12 percent were children of skilled laborers.
- 10 percent were children of military personnel and party or government officials.
- 28 percent were children of parents involved in all other *trades* (described under the title "workers," e.g., workers in art, journalism, sales, transport, etc.).
- 4 percent were children of parents involved in agriculture.

(c) The overwhelming majority of students were Great Russians (82 percent). The second most important group consisted of Jewish students (9 percent), with all

[1] This visit was a part of the cultural exchange program between the National Academy of Sciences and the Academy of Sciences of the USSR.

[2] The details of operation of the Novosibirsk Fiz-Mat School are described in a mimeographed pamphlet entitled *Nauka i Prosveshcheniye, Nauchno-pedagogicheskiy sbornik*, vypusk 1, published by the Redaktsionno-isdatel'skiy otdel of the Siberian Branch, Academy of Sciences, USSR, 1965. The authors of articles in this pamphlet are D. B. Shirkov and A. A. Lyapunov, correspondent members of the USSR Academy of Sciences; Yu. I. Sokolovskiy, docent at the Novosibirsk State University; and S. I. Literat, director of the Novosibirsk Fiz-Mat School.

other national groups (e.g., Armenians, Byelorussians, Bashkirs, Tartars, Ukranians, etc.) making up the remaining 9 percent.

(d) Ninety percent of the students came from cities, and only 10 percent were from the country.

(e) Eighty percent of the students were members of Komsomol, the Communist Youth Organization. (This figure is probably considerably above the national average for this age group.)

In meetings and brief discussions with students at the Novosibirsk school I was impressed by their alertness, friendliness, and good manners. Many were eager to get into contact with American students and to begin "pen-pal" relationships.

THE STAFF of the Fiz-Mat School is building a curriculum similar in pattern to the curriculum in Soviet universities. Courses consist of lectures and practical work sessions. The table below shows the instructional plan of the school for the 1964-65 academic year.

Class sizes are deliberately kept small. There are generally about 30 students in each of the 21 classes in the school. Lectures are given in a large-group situation, with perhaps as many as 200 students attending (all of the members of grade 10, for example). For practical work sessions the 30-student classes are split into 15-student groups. In subjects such as literature, history, and social studies all 30 students of each class meet together. Separate tracks are maintained for students who enter the school in grade 8 for a 3-year program and for students who enter in grade 10 for only a 1-year program.

Lecture courses are given by scientists from the Academy of Sciences of the USSR and by professors from the Novosibirsk State University. It is interesting to note that scientists and professors involved do not make one or two lectures apiece. Generally a single man gives an entire course. Lecture materials, according to the descriptions available, are "reinforced by practical work sessions." Generally the lectures are two hours long. "Problem-solving" sessions involve mainly supervised independent work rather than blackboard solving of problems. Semester examinations are given in all courses, and certificates of completion are required for laboratory and practical work sessions.

Specialized work in the last semester consists of three days a week devoted entirely to specialized work in a particular science specialty elected by the student. The work involves special courses and also research work in various laboratories of the Academy of Sciences. The following are examples of institutes which have taken on students working on projects: Nuclear Physics, Hydrodynamics, Theoretical and Applied Mechanics, Cytology and Genetics, Inorganic Chemistry, Geology and Geophysics. Upon graduation, students receive not only a diploma, but also a professional rating such as mathematician-programer, laboratory assistant in chemistry, laboratory assistant in biology, etc.

Science clubs play a big role in the life of the school. More than 25 of these exist in such fields as nuclear physics, structure of matter, cybernetics, mathematical logic and algebra, differential equations, and theoretical biology. Many students also join Academy of Sciences summer expeditions in biology, geology, and other fields.

Subject	Number of Hours Per Week			
	Ninth Class		Tenth Class	
	Semester		Semester	
	First	Second	First	Second
Mathematics lecture	2	2	2	3
problem sessions	6	6	6	–
Physics lecture	2	2	2	2
problem sessions	4	4	4	2
laboratory work	3	3	3	–
Chemistry	2	2	4	–
special practicum	–	–	1	–
Biology	2	2	2	–
Earth science	2	2	–	–
History	2	2	2	2
Social studies	–	–	–	2
Literature	2	2	2	2
English	3	3	2	2
Subject in a specialty	–	–	–	15
Total number of instructional hours per week	30	30	30	30 *

* There is now discussion about the possibility of reducing the number of classroom hours to 25 in order to give students more time for independent work.

Physical education is also required of all students, but it is not included in this table.

THE SCHOOL has an unusual relationship to the Novosibirsk State University. Extensive participation of scientists from the Academy of Sciences and the Novosibirsk State University in the teaching process has already been mentioned. Scientists who teach at the school get released time from their other duties in order to perform these functions. The scientific and methodological directions to be followed in the school are determined by the school council, which is appointed by the rector of the University. Among the members of the school council are the University's deputy rector for academic affairs, the deans of the various faculties, and several of the more renowned scientists from the institutes of the Academy of Sciences. Various council members become chairmen of committees which are responsible in each subject area for determining the program and arranging for preparation and publication of special curricular materials. Special meetings of teachers in charge of practical work sessions assure the maintenance of high standards and the use of suitable teaching methods. It is clear that the Fiz-Mat School is a carefully controlled University preparatory school for exceptional high-school students.

WHAT is the significance of this kind of experimental, state-operated school within the Soviet educational framework? In the first place, it obviously gives a clear advantage to superior students on university entrance examinations. At the end of the 1963-64 school year, 93 students received certificates of secondary education from the Novosibirsk Fiz-Mat School. Of these all 93 received satisfactory marks on the mathematics entrance examination to Novosibirsk State University. Sixty-four of the 93 received a rating of "excellent." All passed the physics examinations also, 67 with a rating of "5" (highest). Eighty-two students ultimately were accepted as day students and five as evening students at Novosibirsk State University. Forty-seven of these went into physics, 36 into mathematics, 2 into mathematical economics, and 2 into chemistry-biology. Five additional students went on to other institutions of higher learning, and only 1 of the 93 graduates apparently did not continue his education.

Second, these experimental schools have a freedom to try out new curricula and techniques that is uncommon in the Soviet school system. They are allowed to operate fairly freely within the framework of the University to which they are attached without having to account to the Ministry of Education quite as much as do regular Soviet schools. Furthermore they are regarded as fairly small-scale testing grounds where new methods and curricula can be examined before being approved for general distribution. University scientists collaborate with scholars trained in the arts of pedagogy and with experienced teachers in formulating new curricula and techniques. This close association of working scientists, university educators, and teachers is a rather revolutionary combination for the Soviet Union and may produce significant advances in secondary-school science education in the USSR. The future of these schools and their influence on the overall trend of science teaching in the Soviet Union bear watching. ##

At right, two students work on a difficult problem. Below, Dr. Yuriy Borisovich Rumer, a theoretical physicist and director of the Institute of Radiophysics and Electronics, Siberian Branch, Academy of Sciences of the USSR, chats with students about their course work on a walk in the forest surrounding the Academic City.

Academician Mikhail Alekseyevich Lavrent'yev, president of the Siberian Branch of the Academy of Sciences, USSR, and director of the Institute of Hydrodynamics, has just finished a lecture on the physics of explosions and is shown answering questions from students. All photos courtesy of S. I. Literat, Director of the Fiz-Mat School.