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AL-Khwarizmi's Contribution to the Development of Modern Mathematics

Shukurov Khursan Gadoyevich, Norova Intizor Haqberdiyevna
Bukhara academic lyceum of engineering technologies teachers of mathematics

Annotation: The proposed article discusses the contribution of Al-Khwarizmi to the development of modern mathematics, the applied role of mathematics for the specialties for which the university is preparing. The work contains a brief excursion into the history of the development of mathematics from antiquity to the present day. The problems of mathematical education in modern society are raised.

Keywords: Al-Khorezmiy, modern mathematics, history of mathematics development, antiquity, education.

Modern theoretical mathematics is a complex abstract field that frustrates math class students, yet provides the foundation for all the technological marvels that we enjoy today. It would not be superfluous to say that without the extraordinary mind of the great Muslim mathematician, al-Khwarizmi, the world of mathematics would look much different.

In the 20s. 9th century al-Khwarizmi lived and worked in the capital of the Arab caliphate, Baghdad, at the court of the famous caliph, the patron of sciences al-Ma'mun, who gathered here a large number of astronomers, mathematicians, historians and philosophers (many of these scientists were natives of Central Asia).

All the works of al-Khwarizmi that have come down to us were written in Baghdad. The most important of them relate to mathematics. Al-Khwarizmi's algebraic and arithmetical treatises played an exceptional role in the history of science.

The arithmetical treatise is called "The Book of Indian Counting". Its main purpose is to familiarize scientists using the Arabic language with the remarkable invention of Indian mathematicians - the bit-by-bit notation of numbers using nine characters, which are now generally accepted in science and practice and are called Arabic numerals. This name of these numbers is explained by the fact that the Europeans learned about them from the Arabs, but the Arabs themselves called these numbers Indian, and it was al-Khwarizmi who introduced them to these numbers for the first time in his arithmetic treatise.

At the beginning of this treatise it is said: “Al-Khwarizmi said: when I saw that the Indians made up any of their numbers from nine letters, thanks to the arrangement that they established, I wished to reveal what is obtained from these letters to facilitate the student” [1, p. . 9]. Nine "letters" are nine numbers: 1, 2, 3, 4, 5, 6, 7, 8, 9. In addition to these "letters", al-Khwarizmi describes the zero sign. The Arabs do not write from left to right, as we do, but from right to left, therefore, in writing numbers, for example, 10, the Arabs have 0 before 1, which explains the words of al-Khwarizmi that the Indians

“they put a small circle in front of the unit, like o, so that they would know from it that the place of the unit is empty” [1, p. ten]. Al-Khwarizmi describes in detail how to write any whole number using nine digits and zero, how to use these numbers to perform the actions of “doubling”, i.e.

multiplying by 2, “doubling”, i.e. dividing by 2, addition , subtraction, multiplication, division and square root.

Al-Khorezmi's algebraic treatise played no less importance in the history of science. The full title of this treatise is "A Brief Book on the Calculus of Algebra and Almuqabala". This is the first scientific work where the word "algebra" appeared. In fact, some types of algebraic equations were used by the ancient Egyptians and Babylonians. Problems reduced to quadratic equations were able to be solved by geometric methods by the ancient Greeks; a large number of algebraic equations were in written in the III century. n. e. "Arithmetic" by Diophantus. However, in al-Khwarizmi's book, for the first time, we meet the reduction of algebraic equations to one of several canonical forms and the formulation of algorithms for solving each of these canonical forms with geometric proofs of the correctness of these algorithms for the most important cases.

A small section of the book is devoted to problems on proportions, which are solved here with the help of the so-called triple rule, which is very popular among Indian mathematicians, and later in Western Europe. This section is called "The Chapter on Transactions" and at the beginning of it al-Khwarizmi explains that by transactions he means buying and selling, exchange and hiring. For example, in one of the tasks it was required to find out how much to pay for 6 days to an employee whose monthly salary is 10 dirhams. It should be noted that these tasks are characteristic of the rudimentary forms of a commodity society that existed in the era of al-Khwarizmi in the cities of the medieval East.

A special place in the treatise is occupied by the "Chapter on measurement". In fact, this is an independent geometric treatise. First, al-Khwarizmi explains what a square cubit is, according to his terminology - “elbow to cubit” (an Arabic cubit is 50 cm). The following are definitions of various geometric shapes, methods for calculating their areas.

The treatise of al-Khwarizmi contains a large number of tasks related to property relations. They make up two "books" - "The Book of Wills" and "Calculus of Circuits". “Circuits” meant circumstances not previously envisaged that change the position of the persons involved in the task, for example, the sudden death of an heir to whom a terminally ill relative had already made a will. Problems of this kind subsequently led to problems "on the division of the stake", which played a significant role in the emergence of probability theory.

The astronomical work of al-Khwarizmi "Zij al-Khwarizmi" played a very important role in the history of astronomy. Zijs in the medieval East were called astronomical tables with a little theoretical introduction. The work of al-Khwarizmi was one of the first Arab zijs. It is based on the work of the Indian astronomer Brah-Magupta and the pre-Islamic Persian Zij "Zik-i Shatroayar", written in the 7th century; in some places al-Khwarizmi refers to Ptolemy's Almagest. "Zij" begins with a description of the calendars. Along with the Indian calendar, it describes the solar calendar used by the Egyptians, Romans and Persians (the Roman calendar is known to us as the Julian calendar) and the Muslim lunar calendar.

Several chapters of Zij are devoted to trigonometry. One of them tells about the division of circles into degrees - minutes, seconds and smaller parts, "at least to infinity."

Al-Khwarizmi was the author of treatises on the astrolabe (a very popular astronomical instrument of that time), on the sundial, and on the calendar. He owns the "Book of History", containing information about many events that took place in the period from the 4th century. BC e. to 828, including eclipses and earthquakes. The “Book of al-Khwarizmi's introduction to astronomical art” has been preserved in Latin processing, in which there are chapters on arithmetic, geometry, and classification of movements. Following Aristotle, al-Khwarizmi divided movements into transformations and movements in space.

Today, every educated person knows both the name of Muhammad al-Khwarizmi, immortalized in the term "algorithm", and the science of algebra founded by him. Before him, mathematics meant mostly geometry with some dose of number theory.

The work of the scientist "Kitab mukhtasar al-jabr wa-l-mukabala" ("A short book of replenishment and opposition") became, along with the book of Euclid's "Beginnings", the foundation on which the building of modern mathematics is based. It was rewritten many times in the original language and translated into Latin, as a result of which its name was reduced to the word "aljabra" - "algebra".

Al-Khwarizmi in his book focused on two operations - “aljabr” and “almuqabala”, which, unlike arithmetic, allow you to perform four arithmetic operations on expressions containing an unknown. That was a really brilliant idea. Unfortunately, his immediate followers, who set themselves the goal of solving cubic equations, began to understand algebra as the science of equations. This was a deviation from the main idea of the scientist, who considered it the science of algebraic operations and algebraic calculus. This interpretation of the term continued until the middle of the 19th century.

At the beginning of that century, mathematicians were faced with the need to work with objects that are different not only from ordinary numbers, but also from numerical and literal expressions, and on which certain operations can be performed. For example, the Englishman George Boole described the algebra of judgments in logic, the Frenchman Evariste Galois worked with the "algebra" of permutations, which he called a group. Subsequently, the concepts of Clifford algebra, Grassmann algebra, etc. arose. As a result, the word itself acquired one more, this time, nominal meaning, which meant a system of objects of an arbitrary nature, on which one or several operations can be performed.

It involuntarily amazes how far-sighted Muhammad al-Khwarizmi was, putting in the title of his treatise not the concept of an equation, but the name of a pair of operations! In the future, more and more new types of algebras were introduced. It is pleasant to note that one of them, Boole's topological algebras, was developed in Tashkent by mathematicians of Uzbekistan headed by Academician Tashmukhamed Sarymsakov. The monograph, written by him together with his colleagues, was republished in the United States in English translation, and then awarded the Abu Rayhan Beruni State Prize.

At present, this direction of mathematics, founded by this great scientist, is intensively developing within the framework of the scientific school founded by T. Sarymsakov and now headed by Academician Shavkat Ayupov. The series of studies by Sh. Ayupov, K. Kudaibergenov, B. Omirov and U. Rozikov “Development of the theory of non-associative algebras, derivations and nonlinear dynamical systems” has been nominated for the State Prize of the Republic of Uzbekistan.

In order to give a wide range of readers an idea of the content of these works, it is desirable to make one more digression into history. In the algebra of Muhammad al-Khwarizmi, the main object of study was numbers and operations on them - addition and multiplication, as well as subtraction and division. The first two have the properties of displaceability and combination, which in mathematical language are called the laws of commutativity and associativity. As the field of studied objects expanded, those that did not obey these familiar laws arose. Such, for example, are vectors known to every student - their addition behaves “good” from this point of view, but multiplication no longer has either commutativity or associativity.

An important role in the knowledge of nature is played by the property of symmetry, which is reflected in mathematical models. To express the most general concept of symmetry of geometric objects, the Norwegian scientist Sophus Lie introduced the concept of a continuous group. Such objects turned out to be very difficult to study using the means that existed at that time. Then mathematicians turned to the idea, quite similar to the views of Muhammad al-Khwarizmi - to involve a special algebra. This is how the concept of Lie algebra arose. It turned out that in this case the law of associativity does not hold. Subsequently, other algebras of this kind were discovered, which necessitated their study in the most general form. At present, this problem is being successfully developed by Uzbek mathematicians.

Literature

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