Specialized Schools for Mathematics as a Mirror of Change in Russia

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Abstract. This article is devoted to Russia's specialized schools for mathematics. The graduates of such schools include hundreds if not thousands of accomplished mathematicians, physicists, and engineers. The study traces the history of the development of such schools as a reflection of social processes taking place in Russia. Also discussed are the results of surveys taken among students currently enrolled in such schools.

Cet article concerne les écoles russes spécialisées en mathématiques. Les diplômés de telles écoles comptent parmi centaines, si non milliers de mathématiciens, physiciens, et ingénieurs accomplis. Cette étude trace l'histoire du développement de telles écoles comme réflexion des processus sociaux qui ont lieu en Russie. On discute aussi les résultats des enquêtes faites des étudiants actuellement inscrits en telles écoles.

The title of this article parodies the title of a famous text by Lenin (1908), which was required reading in Soviet schools for decades. The present article is devoted to the so-called specialized mathematics schools in Russia, also known as schools with advanced teaching of mathematics. Proof of the success of these institutions can be found today in virtually any major university, since its faculty will almost certainly include a graduate of such a school. Numerous articles, both in Russian and in other languages, have been devoted to the methodological and organizational aspects of the work of these schools, as well as to the history of their development (for references see Donoghue et al., 2000, and Vogeli, 1997). This article will focus primarily on the relationship between social-political changes in Russia and the development of specialized mathematics schools, first providing a brief historical overview of the subject, and then focusing on a study conducted by us of students currently enrolled in such schools. The development of society as reflected in even relatively restricted aspects of education is no less edifying, it would seem, than its reflection in art, which so interested Lenin.

The history of specialized schools for mathematics. Russian (more precisely, Soviet) schools for mathematics first appeared as part of the so-called "thaw" under Khrushchev, after his denunciation of Stalin's Cult of Personality at the famous Twentieth Party Congress in 1956 promised changes not only in Soviet politics, but in society as well. The ensuing changes, in retrospect, turned out to be not all that deep. Moreover, they initially met with certain limits. It was around this time that the outstanding Russian poet Boris Slutsky wrote a line that was subsequently often quoted: "Physicists are held in high esteem, lyric poets are persecuted... " (1959). The government held the "physicists" (mathematicians may be included in this category) in high esteem not only because it was precisely they who were creating a "nuclear shield for the homeland," but also because their activity had far fewer ideological ramifications than did the work of the "poets." As a consequence, it turned out that even in the more "poetic" side of life—in the organization of substitutes, of one sort or another, for public life—the "physicists" had more leeway. This became at least one of the reasons why society perceived going into "physics" as a step in the direction of liberalism.

These schools, which appeared at the beginning of the 1960s under the leadership of prominent Russian mathematicians (first and foremost, Andrei Kolmogorov), consciously or unconsciously reflected the hope that the new generation of students would live under different, more open conditions. Initially, these schools enjoyed greater freedoms than ordinary schools. Among their principals, one could find individuals who were not members of the Communist Party (which was extremely unusual for Soviet schools); and among their teachers, one could encounter such people as Anatolii Vaneev (1990), who had not completed his formal undergraduate education, but had spent a number of years in a labor camp, where he came into contact with Lev Karsavin, one of Russia's major religious philosophers. Even more important was the tradition of open discussions which was cultivated in these schools, as well as the tradition of genuine research in collaboration with the teacher (or rather, in collaboration with the teachers, since whole groups of undergraduate and graduate students often took part in teaching a single class). The independent discovery of even standard assertions, which would have usually simply been memorized elsewhere, went hand in hand with the ability to see in an ordinary school problem a possibility to generalize it and to formulate new, deep questions—in this way, both the curriculum and the teaching methodology fell under the influence of the dominant spirit of these schools.

During the period of "stagnation" (from the 1970s to the mid-1980s), this spirit became unwelcome. It was assiduously suppressed. Fields Medal winner Sergey Novikov (1996) writes that "it is no secret that... the powers that be, often not without reason, found a spirit of dissent within the student population of special schools" which they attributed to "international imperialism and Zionism" (p. 34). Alexei Sossinsky (1989), one of the main contributors to the magazine "Kvant" and a former teacher in Kolmogorov's specialized boarding school in Moscow, notes that during the 1970s "[the boarding school] turned more and more into something like preparatory courses for students from the provinces, with the social background of the students playing a greater and greater role in their acceptance to the school, and their actual aptitude for science playing a lesser and lesser role." The spirit of research, and consequently the spirit of the unknown and unpredictable, gradually disappeared, and what replaced it was a kind of skill at solving problems on college entrance exams. Frequently, these problems were indeed very difficult, but they were not posed as general scientific problems and were oriented more toward speed, knowledge, and skills, than toward interest and contemplation.

Gorbachev's "Perestroika," which began in 1985, aroused a new wave of interest in specialized mathematics schools. A return to the combination of productivity and limited freedom, which had been possible twenty years earlier, appeared as a way to save the economy. CPSU Central Committee Secretary Yegor Ligachev (1988), speaking before the Central Committee, called for an expansion of the system of specialized mathematics schools, and their number immediately began to grow. For the most part, however, these schools were "mathematics schools" in name only: despite the large number of hours devoted to mathematics in their curriculum, the spirit of research and creativity did not penetrate them—among other reasons, due to the fact that there were not enough teachers who were capable of introducing this spirit into the classrooms.

The further development of Russian society has led to even more marked changes in the course of which mathematics, as well as employment in institutions of higher education in general, have lost a great deal of prestige. The views and values of the potential students of mathematics schools have undergone significant changes. It is natural to suppose that such changes have influenced conditions even in those schools which possess the finest teaching staffs. Therefore, it appears useful to conduct not only a general analysis of the current policies of Russian authorities toward mathematics schools (policies whose character, we may briefly note, is quite contradictory),

but also a more "local" investigation of the views and opinions of the students currently enrolled in them. At present, there is an acute lack of such research.

Methodology. The present article describes a pilot study of two groups of 8-graders and 11-graders (14-year-olds and 17-year-olds) in one of St. Petersburg's mathematics schools. A questionnaire was prepared for the study (in putting it together, the author relied substantially on the work of Kloosterman, 2002, somewhat shortening the original questions and altering those that were not culturally relevant). In contrast to Kloosterman's work, these questionnaires were not used in oral interviews, but submitted for written responses (in order to allow the respondents to express their views more fully, an open-question approach was chosen over a multiple-choice format). All together, 18 questionnaires were collected from 8-graders and 19 from 11-graders (initially, 25 and 27 had been handed out, respectively). Naturally, the present study does not claim to provide any kind of statistical proof. Its aim, rather, is to give a qualitative analysis of the students' responses and to identify various key types among them.

Information about the participants of the study. It must be noted that the respondents do not include, for example, winners of city-wide mathematics Olympiads: an effort was made to select groups of "ordinary" mathematics school students, as it were, whose position could be considered typical of the broader category of students to which they belonged. The average grade in mathematics (derived differently in each school, however, and therefore not particularly informative) for the 11-graders surveyed was 3.9; for the 8-graders surveyed, it was 4.1 (out of a maximum 5).

Among their favorite extracurricular activities, 18 of the respondents named sports, 10 named computer-related activities, 6 named music, 3 named simply spending time with friends, and 3 did not respond (3 of the respondents gave 2 answers). In response to a question about their plans after graduating from high school, all of the 11-graders mentioned attending college, and only three respondents gave a general answer, while the others actually specified concrete top colleges in St. Petersburg which they planned to attend. The 8-graders presented a somewhat different picture: 3 replied that they do not know yet what they will do after finishing high school; 10 responded that they will go on to college; and 5 specified which college they plan to attend. It is interesting to note that two of the 8-graders indicated that they plan to study abroad.

The answers of the participants of the study. The respondents were asked to evaluate on a scale of 1 to 10, with 10 being the highest, (a) how much they like school, (b) how useful they think school is for the things they want to do, (c) how much they like math. The table below shows the distribution of the scores they provided (the number of students who gave each score is indicated).

Points	a			b			c		
	11th grade	8th grade	total	11th grade	8th grade	total	11th grade	8th grade	total
10	3	3	6	5	5	10	4	4	8
9	7	10	17	5	4	9	6	4	10
8	7	4	11	4	4	8	4	5	9
7	1	1	2	5	2	7	5	4	9
6	1	0	1	0	0	0	0	1	1
5	0	0	0	0	2	2	0	0	0
No answer	0	0	0	0	1	1	0	0	0
Average	8.5	8.8	8.7	8.5	8.4	8.4	8.5	8.3	8.4

As can be seen, the scores in all three cases are quite high.

Also noteworthy were the students' responses to the question, "What influences you to work hard in math?" They may be broken down into several groups. The results are indicated in the table below.

Response	11th grade	8th grade	total
Mathematics will be a necessary tool in the future (in life or other subjects)	5	2	7
The attraction of mathematics itself, an interest in and penchant for mathematics	11	11	22
Considerations of prestige	0	1	1
Mathematics is no different from any other subject	0	3	3
No answer given	3	1	4

A series of questions was aimed at identifying possible extracurricular influences. When asked whether their parents made use of mathematics, eight 11-graders and nine 8-graders answered in the affirmative, and nine 11-graders and seven 8-graders replied in the negative (two students from each grade level replied that they did not know or did not give an answer). Only one 8-grader indicated that he personally made use of mathematics at his part-time job (all others replied that they had either never worked part-time, or that they had done so without making use of mathematics). A question about their friends' attitudes toward mathematics elicited quite varied responses. A number of respondents (10 students) indicated that they had never discussed this subject with their friends and did not know their attitudes toward it. Approximately as many (11 students) replied that their friends' attitudes toward mathematics varied. Again, more or less the same number (13 students) responded that their friends had a very positive attitude toward mathematics, frequently emphasizing the fact that their friends were students from the same school. Finally, only three students (all of them 11-graders) replied that their friends did not like mathematics ("they consider it useless and incomprehensible nonsense").

At the same time, when asked how important their teachers' and friends' attitudes toward their academic success were to them, the respondents often stressed the fact that their friends' attitudes did not matter very much to them ("they have no influence," "they play no role," "friends' attitudes are irrelevant"). Naturally, the opposite point of view is also represented ("friends' attitudes are interesting," "I don't want to look like an idiot," "I'm an important person in class and have to maintain my level"), but all together, there are about three times fewer responses emphasizing the importance of friends' attitudes than responses stressing the lack of such importance. The case with the attitudes of teachers is rather different: only 15 students responded that their teacher's opinion is not important to them.

Students typically evaluated their success in mathematics based on their grades in school, with 9 respondents evaluating them as "good," 19 as "average," and only 5 as "poor" (4 students did not respond). The main shortcoming usually indicated in these responses was inattentiveness, inability to concentrate, etc. With few exceptions, the respondents rejected the notion that they possessed some kind of special talent, but at the same time they expressed the opinion that talent did not play a particularly important role in studying mathematics: "you need an inclination and a desire, not talent," "you need to be interested," "you need patience and effort," "something comes from nature, but it is important to work and develop yourself."

The students' views of mathematics were of the utmost interest to us. Following Kloosterman, we asked them to describe how they would explain what mathematics is to "an alien from outer space." Almost half of the students (16 people) did not give an answer; four others

merely stated that mathematics was a useful science. The others attempted to formulate definitions. Among them were the following: "Mathematics is the science of coding processes and phenomena and operations involving these codes"; "the science of numbers and operations involving numbers, as well as their applications"; "a science that uses forms, tables, and graphs to describe the fundamental processes of life"; "a logically structured technical science connected with precise measurement and calculation."

Kloosterman posed this question in order to determine the extent to which "the student sees math as 'rule-based' and believes that math involves complex problems." As can be seen from their responses, the students in our study clearly do not perceive mathematics as being reducible to a set of rules. It is not surprising, therefore, that fewer than one third of the respondents agreed with the statement that memorization is important in mathematics (and even those that did agree with this statement often added the explanation that memorization speeds up the process of problems solving, but that understanding is still more important).

The students were virtually unanimous in their rejection of the statement that studying mathematics today is less practical from a career perspective than it once was: "this is so only in particular cases, but the general tendency is in the opposite direction"; "on the contrary, mathematics is now used more widely in technology"; "no, the development of computers is impossible without mathematics." In all of these instances, it is specifically the applied significance of mathematics that is used as an argument.

Discussion. The answers of the respondents, as can be readily seen, differed rather considerably from the responses described by Kloosterman. Just like the students he interviewed, our respondents are not especially interested in a general definition of mathematics, but they do view it as a science, and moreover a useful science, rather than a dull set of rules. Mathematics is interesting to them. It is because of this, and not just because of its importance for their careers, that they began to study mathematics intensively. The example of their parents appears to have had little direct influence on the formation of their interest in mathematics, and the influence of their friends or work is even smaller. It is natural to connect their interest in mathematics to those opportunities which their school has provided for them, as well as with the profound respect that mathematics has continued to command in society. Naturally, as our study shows, by no means all Russian students have an interest in mathematics; it is clear, however, that despite the changes of recent years, such students are still sufficiently numerous.

How far these students' interest in mathematics extends, and what its parameters are, remains unknown. The present study does not aim to investigate the differences between future research mathematicians and future consumers of mathematics. It can only be noted that the view of mathematics as, above all, a useful discipline for practical purposes, and only secondarily a theoretical field valuable in and of itself, is rather strongly expressed in the responses to the questionnaires.

Conclusion. The history of mathematics schools continues. Social and political changes have found their reflection in these schools, both in the organization of the teaching process, and in the spirit that reigns in the classrooms, and even in the nature of the assignments given to the students. As a rule, the corresponding changes in the schools have taken place rather quickly. At the same time, the interests and inclinations of teenagers, as well as the values of the society in which they live, have displayed a certain stability—the established attitude toward mathematics as a science and subject remains unchanged in at least a part of society (how this positive social attitude will be used, however, and to what extent it will prove possible to educate a new generation of research mathematicians, will depend above all on contemporary political and social circumstances).

The presence of such a positive social attitude can be explained by a series of factors, not the least of which is the successful experience of the work of the mathematics schools. The attitude of society, and the attitude of students in particular, is not an unchanging fact that must simply be studied. It can and must be improved. The successful work of mathematics educators can contribute to the cultivation of a positive attitude toward the subject among new generations of students as well.

References

Donoghue, E.F., Karp, A., Vogeli, B.R. (2000) Russian Schools for the Mathematically and Scientifically Talented: Can the Vision Survive Unchanged? In *Roeper Review. A Journal of Gifted Education.* Vol. 22, # 2, 121-122.

Kloosterman, P. (2002) Beliefs about Mathematics and Mathematics Learning in the Secondary School: Measurement and Implications for Motivation. In G. Leder, E. Pehkonen, G. Törner (Eds.) *Beliefs: A Hidden Variable in Mathematics Education?* Dordrecht/Boston/London: Kluwer Academic Publishers, 247-269

Lenin, V.I. (1908/1963), "Leo Tolstoy as the Mirror of the Russian Revolution," in *Collected Works*, 4th English Edition, Moscow: Progress Publishers, vol.15, 202-209.

Ligachev, E. (1988) On the Restructuring of High School and College Education and the Party's Role in Its Implementation. [O hode perestroika sredney i vyshey shkoly I zadachah partii po ee osuschestvleniu]. Report Delivered at the Plenary Meeting of the Central Committee of the Communist Party of the Soviet Union, 17 February 1988, *Kommunist*, No. 46, pp. 32-66.

Novikov, S.P. (1996). Mathematics in Russia Is More Than a Science, or Is There a Future for Mathematics Education in Russia? [Matematika v Rossii Bol'she, Chem Nauka, ili Matematicheskove Obrazovanie v Rossii-est'li Perspektivy?] *Znanie-sila*, 5, 29-37

Sossinsky, A. (1989) Our Round Table [Nash kryglyi stol] (for the Twenty-Fifth Anniversary of Specialized Boarding Schools in Physics and Mathematics) *Kvant*, # 2, 2-5, 15

Vaneev, Anatolii (1990) *Two Years in Abesi: In Memory of L. P. Karsavin* [Dva goda v Abesi: v pamiat' o L.P.Karsavine]. Brussels': Life with God.

Vogeli, B.R. (1997). Special Secondary Schools for the Mathematically and Scientifically Talented. An International Panorama. New York: Teachers College Columbia University.