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MATHEMATICS AS A PROFESSION IN THE USSR

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[Comment: Andrey Nikolayevich Kolmogorov (1903-) has been a professor at Moscow University since 1941, an Academician since 1945, a member of the Division of Mathematical Statistics since 1948, and one of the most prominent Soviet mathematicians. Source for the following is a German rendition of an article in the Soviet periodical Sovetskaya Nauka, Moscow, 1952.]

Obviously mathematics is important in mechanics, physics, and astronomy. Mathematics is equally important in the practical work of engineers and technical personnel. However, the selection of mathematics as a profession is not a simple one.

Most people imagine that mathematical textbooks and handbooks contain sufficient rules and formulas to solve any practical problem. Even educated people wonder if it is possible to discover anything new in mathematics.

The fundamentals of mathematics taught in school were discovered long ago but this elementary knowledge becomes useful only when the student learns to derive it by himself. Therefore, students need teachers who not only know their subject well, but also are enthusiastic about it and consider it a living, growing subject.

It is even more important that men who intend to use mathematics in the solution of technical problems possess the ability to find a new mathematical approach; this is especially true of engineers who perform mathematical computations.

Since not every man has the required mathematical skill and ability, most of our applied scientific-research institutes and some of our big industrial plants have begun to engage specialized mathematicians who cooperate with their engineers; but in many fields, unfortunately, mathematicians are still lacking. Many problems require enormous computational work surpassing individual human capabilities, and must be solved by our calculator bureaus, which are staffed with many dozens of computers and which are giving very good results. Stresses of dams under elastic strains, filtration of water under dams, air resistance in aerodynamics or in ballistics are typical examples of problems in computation which keep our calculator bureaus busy for months and even years. This often painfully detailed work requires computers not only with experience, but also with the requisite mathematical background.

Many of our mathematicians who possess creative initiative coupled with thorough knowledge acquired in our universities are now endeavoring to present mathematical problems in a form amenable to numerical solution with less difficulty than usual. The mathematical theory of computational methods is developing into a broad science, and the need for specialists who have mastered these techniques increases with the development of machine computation. These mathematicians are often confronted with the peculiar problem of "programing", i.e., setting the computational procedure in a form suitable for automatic processing by machines.

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The concept of mathematics as a science restricted entirely to its own theoretical foundations is basically false. Actually, mathematics is continuously being confronted with new ideas, new theories. New problems of mechanics (nonlinear oscillations, mechanics of ultrasonic velocities) and of physics (quantum physics) and related topics are introducing further developments into mathematics.

On the other hand, after the accumulation of a certain number of special problems and their particular solutions, new general theories are developed which facilitate standardized methods for general solutions. For instance, functional analysis, which is related to mathematical analysis approximately as algebra is related to arithmetic, is developing now, whereas mathematical analysis was created in the 17th and 18th centuries and is regularly taught at all higher educational institutions. The so-called operator technique of functional analysis is already widely applied in modern physics and engineering.

During the first years of the October Revolution, our youth endeavored to enter our technical schools, which they considered the gateway to participation in the socialistic reconstruction. Later when scientific education was urgently needed in the economic development of our country, it became essential to overcome the diffidence, now eliminated, of some youths toward universities. But young students are still in awe of mathematics, which they regard as a dry and abstract science, more awesome than other sciences. Such a notion should be refuted.

Cooperation between mathematicians and representatives of related fields is now closer than ever and becomes most fruitful if mathematicians do not restrict themselves to the solution of a problem, but try to penetrate deeply into the physical and technical meanings. The specialist in mathematical and theoretical physics, in theoretical mechanics, or in theoretical geophysics may be educated in two ways: he may start his education with the study of physics, mechanics, or geophysics; or he may attend lectures at the mathematical faculty of a university and simultaneously work in his specific field.

The predominant opinion is that better results are obtained by the second method, because it is easier to study aerodynamics, gas dynamics, seismography, and dynamic meteorology with a solid mathematical foundation. To some, such a viewpoint seems exaggerated because, for example, mathematicians active in related fields have rarely been able to master experimental techniques. We have to admit, however, that outstanding specialists in the natural sciences have come from the ranks of graduated mathematicians.

The common notion that special aptitude is needed for the study and comprehension of mathematics is an exaggerated one. Nevertheless, it is natural to attempt to verify the student's mathematical abilities or, as it is often expressed, "mathematical talent" before he selects mathematics as his profession.

Just what are these abilities? First, success in mathematics does not depend completely on memorizing facts, especially formulas. Anyone who has had some experience in handling algebraic computations and in using clever transformations of complex formulas knows that an adequate method of solution may be found without the use of standard formulas. The finding of such a method early marks the ability of a mathematician for serious scientific work.

Second, the mathematician always endeavors as far as possible to illustrate geometrically the problems which he analyzes. Therefore, geometrical representation or, as it is often called, "geometrical intuition," is an important ability in all branches of mathematics, even in the most abstract ones.

Third, the ability to make deductive logical conclusions is another characteristic of mathematical aptitude. The understanding of the principle of mathematical derivation and the ability to apply such principles correctly are good criteria of maturity in logic, the necessary prerequisite of a mathematician.

The introduction of variable quantities and the creation of differential and integral calculus made complicated computations which previously used elementary mathematics much simpler and easier. Differential equations simplify the expression of laws governing celestial bodies moving under gravitational action, of principles and operation of various radio-engineering circuits, of stress distribution in mechanical constructions, etc. Mathematicians are expected to establish methods for the solution of such equations by natural scientists and physicists.

In this article, we have been trying to clarify for the future mathematics student the diversity of interests and aims of mathematical studies.

The need for mathematicians in scientific and industrial research institutes, in related sciences (physics, geophysics), and in various fields of modern engineering is continuously growing.

Mathematicians in such institutes do not confine their operations to guidance and execution of computations (as in calculator bureaus or stations) or to the solution of mathematical problems presented by machinists, physicists, or engineers, but specialize in their profession after a thorough education in mathematics as many famous scientists have done (e.g., among the students of Moscow University, one can name M. V. Keldysh and M. A. Lavrent'yev in mechanics and A. N. Tikhonov in geophysics).

Generally speaking, the study of mathematics is the most important educational background for specialists in all fields of pure science and engineering, since all these sciences require a modern mathematical apparatus.

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