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THE TEACHING OF AL-KHOREZMI AND ITS CURRENT SIGNIFICANCE IN THE THIRD RENAISSANCE OF UZBEKISTAN

Tukhtaeva Nargiskhon Isamutdinovna,
Teacher of the Kattakurgan Branch of the Samarkand
State University

RESUME

The article substantiates the scientific contribution to various sciences of Al-Khorezmi on the development of society and the influence of the thinker's teachings on the First Renaissance in Central Asia in the X-XII centuries. The article argues that as a result of the heritage of the great scientist, you can acquire new important facts for the modern development of computer science and other exact and natural sciences. The concept of the scientist's scientific ideas in the process of scientific development of modern Uzbekistan is analyzed.

Keywords: science, method, mathematics, computer science, the Middle Ages, algebra, Renaissance, development.

The rapid development of science and culture of our independent republic naturally requires a broad, in-depth and consistent study of our cultural heritage, which is its main source. As you know, the history of the peoples of Central Asia, which has a long history, has passed through various events, periods of ups and downs. These periods have undoubtedly left a certain mark on history. In particular, the IX-XII centuries played an important role in the development of our culture. This period glorified the peoples of Central Asia in world culture. Because the cultural achievements of the peoples of Central Asia during this period, innovations in the field of science are an integral part of world culture, the development of science. During the Early Middle Ages, Central Asia became the world center of sciences, which gave the world numerous scientists.

Among the famous scientists of that time is al-Khwarizmi Muhammad ibn Musa (full name Abu Abdullah Muhammad ibn Musa al-Khwarizmi).

Unfortunately, very little information about the life of al-Khwarizmi has been preserved.

It is known that he was born on the territory of present-day Uzbekistan in Khorezm (present-day Khiva) around 800 AD. e.

Muhammad ibn Musa spent much of his life at the court of the Baghdad caliph al-Ma'mun, a great patron of science. He headed the library of the House of Wisdom, a kind of Baghdad Academy, in Baghdad.

In the library of the House of Wisdom , Muhammad wrote numerous works on astronomy and mathematics.

In world science, Muhammad ibn Musa is known for his treatise on mathematics "On Numbers and Actions with Them".

In this work, for the first time, a systematic exposition of arithmetic based on the decimal positional system of calculus is given. And although the original Arabic text is lost, thanks to its translation in the XII century from Arabic into Latin, European scholars first became

acquainted with the Indian-Arabic way of counting. Since that time, "Arabic" numerals have forever entered European and world mathematics.

The second treatise of Ibn Musa, a textbook of mathematics, published by him under the title "Kitab al-jabr wal muqabala" around 830, is devoted mainly to the solution of equations of the first and second degree. Ibn Musa emphasized that he wrote his book to help people solve their problems in everyday life. He considered such important issues for that time as the division of inheritance, merchant accounts, court cases, trade transactions, etc.

The scientist gave a classification of numerical linear and quadratic equations and a method for their solution.

The method that Muhammad ibn Musa uses consists of two operations. The first operation, which he calls "al-jabr", that is, restoration, consists in eliminating negative quantities from the equation by adding expressions on both sides of the equation opposite to these negative quantities. The second operation is called "wal-muqabala", that is, opposition.

In fact, the actions of al-Jabra and Almuqabal are the currently used transfer of the terms of the equation from one part of the equation to another and the reduction of such terms.

These two operations allowed al-Khwarizmi to bring any algebraic equation of the first and second degree to six canonical forms.

These equations were written by him verbally, the solution of these equations al-Khwarizmi also expressed in the form of verbal rules.

If the Greeks solved quadratic equations in a purely geometric way, then the method of al-Khwarizmi is almost algebraic. He can solve any quadratic equation according to its general rule (find positive roots), and uses the drawing only to explain the validity of his rhetorical solution. And this is a huge step forward compared to the geometric algebra of the Greeks.

If we translate into our modern mathematical language the descriptive methods of solving six types of linear and quadratic equations, the data of al-Khwarizmi, we get the known formulas by which you can find the roots of the equations.

The name Khorezmi, in its Latinized form Al-Khorezmi, is immortalized in the universally known mathematical term algorithm. Algorithm is a slightly modified form of the name Alkhorezmi, influenced by the Greek word "arrhythmos" - number.

The name of Khorezmi ben Musa is associated with another important mathematical concept - algebra. Algebra is the Latinized name for the operation "al-jabr", used by Khorezmi Muhammadom bin Musa to solve equations. In his mathematical works, Khorezmi ibn Musa gave rise to a new branch of mathematics - algebra.

The scientific heritage of Khorezmi had a great influence on the development of mathematics and other sciences and firmly entered the treasury of human culture.

Of great importance for astronomy of that time was his book on the astrolabe (an instrument for determining latitude). His collection of astronomical and trigonometric tables was translated into Chinese and European languages.

Al-Khwarizmi also made a considerable contribution to geography. He is considered the author of the first work on mathematical geography. For the first time in Arabic, he described the habitable part of the Earth known by that time, gave a map with the coordinates of the most important settlements, with seas and oceans, mountains and rivers.

And his Book of pictures of the Earth is not just a translation of the works of predecessors, but an original work containing a lot of new data. He organized scientific expeditions to Byzantium, Khazaria, Afghanistan. Under his leadership, the length of one degree of the earth's meridian was calculated.

But, despite the wide range of his scientific interests, the main science of his life is mathematics. The brilliant scientist first gave a systematic exposition of arithmetic as a science based on the decimal system of calculus, he first introduced algebra as a science of general methods for solving numerical linear and quadratic equations.

The famous historian of science George Sarton characterizes al-Khwarizmi as follows: "... the greatest mathematician of his time, and if you take into account all the circumstances, and one of the greatest scientists of all time."

"He influenced mathematical thinking to a greater extent than any other medieval writer" – Philip Hittie (1886–1978), famous American scientist, professor at Princeton University.

Very little information about the life of the scientist has been preserved. He was supposedly born in Khiva in 783. In some sources, al-Khwarizmi is called "al-Majusi", that is, a magician, from this it is concluded that he came from a family of Zoroastrian priests who later converted to Islam.

As for the religion of al-Khwarizmi, Tumer notes that:

Another epithet given to him by al-Tabari, "al-Majusi", seems to indicate that he was an adherent of the ancient Zoroastrian religion. But the pious preface to al-Khwarizmi's Algebra shows that he was a devout Muslim, so the epithet al-Tabari could mean no more than that his ancestors (and possibly he in his youth) were Zoroastrians. [2.93]

The last mention of al-Khwarizmi dates back to 847, when Caliph al-Wasiq died. Al-Khwarizmi is mentioned among the persons present at his death. It is believed that he died in 850. [2.84]

Al-Khwarizmi was born in an era of great cultural and scientific upsurge. He received his primary education from the outstanding scientists of Maverannahr and Khorezm. At home, he became acquainted with Indian and Greek science, and he came to Baghdad as a well-established scientist. [2.93]

In 819, al-Khwarizmi moved to the Baghdad suburb of Qattrabbul, and he spent a significant period of his life in Baghdad, leading the Houses of Wisdom under Caliph al-Ma'mun (813–833). "Bayt al-hikma"). Before becoming caliph, al-Ma'mun was the governor of the eastern provinces of the Caliphate, and it is possible that from 809 al-Khwarizmi was one of the court scholars of al-Ma'mun. In one of his writings, al-Khwarizmi praised al-Ma'mun, noting his "love of science and desire to bring scientists closer to him, extending a wing of his patronage over them and helping them to clarify what is unclear to them and to alleviate what isdifficult for them" [3. 79]

The House of Wisdom was a kind of Academy of Sciences, where scientists from Syria, Egypt, Persia, Khorasan and Transoxiana worked. It housed a library with a large number of ancient manuscripts and an astronomical observatory. Here, many Greek philosophical and scientific works were translated into Arabic. At the same time, Habbash al-Hasib, al-Farghani, Ibn Turk, al-Kindi and other outstanding scientists worked there.

By order of caliph al-Ma'mun, al-Khwarizmi worked on the creation of tools for measuring the volume and circumference of the earth. In the year 827, in the sinjar al-Khwarizmi desert, he

took part in measuring the length of the degree of the arc of the earth's meridian in order to clarify the circumference of the Earth found in antiquity. Measurements made in the Sinjar desert remained unsurpassed in accuracy for 700 years.

Around 830, Muhammad ibn Musa al-Khwarizmi created the first known Arabic treatise on algebra. Al-Khwarizmi dedicated two of his works to Caliph al-Ma'mun, who patronized the scholars of Baghdad.

Under Caliph al-Wasik (842–847), al-Khwarizmi led an expedition to the Khazars, the last mention of him dates back to 847.

Al-Khwarizmi first presented algebra as an independent science of general methods for solving linear and quadratic equations, gave a classification of these equations.

Historians of science highly appreciate both scientific and popularizing activities of al-Khwarizmi. The famous historian of science J. Sarton called him "the greatest mathematician of his time and, if all the circumstances are taken into account, one of the greatest of all time."

Al-Khwarizmi's works were translated from Arabic into Latin, and then into new European languages. On their basis, various textbooks on mathematics were created. The works of al-Khwarizmi played an important role in the formation of Renaissance science and had a fruitful influence on the development of medieval scientific thought in the countries of the East and the West.

Al-Khwarizmi developed detailed trigonometric tables containing the functions of sinus, cosine, tangent, and cotangent. In the twelfth and thirteenth centuries, on the basis of al-Khwarizmi's books, the works Carmen de Algorismo (Alexander of Wildieu) and Algorismus vulgaris (John Sacrobosko) were written in Latin. Until the SIXTEENth century, translations of his books on arithmetic were used in European universities as the main textbooks on mathematics.

Al-Khwarizmi is the author of serious works on astronomy. In them, he talks about calendars, calculations of the true position of the planets, calculations of parallax and eclipse, compilation of astronomical tables (zij), determination of the visibility of the moon, etc. The basis of his work on astronomy was the work of Indian astronomers. He carried out thorough calculations of the positions of the Sun, the Moon and the planets, solar eclipses. Al-Khwarizmi's astronomical tables were translated into European, and later, Chinese, languages.

In the field of geography, al-Khwarizmi wrote the book "The Book of pictures of the earth" (Kitab surat al-ard), in which he clarified some of the views of Ptolemy. The book included a description of the world, a map and a list of coordinates of the most important places. Despite the fact that the map of al-Khwarizmi was more accurate than the map of the ancient Greek astronomer, his works did not replace the Ptolemaic geography used in Europe. Using his own discoveries, al-Khwarizmi corrected Ptolemy's research on geography, astronomy, and astrology. To compile a map of the "known world", al-Khwarizmi studied the works of 70 geographers. [4.217]

Muhammad ibn Musa al-Khwarizmi was the author of the first book on world history compiled by a representative of Central Asia. Unfortunately, his "Book of History" ("Kitab al-ta'rih") has survived only in fragments. A chain of extracts from the "Book of History" makes it possible to establish that the work of al-Khwarizmi was written in the form of annals, that is, a chronicle. The events in it were described sequentially, by year. For example, he gave information about the time of birth of Alexander the Great. About the dates of birth, the beginning of the "prophetic" activity and the death of the founder of Islam Muhammad. About the death of

Muhammad, the beginning of the reign of Caliph Abu Bakr, the military actions of the Arabs against Byzantium and Iran in 631-653, about the conquest of Syria, Iraq, Iran and Transoxiana by the Arabs, about the war of the Arabs with the Khazars in 728-731 .

Al-Khwarizmi was the author of 9 works:

1. A Book of Indian Counting (Arithmetic Treatise, Book of Addition and Subtraction);
2. A Brief Book of Replenishment and Opposition (Kitab al-Jabr wa-l-Muqabala);
3. The book on actions by astrolabe (Kitab al-amal bi-l-asturlabat) is incompletely included in al-Farghani's work, in sections 41-42 of this book a special compass was described to determine the time of prayer;
4. A book about the sundial (Kitab ar-ruhama);
5. The Book of the Picture of the Earth (Book of Geography, Kitab Surat al-Ard);
6. A treatise on the definition of the jewish era and their holidays (Risala fi istihraj tarikh al-yahud wa ayadihim);
7. The book on the construction of the astrolabe has not survived and is known only from references in other sources;
8. Astronomical tables ("Zidge");
9. The book of history contained horoscopes of famous people.

Of these 9 books, only 7 have survived. They have been preserved in the form of texts either by Al-Khwarizmi himself, either in Translations into Latin or by his Arabic commentators. [2.271] Al-Khwarizmi is best known for his "Book of Replenishment and Opposition" (Al-Kitab al-Muhtasar fi Hisab al-Jabr wa-l-Muqabala), which played a crucial role in the history of mathematics. From the word al-jabr (in the title) came the word algebra. The original Arabic text is lost, but the content is known from the 1140 Latin translation of the English mathematician Robert of Chester . The manuscript, which Robert of Chester titled as The Book of Algebra and Al-Muqabal, is kept in Cambridge. Another translation of the book was made by the Spanish Jew John of Seville. Conceived as an initial guide to practical mathematics, "Kitab al-Jabr..." in its first (theoretical) part, it begins with the consideration of equations of the first and second degree, and in the final two sections it moves on to the practical application of algebra in matters of measuration and inheritance. The word al-jabr ("replenishment") meant the transfer of the negative term from one part of the equation to another, and al-muqabala ("opposition") is the reduction of equal terms in both parts of the equation.

In the theoretical part of his treatise, al-Khwarizmi gives a classification of equations of the 1st and 2nd degree and distinguishes six types of quadratic equation$ax^2 + bx + c = 0$:

- «квадрат» равен «корню» $ax^2 = bx$ (пример $5x^2 = 10x$);
- "square" is equal to the free term $ax^2 = c$ (example$5x^2 = 80$);
- "root" is equal to the free term$bx = c$ (example $4x = 20$);
- "square" and "root" are equal to the free term $ax^2 + bx = c$ (example $x^2 + 10x = 39$);
- "square" and free term are equal to the "root" $ax^2 + c = bx$ (example$x^2 + 21 = 10x$);
- the "root" and the free term are equal to the "square" $bx + c = ax^2$ (example $3x + 4 = x^2$).

This classification is explained by the requirement that both parts of the equation have positive terms.

Having characterized each kind of equations and showing the rules for their solution by examples, al-Khwarizmi gives a geometric proof of these rules for the last three types, when the solution is not reduced to a simple extraction of the root.

To give squarely canonical views, al-Khwarizmi introduces two actions. The first of these, al-jabr, consists in transferring a negative member from one part to another in order to obtain positive members in both parts. The second action, al-muqabala, is to introduce similar terms in both parts of the equation. In addition, al-Khwarizmi introduces a rule for multiplying polynomials. He shows the application of all these actions and the rules introduced above with the example of 40 problems.

The geometric part is devoted mainly to the measurement of areas and volumes of geometric shapes.

In the practical part, the author gives examples of the use of algebraic methods in solving household methods, measuring land, building canals, etc. In the "Chapter on Transactions" the rule for finding an unknown member of the proportion for three known members is considered, and in the "Chapter on Measurement" - the rules for calculating the area of various polygons, the approximate formula for the area of the circle and the formula for the volume of the truncated pyramid. It is also joined by the "Book of Wills", devoted to mathematical problems arising from the division of inheritance in accordance with Muslim canon law.

Al-Khwarizmi's Algebra, which marked the beginning of the development of a new independent scientific discipline, was later commented on and improved by many Eastern mathematicians (Ibn Turk, Abu Kamil, al-Karaji, etc.). This book was translated twice in the XII century into Latin and played an extremely important role in the development of mathematics in Europe. . Under the direct influence of this work was such an outstanding European mathematician of the XIII century as Leonardo of Pisa.

The Latin translation of the book begins with the words "Dixit Algorizmi" (al-Khwarizmi said). Since the work on arithmetic was very popular in Europe, the Latinized name of the author (Algorizmi or Algorizmus) became a household name, and medieval mathematicians called arithmetic based on the decimal positional number system. Later, European mathematicians began to call any calculation according to strictly defined rules. Currently, the term algorithm means a set of instructions describing the order of actions of the performer to achieve the result of solving the problem for a finite number of actions.

Astronomy occupied a leading place among the exact sciences in the medieval East. It was impossible to do without it either in irrigated agriculture, or in maritime and land trade. By the IX century, the first independent works on astronomy in Arabic appeared, among which a special place was occupied by collections of astronomical and trigonometric tables (ziji). Ziji served to measure time, with their help the positions of the luminaries on the celestial sphere, solar and lunar eclipses were calculated.

Among the first zijs is "Zij al-Khwarizmi", which served as the basis for medieval research in this area both in the East and in Western Europe. Although the Zij al-Khwarizmi is mainly a treatment of Brahmagukhut-siddhanta, many of the data in it are given at the beginning of the Persian era of Yazdigerd, and along with the Arabic names of the planets, the tables of the equations of the planets of this zij give their Persian names. Adjacent to this ziju is also the

Treatise on the Calculus of the Jewish Era. Al-Khwarizmi's "Chronicle Book", mentioned in various sources, has not survived.

The book began with a section on chronology and calendar, which was very important for practical astronomy, since due to the difference in calendars it was difficult to determine the exact dating. The existing lunar, solar and lunisolar calendars and different beginnings of the chronology led to many different eras and in different peoples the same event was dated differently. Al-Khwarizmi described the Islamic Julian calendar (the "rum" calendar). He also compared different eras, among which the ancient era of India (began in 3101 BC) and the "Alexander era" (began on October 1, 312 BC). According to al-Khwarizmi's calculations, the beginning of the Islamic era of chronology corresponds to July 16, 622. Al-Khwarizmi adopted a meridian passing through a place called Arin as the initial meridian, from which the time was counted; I. Y. Krachkovsky identified Arin with the city of Ujjain in India. The Zijja refers to the "Dome of Arin", since it was believed that the meridian of Ujjain coincided with the meridian of the island of Sri Lanka, allegedly lying on the equator; according to the ideas of Indian geographers, in the "middle place" of the Earth, the point of intersection of the prime meridian and the equator, there is a certain "dome", or "Dome of Ujjain". In Arabic spelling, the words Ujjain and Arin differ little, therefore, the Dome of Ujjain evolved into the Dome of Arin, or simply Arin.

Al-Khwarizmi wrote the "Book of Indian Accounting", which contributed to the popularization of Arabic numerals and the decimal positional system of writing numbers throughout the Caliphate, up to Muslim Spain. The Arabic text was lost, but its Latin translation of the twelfth century "Algoritmi de numero Indorum" has been preserved. The Latin translation did not preserve many details of the original text of al-Khwarizmi. The book had a huge impact on the original text of al-Khwarizmi. The book had a huge impact on the book. later leadership not only of the East, but also of the West.

The book describes finding a decimal number consisting of nine Arabic numerals and a zero. Al-Khwarizmi may have been the first mathematician to use zero in the notation of a number. In the original "Book of Indian Accounting" a method of finding a square root was described, but in the Latin translation it is not.

Two hundred years after the writing of the Book of Indian Accounting, the Indian system had spread throughout the Islamic world. In Europe, "Arabic" numerals are first mentioned around the year 1200. Arabic numerals were originally used only in universities. In 1299, a law was passed in Florence, Italy, prohibiting the use of Arabic numerals. But since Arabic numerals began to be widely used by Italian merchants, by the XVI century. the whole of Europe switched to them. Until the beginning of the XVIII century. in Russia, the Cyrillic number system was used, after which it was replaced by a number system based on Arabic numerals.

His works on mathematics and astronomy were also associated with his works on geography. Al-Khwarizmi's "Book of the Picture of the Earth", the first geographical work in Arabic and the first work on mathematical geography, had a strong influence on the development of this science.

For the first time in Arabic, he described the habitable part of the Earth known by that time, gave a map with 2402 settlements and the coordinates of the most important settlements. In many ways, he relied on Greek works (The Geography of Ptolemy), but his Book of pictures of

the Earth is not just a translation of the works of his predecessors, but an original work containing a lot of new data. He organized scientific expeditions to Byzantium, Khazaria, Afghanistan, under his leadership the length of one degree of the earth's meridian was calculated (very accurately for those times), but his main scientific achievements are related to mathematics. In the "Book of the Picture of the Earth" the definition of latitude and longitude was given.

From October 16 to October 22, 1979, on the initiative of Donald Knuth and Andrey Ershov with the support of the Academy of Sciences of UzR, the International Symposium "Algorithms in Modern Mathematics and Its Applications" was held in the city of Urgench in Uzbekistan, dedicated to the 1100th anniversary of the term "algorithm".

In 1983, the 1200th anniversary of al-Khwarizmi was widely celebrated in Uzbekistan.

- Since 1987, the International Khorezmi Prize has been awarded.
- In Khiva, a monument was erected in honor of al-Khwarizmi.
- In Tashkent (Uzbekistan), an array and a street are named after al-Khwarizmi.
- Al-Khwarizmi Street in Dashoguz, Turkmenistan.
- Urgench State University named after Al-Khwarizmi in the city of Urgench.
- Khorezmi University in Iran.
- Since 2017, Tashkent University of Information Technologies has been named after al-Khwarizmi. [5]

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