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Specialized Schools for Mathematics as a Mirror of Change in Russia

The title of the present work is a parody of the title of a famous article by Lenin (1908), which was required reading in Soviet schools for decades. Its aim is to trace the ways in which social and ideological concerns are reflected both in the purely methodological aspects of education and in students' opinions regarding the education process and its contents (such an influence seems to be no less significant than the influence of social concerns on the realm of art).

Today, there is probably little need to convince anyone that the teaching of even such a discipline as mathematics—apparently so far removed from social upheavals—in reality reflects these very transformations in society and ideology (see, for example, Mellin-Olsen, 1987). However, the precise workings of these social influences—and how exactly that which happens in society affects that which happens in the classroom—require further study and elucidation. The present article represents an attempt to combine the methods of historical and sociological analysis. Studying processes that take place over many decades turns out to be useful because it facilitates a better understanding of the essence of these developments and reveals their underlying significance, which is not always apparent when an event is examined outside of its long-term historical context. The analysis of contemporary schools presented here, on the other hand, relies in large part on the results of surveys taken of today's students.

The article is devoted to so-called specialized mathematics schools, which are also known as schools with advanced teaching of mathematics. The phenomenon of Russian schools with advanced teaching of mathematics has been studied by numerous researchers (see, for example, Chubarnikov and Pyryt, 1993; Grigorenko and Clinkenbeart, 1994; Vogeli, 1997; Karp and Vogeli, 2003, etc.). These schools, which appeared in the early 1960s, became the main centers of preparation for students who would go on to become professional mathematicians and physicists, as well as highly qualified engineers and teachers. At the present time, for example, graduates of such schools comprise over 90% of the mathematics department of St. Petersburg State University. No analogous statistics about universities in the United States exist, but even a cursory survey of the data warrants the conclusion that practically any American university of any importance has several graduates of Russian special schools in its mathematics department. It was in part due to the influence of Russian mathematics schools that schools with an in-depth study of mathematics started appearing around the globe (note, for example, such schools as The North Carolina School for Science and mathematics or The Illinois Mathematics and Science Academy). Studies of Russian mathematics schools frequently limit themselves to the methodological or organizational aspects of their activity, which are indeed of considerable interest (see, for example, Schvarzburd, 1967). However, an examination of the connection between their development and the development of society appears no less interesting.

Several distinct periods and stages can be identified in the history of the development of Russian mathematics schools— a history that is by now comparatively long. The first of them, the formative stage, not by accident took place during the period of a "thaw" in politics. It was precisely the liberalization of the regime—however short-lived it may have been—that enabled collective action on the part of the Russian mathematics community to create and develop such schools, as well as the possibility to select students based on their abilities and interests. No less important was the atmosphere of optimism and hope in which these schools were created, which was likewise an outcome of real or anticipated changes.

The second period in the development of schools with advanced teaching of mathematics corresponded to the so-called period of stagnation in Soviet politics. The schools accumulated practical experience and underwent a certain degree of methodological development. However, the spirit of scientific research and preparation for the free study of science largely left them, a fact that was again connected to processes taking place in society at the time.

The changes that began in the country during the middle of the 1980s (Gorbachev's "Perestroika") brought with them substantial transformations in the life of schools with advanced teaching of mathematics. These schools, which had only recently been almost officially compared to a cancer on the healthy body of Soviet education, suddenly found themselves in the position of a model endorsed by the authorities. At the end of the 1980s the number of specialized

mathematics classes and schools increased dramatically. It turned out, however, that in the course of this process the very understanding of the specific nature of mathematics schools underwent considerable changes (Donoghue et. al., 2000).

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.

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.

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 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. In all three cases, the scores turned out to very high, with the average scores being, respectively, 8.7, 8.4, and 8.4 (note that only two students gave a score of 5 in response to question (b), while all other scores were significantly higher). The differences between the 8-graders and the 11-graders, in this instance, turned out to be negligible.

Also noteworthy were the students' responses to the question, "What influences you to work hard in math?" Most of the respondents (22) indicated that they were drawn to mathematics itself, and that their main motive in studying mathematics was interest. A noticeably smaller number of responses cited the usefulness of mathematics (in other subjects or in practical life).

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.

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.

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