Entrance Examinations to the Mekh-mat

A. Shen

Preliminaries

At one time, discrimination against Jews in entrance examinations to the leading post-secondary institutions, especially Mekh-mat at Moscow State University (MGU), was a fiercely debated subject. I think that we can now afford to look more calmly at the events and see their role in the history of Russian mathematics.

This kind of discrimination was sometimes talked about as if it were the main, and virtually the only, blemish on the otherwise spotless reputation of the national party. This tone was sometimes understandable (for example, one had to talk this way in complaints about Mekh-mat submitted to the Committee of Party Control of the Central Committee). In reality, of course, this was just one of many injustices, some far worse.

I entered the Mekh-mat in 1974, began my graduate studies in 1979, and completed them in 1982. I have worked in mathematical schools from 1977 until today. I will write mostly about things I have had direct contact with. Let us hope my account will be supplemented by others.

In many countries, including Russia, the proportion of Jews is appreciably greater among scholars than in the whole population. In entrance to mathematical classes and schools (with equal requirements for all applicants), the proportion of Jews among those who passed the examinations (and among those taking them) is significantly higher than in the population as a whole. Whatever the meaning of this phenomenon, it has to be kept in mind.

Elimination of Undesirable School Graduates

After certain events in 1967 (the well-known letter of 99 mathematicians in defense of Esenin-Volpin) and especially in 1968 (mathematicians protesting the intervention in Czechoslovakia), the situation at the Mekh-mat worsened significantly. I.G. Petrovskii ("the last non-party rector of MGU"), who had done many good things, died in 1973. His successor, R.V. Khokhlov ("the last decent rector of MGU"), perished in 1977. By 1973, the "special program" of elimination of undesirable graduates, especially Jews, was in full swing. The category of "undesirables" included the (small) group of those who didn't belong to the Komsomol. From that time on and until 1989-1990, when this practice was halted, the situation stayed much the same. The number of victims did change: in later years, the potential victims, aware of the barriers, didn't try to apply. Also, in the mid-80s there was a time when Mekh-mat students — unlike students at other institutions — were drafted. This reduced the number of applicants to Mekh-mat.

Yet another form of discrimination began in 1974. It was open but no less unjust. It involved a two-stage competition for Muscovites and non-Muscovites (the same number of places were reserved for each group although non-Muscovites were more numerous). The ostensible reason was the shortage of rooms. An applicant who did not ask for a place in a hostel (but had no close relations in Moscow) was, however, also classified as a non-Muscovite. The harm from this discrimination was offset by the lower level of the competition for non-Muscovites.

During the period of anti-Jewish discrimination the following people were among the responsible officers of the admissions committee (in various capacities): Lupanov (current dean of the Mekh-mat), Sadovnichii (current rector of MGU), Maksimov, Proshkin, Sergeev, Chasovskikh, Tatarinov, Shidlovskii, Fedorchuk, I. Melnikov, Aleshin, Vavilov, and Chubarikov.

How Things Were Done: The Procedure

Direct discrimination was a natural concomitant of the shabby conduct of the examinations. The written part of the examination in mathematics consisted of a few simple problems that required only computational accuracy, and one or two very involved and artificial problems (the last problem was usually of this kind). Only "pure plusses" were counted. A flaw in the solution (sometimes invented and sometimes due to the checker's failure to understand the work) meant loss of most of the credit for the problem. As a result, most of the applicants got threes and twos (out of five); the examination was almost totally uninformative.

Now we come to the oral part of the examination in mathematics. Even if there were no discernible discrimination, it is virtually impossible for all examiners to make the same demands on applicants. The questions on the tickets are very general and imprecise, and the requirements of the examiners are necessarily not comparable; all the more so because, as a rule, the examiners had no school contact with the students.

The examinations included writing a composition and passing an oral test in physics. The physics exam was given by members of the MGU Physics Faculty. It was not a particularly brilliant faculty, and the task of giving examinations was assigned to its less brilliant members.

Some Examples. In 1980 no credit was given for the solution of a problem (an equation in *x)* because the answer was in the form "$x = 1;2$" and the written answer was "$x = 1$ or $x = 2$" (the school graduate was Kricheskii, the senior examiner in mathematics was Mishchenko; source: B.I Kanevskii, V.A. Senderov, *Intellectual Genocide*, Moscow, Samizdat, 1980). In 1988, during an oral examination, a student who defined a circle as "a set of points equidistant — that is, at a given distance — from a given point" was told that his answer was incorrect because he hadn't stipulated that the distance was not zero (the textbook had no such stipulation). The graduate's name was Arkhipov and the names of the examiners were Kovalev and Ambroladze. The 1974 examination in physics included the question "What is the direction of the pressure at the vertical side of a glass of water". The answer "perpendicular to the side" was declared to be incorrect (pressure is not a vector and is not directed anywhere — graduate Muchnik).

Procedural Points. Sometimes the questioning began a few hours after the distribution of tickets (school graduate Temchin, 1980, waited three hours). The questioning could last for hours (5.5 in the case of the graduate Vegrina; examiners Filimonov and Proshkin, 1980; cited by B.T. Polyak, letter to *Pravda*, Samizdat, 1980). Parents and teachers of the graduates were not allowed to see the student's papers (letter 05-02/27, 31 July 1988, secretary of the admissions committee L.V. Yakovenko). An appeal could be lodged only within an hour after an oral examination. The hearing involved in an appeal was extremely hostile (in 1980, A.S. Mishchenko faulted graduate Krichevskii at the hearing for appealing against precisely those remarks of the examiners where he (Krichevskii) was clearly in the right; Kanevskii and Senderov, *op. cit.).*

How It Was Done: "Murderous" Problems

An important tool (in addition to procedural points and pickiness) was the choice of problems. Readers who are mathematicians can evaluate the level of difficulty of the problems below by themselves. We can assure non-mathematical readers that the level of difficulty of the "murderous" problems is comparable to that of the All-Union Mathematical Olympiads, and many of them *are* olympiad problems. (For example, the problem N2 of Smurov and Balsanov turned out to be the most difficult problem of the second round of the All-Union Olympiad in 1985. It was solved by 6 participants, partly solved by 3, and not solved by 91.)

For comparison, we adduce first typical ordinary problems (from the mid-1980s). Grades quoted are out of 5.

First variant (those who solve both parts get a grade of 5).

1. Show that in a triangle the sum of the altitudes is less than the perimeter.
2. The number p is a prime, $p \geq 5$. Show that $p^2 - 1$ is divisible by 24.

Second variant (those who solve the first two parts get a grade of 4).

1. Draw the graphs of $y = 2x + 1$, $y = |2x + 1|$, $y = 2|x| + 1$.
2. Determine the signs of the coefficients of a quadratic trinomial from its graph.
3. x and y are vectors such that $x + y$ and $x - y$ have the same length. Show that x and y are perpendicular.

Now the "murderous" problems. The names of the examiners and the years of the examinations are given in parentheses.

1. K is the midpoint of a chord AB. MN and ST are chords that pass through K. MT intersects AK at a point P and NS intersects KB at a point Q. Show that $KP = KQ$.
2. A quadrangle in space is tangent to a sphere. Show that the points of tangency are coplanar. (Maksimov, Falunin, 1974)

1. The faces of a triangular pyramid have the same area. Show that they are congruent.
2. The prime decompositions of different integers m and n involve the same primes. The integers $m + 1$ and $n + 1$ also have this property. Is the number of such pairs (m, n) finite or infinite? (Nesterenko, 1974)

1. Draw a straight line that halves the area and circumference of a triangle.
2. Show that $(1/\sin^2 x) \leq (1/x^2) + 1 - 4/\pi^2$
3. Choose a point on each edge of a tetrahedron. Show that the volume of at least one of the resulting tetrahedrons is $\leq 1/8$ of the volume of the initial tetrahedron. (Podkolzin, 1978)

We are told that $a^2 + b^2 = 4$, $cd = 4$. Show that $(a - d)^2 + (b - c)^2 \geq 1.6$. (Sokolov, Gashkov, 1978)

We are given a point K on the side AB of a trapezoid $ABCD$. Find a point M on the side CD that maximizes the area of the quadrangle which is the intersection of the triangles AMB and CDK. (Fedorchuk, 1979; Filimonov, Proshkin, 1980)

Can one cut a three-faced angle by a plane so that the intersection is an equilateral triangle? (Pobedrya, Proshkin, 1980)

1. Let H_1, H_2, H_3, H_4 be the altitudes of a triangular pyramid. Let O be an interior point of the pyramid and let h_1, h_2, h_3, h_4 be the perpendiculars from O to the faces. Show that $H_1^4 + H_2^4 + H_3^4 + H_4^4 > 1024\, h_1 \cdot h_2 \cdot h_3 \cdot h_4$.
2. Solve the system of equations $y(x + y)^2 = 9$, $y(x^3 - y^3) = 7$. (Vavilov, Ugol'nikov, 1981)

Show that if a, b, c are the sides of a triangle and $A.\ B.\ C$ are its angles, then

$$\frac{a+b-2c}{\sin(C/2)}+\frac{b+c-2a}{\sin(A/2)}+\frac{a+c-2b}{\sin(B/2)}\geq 0.$$

(Dranishnikov, Savchenko, 1984)

1. In now many ways can one represent a quadrangle as the union of two triangles?
2. Show that the sum of the numbers $1/(n^3 + 3n^2 + 2n)$ for n from 1 to 1000 is < 1 /4. (Ugol'nikov, Kibkalo, 1984)

1. Solve the equation $x^4 - 14x^3 + 66x^2 - 115x + 66.25 = 0$.
2. Can a cube be inscribed in a cone so that 7 vertices of the cube lie on the surface of the cone? (Evtushik, Lyubishkin, 1984).

1. The angle bisectors of the exterior angles *A* and *C* of a triangle *ABC* intersect at a point of its circumscribed circle. Given the sides *AB* and *BC*, find the radius of the circle. [The condition is incorrect: this doesn't happen — A. Shen.]
2. A regular tetrahedron *ABCD* with edge *a* is inscribed in a cone with a vertex angle of 90° in such a way that *AB* is on a generator of the cone. Find the distance from the vertex of the cone to the straight line *CD*. (Evtushik, Lyubishkin, 1986).

1. Let log(a,b) denote the logarithm of *b* to base *a*. Compare the numbers log(3,4) · log(3,6) · ... · log(3,80) and 21og(3,3) · log(3,5) · log(3,79).
2. A circle is inscribed in a face of a cube of side *a*. Another circle is circumscribed about a neighboring face of the cube. Find the least distance between points of the circles. (Smurov, Balsanov, 1986).

Given *k* segments in a plane, give an upper bound for the number of triangles all of whose sides belong to the given set of segments (Andreev, 1987) [Numerical data were given, but in essence one was asked to prove the estimate $O(k^{15})$. A. Shen.]

Use ruler and compasses to construct, from the parabola $y = x^2$, the coordinate axes. (Kiselev, Ocheretyanskii, 1988)

Find all *a* such that for all $x < 0$ we have the inequality

$$ax^2 - 2x > 3a - 1. \quad \text{(Tatarinov, 1988)}$$

Given the graph of a parabola, to construct the axes. (Krylov E.S., Kozlov K.L., 1989) [These examiners told a graduate that an extremum is defined as a point at which the derivative is zero. They also reproached another graduate for not saying "the set of ALL points" when he defined a circle as the set of points at a given distance from a given point.]

Let *A,B,C* be the angles and *a,b,c* the sides of a triangle. Show that

$$60° \leq \frac{aA+bB+cC}{a+b+c} \leq 90°$$

(Podol'skii, Aliseichik,1989)

Statistics—The Mekh-mat at MGU and Other Institutions

The most detailed data on graduates of mathematical schools were obtained in 1979 by Kanevskii and Senderov. They divided the graduates of schools 2, 7, 19, 57, 179, and 444 who intended to enter the Mekh-mat into two groups. One group of 47 consisted of students whose parents and grandparents were not Jews. Another group of 40 consisted of students with some Jewish parent or grandparent. The results of olympiads (see table below) show that the graduates were well prepared, but when it comes to admission, the results are noticeably different.

Mekh-mat at MGU

	First group	Second group
Total graduates	47	40
Olympiad winners	14	26
Multiple winners	4	11
Total olympiad prizes	26	48
Admitted	40	6

Kanevskii and Senderov give figures also for two other institutions:

MIFI

	First group	Second group
Total graduates	54	29
Admitted	26	3

MFTI

	First group	Second group
Total graduates	53	32
Admitted	39	4

Of course, the character of the entrance examinations became known to school graduates, and those suspected of Jewishness began to apply to other places, for the most part to faculties of applied mathematics where there was no discrimination. (One very well-known place was the "kerosinka" —the Gubkin Oil and Gas Institute.)

Mathematical Schools and Olympiads

When we talk about mathematical schools, we exclude the boarding school #18 at MGU. Proximity to the Mekh-mat unavoidably leaves its imprint. In the remaining schools, discrimination by nationality was mostly insignificant.

As a rule, selection of students for a particular class depended largely on the teachers of mathematics and was controlled by the administration to a minor extent. In 1977, in school #91, the administration was presented with a list of students in the math class and did not make any changes. In 1982, in school #57, the situation was more complicated because the school was subject to district administration, and the class list had to be acceptable to the district committee. So some students favored by the district authorities were accepted outside the competition. In 1987, in school #57, "wartime resourcefulness" was successfully applied: Russian names picked at random were added to the list of students sent for approval to the district committee (which did not check which of the students on the list later attended). It seems that after that there were no problems (perestroika!).

One could speculate that discrimination in admissions to the Mekh-mat (very well known to both teachers and students of math classes) and the large percentage of Jews among teachers and students could give rise to a problem of "interethnic relations" (injustice often gives rise to injustice in reverse). I have often heard such speculations, but I am convinced that in most mathematical classes (and the best ones) no such things happened.

As for the olympiads, the Moscow city olympiad was for quite a long time relatively independent from official departments. But in the late 1970s, after Mishchenko's letter to the partkom (it is amusing that recently Mishchenko asserted publicly that he was not in the least involved, but he did not challenge the authenticity of his letter), control of the olympiads was given to Mekh-mat— and, to a large extent, to the very same people who controlled the entrance examinations. It seems to me that the result was not so much discrimination as plain incompetence. (For example, in 1989, after my conversation with the people who managed the olympiad, it became clear that a large bundle of papers got lost. Following urgent requests, it was found. I was even permitted to see the papers of the students in the class in which I lecture. A significant portion of these papers were improperly corrected.)

General Remarks, History

It seems that now practically no one denies there was discrimination in entrance examinations (that is, no one except possibly university administrators — but then they are the people least able to shift responsibility). In particular, Shafarevich mentions this kind of discrimination in his article in the collection *Does Russia have a Future?*

This discrimination causes two kinds of harm. First, many gifted students have been turned away or have not tried to enter the Mekh-mat. In addition to this direct harm, there is also an indirect kind: participation in entrance examinations has become a means of checking the loyalty of graduate students and co-workers, and a criterion for the selection of co-workers. Many distinguished people (regardless of nationality) who refused to be accomplices have not been employed by the Mekh-mat.

The situation has brought protests whose form depended on the circumstances and the courage of the protesters. I probably know only some of the incidents. In 1979, document #112 of the Moscow group for implementing the Helsinki agreements, titled "Discrimination against Jews entering the university," was signed by E. Bonner, S. Kallistratova, I. Kovalev, M. Landa, N. Meiman, T. Osipova and Yu. Yarym-Ageev. Included in this document were the statistical data collected by B.I. Kanevskii and V.A. Senderov.

On the basis of the 1980 admission figures, Kanevskii and Senderov wrote, and distributed through Samizdat, the paper "Intellectual Genocide: examinations for Jews at MGU, MFTI and MIFI."

I well remember my reaction, at that time, to the activities of Kanevskii and Senderov (which I now realize was largely a form of cowardice): the result of their collecting data will be that students of math schools will be rejected just like Jews. (This did not happen, although there were such attempts.)

Also, Kanevskii, Senderov, mathematics teachers in math schools, former graduates of math schools, and others, helped students and their parents to write appeals and complaints. Incidentally, this activity was sometimes criticized in the following terms: "By inciting students to fight injustice you are using others to fight your war with the Soviet authorities, and you are subjecting children and their parents to nervous stress." In some cases, the plaintiffs succeeded (by threatening to cause an international scandal or by taking advantage of a blunder of an examiner), but an overwhelming majority of complaints were without effect.

There were attempts to help some very capable students (Jews or those who could be taken for Jews) by undercover negotiations. I myself took part in such attempts twice, in 1980 and in 1984. In one case it was possible to convince the admissions commission that the graduate was not a Jew, that his name just sounded Jewish; and in the second case they closed their eyes to the Jewishness of the graduate's father. It was not a simple matter to find a chain of people, ending with a person who was a member of the admissions committee, each of whom could talk to the next one about such a delicate topic. (In one case I know of, one member of such a chain, was A.N. Kolmogorov.) To this day I have two minds about the morality of these activities of ours.

In 1979-1982, on the initiative of B.A. Subbotovskaya and with the active support of B.I. Kanevskii, mathematics instruction was organized for those not going to the Mekh-mat: once a week, every Saturday afternoon, lectures on basic mathematical subjects were presented to interested students. These sessions took place at the "kerosinka" or at the humanities building of MGU (of course, without the knowledge of the administration — we simply took advantage of the available empty rooms). Xerox copies of the lectures were given out to the students. These studies were referred to as "courses for improving the qualifications of lecturers in evening mathematical schools," but the participants usually called them "the Jewish national university." This went on for a number of years, until one of the participants, and Kanevskii and Senderov, were arrested for anti-Soviet activity; after an interrogation at the KGB, B.A.Subbotovskaya died in a car accident in unclear circumstances. It should be noted that some of the participants in these studies who were not Mekh-mat students (some *were* Mekh-mat students) were very gifted, but very few of them became professional mathematicians.

I remember my reaction, at the time, to the arrest of Senderov and others; well, instead of teaching mathematics they engaged in anti-Soviet agitation, and because of them (!) now everyone has been caught in the act.

Other attempted protests: in 1980 and 1981 B.T. Polyak wrote to *Pravda* about scandalous practices (without bringing in the issue of anti-Semitism — he must have hoped that he could influence the Mekh-mat within the existing system).

Perestroika began in 1988 and one could openly and safely write about anti-Semitism (even to the Committee of Party Control, then still in existence). Some people, including Senderov, then released from prison, went to various departments, including the city partkom and the city Department of Education, trying in some way to influence the Mekh-mat. "The dialogue with the opposition" took more concrete forms and there were no accusations of anti-Soviet agitation, but the only positive result was that one of the graduates involved was allowed a special examination. After that, the discussion continued inside the university (at meetings of the scientific council of the Mekh-mat, in wall newspapers, and so on). It died down gradually, because discrimination in entrance examinations ceased, and many of the participants in the discussion scattered all over the world.

Institute for Problems of Information Transmission
Ermolovoi 19
101447 Moscow Russia