

**AL-KHWARIZMI'S SCIENTIFIC LEGACY AND ROLE IN PROMOTING THE
DECIMAL NUMBER SYSTEM***Usmonova Gulruh Khusan kizi**Student of Shahrizabz State Pedagogical Institute,**Faculty of Pedagogy, 1st-year student of Primary Education Department*

Abstract: This article highlights the scientific legacy of the great scholar Abu Abdullah Muhammad ibn Musa al-Khwarizmi, particularly his invaluable contribution to the promotion of the decimal number system. The author analyzes al-Khwarizmi's scientific work in developing the concepts of algebra, arithmetic, algorithms, and the number zero. It is substantiated that through his work "The Book of Hindu Calculation", the decimal system and the digit zero entered the Islamic world and subsequently influenced European science. The article also explores, based on scientific sources, how al-Khwarizmi's works impacted the development of European science. Furthermore, it emphasizes the relevance of al-Khwarizmi's legacy in the context of today's information technology.

Keywords: Al-Khwarizmi, decimal number system, algorithm, zero digit, algebra, Hindu calculation, scientific legacy, Bayt al-Hikma, history of mathematics, Eastern scholars, European Renaissance.

Introduction.

In the 9th century, science and knowledge flourished in the Muslim East, and during this period, many scholars made significant scientific discoveries recognized worldwide. Among them, Abu Abdullah Muhammad ibn Musa al-Khwarizmi stands out as one of the most prominent figures. He made lasting contributions to mathematics, astronomy, geography, and other sciences. Through his promotion of the decimal number system in the Islamic world, this system later spread to Europe.

"Al-Khwarizmi refined calculation methods and gave mathematics a modern form. Through his works, mathematics gained the status of an applied science." [5]

Main part of the article.

The great mathematician, astronomer, and geographer Muhammad al-Khwarizmi lived and worked during the late 8th century and the first half of the 9th century. Al-Khwarizmi conducted scientific research at the "Bayt al-Hikma" – the "House of Wisdom" in Baghdad. There, he was engaged in translating Greek and Indian sources into Arabic and analyzing them.

Out of more than 20 works written by Al-Khwarizmi, only 10 have survived to the present day. Among them are the famous "The Compendious Book on Calculation by Completion and Balancing" (on the foundations of algebra), "The Book on Hindu Calculation" or "The Book on

Addition and Subtraction" (related to arithmetic), and the geographical work titled "Kitab Surat al-Ard" (The Image of the Earth). He also authored scientific works such as "Zij", "The Book on the Use of the Astrolabe", "The Book on the Construction of the Astrolabe", "Treatise on Determining the Azimuth Using the Astrolabe", "Kitab ar-Ruhama", "Kitab at-Tarikh", and "Treatise on Determining the Jewish Calendar and Festivals". Of these works, four are preserved in Arabic, one is included in a work by Al-Farghani, two are preserved in Latin translations, and the remaining three have not yet been found.

His most famous work is "Al-Kitab al-Mukhtasar fi Hisab al-Jabr wal-Muqabala", which is considered the first theoretical foundation of algebra. It is from this very work that the term "algebra" was derived, and the discipline was established as an independent branch of science. The book was translated into Latin in 12th-century Spain. The only surviving manuscript of this translation, copied in the 14th century, is preserved in the library of the University of Cambridge. The treatise begins with the phrase "Dixit Algorizmi", meaning "Al-Khwarizmi said". [1]

He says: "I have composed a concise book on calculation by completion and balancing, covering both simple and complex problems in arithmetic, because it is necessary for people in matters of inheritance distribution, the drafting of wills, division of property, legal proceedings, trade, and all kinds of transactions, as well as in land measurement, canal construction, practical geometry, and other similar diverse tasks." [1] This shows that Al-Khwarizmi emphasized that the problems presented in his work were derived from the practical needs of his time.

The words "al-jabr" and "al-muqabala" in the title of the treatise mean "restoration" and "balancing" — the two fundamental operations of medieval algebra. The word "al-jabr" became "algebra" in Latin transcription and remained the name of the new science founded by Al-Khwarizmi. The treatise consists of three parts. The first is the algebraic part, which ends with a small section related to commercial transactions; the second is the geometric part, which discusses measurements using algebraic methods; and the third part is about wills, which the author refers to as "The Book of Wills."

The Latin manuscript of the treatise preserved in the library of the University of Cambridge was published in 1857 by B. Boncompagni. A photoreproduction of this manuscript was also published by the historian A. P. Yushkevich. In honor of the 1200th anniversary of Al-Khwarizmi, a reprint and an Uzbek translation of the work were published in 1983.

In his astronomical works, Muhammad al-Khwarizmi analyzed Indian astronomical tables and compiled his own set of astronomical tables, which became known as the "Khwarizmi Zij." His most significant astronomical work is his "Zij" treatise, which he wrote around the year 830.

This work is fully titled "Zij as-Sindhind." It was written at the House of Wisdom (Bayt al-Hikma) in Baghdad, which was a major scientific center of its time. The treatise includes astronomical tables related to the movements of the sun, moon, and planets, as well as calculations of the year, calendar construction, timekeeping, and azimuth determination. In this work, Al-Khwarizmi based his research on Indian astronomy, but he adapted it to fit the scientific traditions of the Arab world.

Al-Khwarizmi's *Zij* consists of 37 chapters and 116 tables. The first five chapters are devoted to chronology, outlining the rules for converting dates from the eras of the "Deluge," "Alexander," "Safar," and the Christian calendar into the Hijri era. Chapter 6 explains the division of a circle into 12 zodiac signs, each sign into 30 degrees, each degree into 60 minutes, and each minute into 60 seconds, and so on into smaller units. Chapters 7 to 22 are dedicated to the movements of the Sun, Moon, and the five visible planets. In these chapters, Al-Khwarizmi skillfully utilized ancient and early medieval Indian astronomical data, as well as Persian and Greek sources, and described planetary motion based on Ptolemy's geocentric system. Chapter 23 is devoted to trigonometry.[1] "*Zij as-Sindhind*" had a significant impact on the scientific world of Europe. Its Latin translation was made in the 12th century by Adelard of Bath and became known as the "*Astronomical Tables*." This work was one of the key sources that stimulated the development of astronomy in Europe. In conclusion, Al-Khwarizmi's "*Zij*" was a comprehensive compilation of the advanced astronomical knowledge of its time and remained a widely used and fundamental scientific source for centuries.

In the treatise written by Al-Khwarizmi titled "*Kitab al-Jam' wal-Tafriq bi Hisab al-Hind*", the foundations of the Indian decimal numeral system are explained. In this system, the position of each digit holds a specific value. This work, created by Al-Khwarizmi, is based on the decimal system and is dedicated to simplifying calculations using the digits from 1 to 9. He thoroughly studied the Indian work "*Sindhind*", which deals with astronomy and mathematics, and simplified its complex and confusing aspects, corrected certain errors, and added new chapters, presenting it in a revised form. This treatise became known as "*The Abridged Sindhind*" or "*Al-Khwarizmi's Treatise on Indian Arithmetic*." Al-Khwarizmi was the first to explain Indian numerals in Arabic and, based on them, developed a simplified and practical system for calculation. Before him, ancient civilizations used complex and inconvenient methods of computation. It was Al-Khwarizmi who introduced the concept of zero into the numeral system, making it possible to write any large number accurately and define place value. This marked a major turning point in mathematics and later had a strong influence on the development of science in Europe. This system spread to Europe through the Arabs in the 10th–11th centuries and formed the foundation of the modern numeral system. In this way, Al-Khwarizmi is recognized in the history of science as a great scholar who brought revolutionary innovations in numerals and methods of calculation.

"By studying Indian methods of calculation, Al-Khwarizmi clearly explained the system in which the value of a number depends on its position." [4]

Al-Khwarizmi was one of the scholars who introduced the number zero (0) into calculations. He used zero as a key element to indicate place value and to simplify computations. The calculation methods he developed later gave rise to the term "algorithm." This term is derived from his name — Al-Khwarizmi → Algoritmi → Algorithm. Today, in computer science and informatics, the concept of an "algorithm" is widely used to describe a method for solving any problem.

Al-Khwarizmi clearly explains the order of performing arithmetic operations (algorithms) based on the Indian method. He also places great emphasis on the use of the "circle," that is, zero, in explaining the rules of addition and subtraction. The scholar writes: "If you want to add a number to another or subtract one number from another, write both numbers in two rows—one

beneath the other—placing the units under the units and the tens under the tens. If you want to add the two numbers, then add each place value to the corresponding one above it, that is, units to units and tens to tens. If, in any place value — whether units, tens, or another — the total reaches ten, then write one in its place and carry it over to the row above. That is, if you have ten in the first place value (the units), replace it with one and carry it to the tens place, where it will represent ten. If there is something less than ten remaining in a place value, or if the number itself is less than ten, leave it as it is. But if nothing remains, do not leave the place empty — instead, place a small circle (zero) there. Let the circle remain in that place, because if it is left blank, the number of place values will be reduced, and the second digit might be mistaken for the first. As a result, you would make an error in your calculation.” [2]

Al-Khwarizmi’s works on mathematics and arithmetic were translated into Latin in the 12th century and introduced to Western scholars. His name became known in Latin as “Algoritmi.” Overall, Al-Khwarizmi’s scientific legacy made a significant contribution to the development of science during the European Renaissance. His works served as a bridge for the exchange of knowledge between Eastern and Western sciences and became a foundation for the advancement of modern science.

“Al-Khwarizmi’s arithmetic laid the foundation for European mathematics. Without his works, Europe would have continued using Roman numerals for calculations for a much longer time.” [3]

Conclusion.

Al-Khwarizmi is a scholar who left an indelible mark on the history of human science. The decimal system, the concept of zero, and calculation algorithms he promoted form the foundation of modern mathematics and technology today.

His legacy continues to be used in scientific research, education, and applied sciences. Every new generation should take pride in his scientific work and draw inspiration from it. Many scientific centers and institutes in Uzbekistan and around the world are named after Al-Khwarizmi, reflecting his high scientific status.

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