МЕДИЦИНА, ПЕДАГОГИКА И ТЕХНОЛОГИЯ: ТЕОРИЯ И ПРАКТИКА
Researchbib Impact factor: 11.79/2023
SJIF 2024 = 5.444
Том 2, Выпуск 12, 31 Декабрь

THE CONCEPT OF ZERO. (FROM THE PAST TO THE PRESENT)

Khudaikulova Saida Zakirovna
Teacher of Termez State Pedagogical Institute
Phone: +99890-246-47-47
E-mail: hudaykulova.sz@gmail. com
Khalilova Romina Muslihiddinovna
2nd-year student of
Temez State Pedagogical Institute

Key words: Zero, Indian Mathematics, Modern Technology, Probability Theory, Philosophy.

Abstract: This article discusses the emergence, development, and role of the concept of "zero," which holds a significant place in the history of mathematics. It explores fascinating facts related to the discovery of zero in India and the Islamic world, as well as its introduction to Europe. Additionally, the philosophical and practical importance of zero is examined.

One of the greatest discoveries in the history of mathematics is the concept of “zero”. Today, this concept, which is an integral part of mathematical practice, initially started as a simple symbol. However, its true power and potential were revealed later with the advancement of human knowledge and science. This article explores the origin of the concept of zero, its development over time, and its role in various fields of science.

Zero (*nullus* in Latin, meaning "nothing"), or "nol," is the number that represents the boundary between positive and negative numbers. Main properties:

The earliest ancestor of zero is considered a special symbol used to indicate an empty place in the Babylonian numeral system, which was in use until the 5th century BCE. Ancient Greek astronomers adopted the Babylonian base-60 numeral system but replaced the cuneiform symbols with letters for denoting numbers. In their system, zero was not considered a number. To mark the missing place in the base-60 system, they used the first letter of the word *ouden* (meaning "nothing"), resembling the modern "0" (Reference: *Young Mathematician's Encyclopedia*, Tashkent, Encyclopedia Editorial Board, 1991, p. 273).

The Origin of the Concept of Zero: In early mathematical cultures, the concept of "zero" did not exist. For example, the Roman numeral system lacked a symbol for "0." However, as humanity's needs for calculations grew, the use of zero became essential.

Babylonian Culture (3000 BCE)

Babylonian mathematicians used a placeholder to signify the absence of a value between numbers. However, this was not a fully developed concept of zero as we understand it today.

Maya Civilization

By the 4th century CE, the Maya civilization had a clear use of zero in their calendar systems. They used a distinct symbol to represent zero, making it one of the earliest known instances of zero being used as a number in calculations.

Indian Mathematics

The true birth of the concept of "zero" occurred in India. In the 5th century, mathematicians like Brahmagupta and Aryabhata introduced zero as a numeral and developed a system for using it in calculations. Brahmagupta formulated the first rules for operations involving zero, including multiplication and division, laying the foundation for its mathematical application.

Development of Zero in the Islamic World

During the Middle Ages, the Islamic world became a center of flourishing mathematics and science. Scholars in the Islamic world not only adopted the concept of zero but also sought to understand it from both mathematical and philosophical perspectives. They played a pivotal role in disseminating and further developing zero within the decimal numeral system, integrating it into advanced calculations and scientific endeavors.

Al-Khwarizmi

The famous mathematician Muhammad ibn Musa al-Khwarizmi introduced Indian numerals (including zero) to the Arab world. Through his works, Europe came to understand the concept of zero. The term "algebra" itself originates from al-Khwarizmi's book *Al-Jabr*. Al-Khwarizmi detailed the arithmetic operations (algorithms) based on the Hindu system, and he placed great emphasis on the concept of "circle" to represent zero in the process of addition and subtraction. He wrote: "If you want to add a number to another or subtract one number from another, arrange both numbers in two rows—one below the other—aligning the ones place under the ones place, the tens place under the tens place, and so on. If you want to add two

numbers, for example, add each place value to its corresponding place value above it, i.e., add the ones to the ones, and the tens to the tens. If at any place, such as the ones or tens, or any other place, the sum reaches ten, replace it with one and carry it over to the next place. For example, if you have ten ones in the ones place, make it one and carry it to the tens place, where it will represent ten. If anything smaller than ten remains in a place or if the number itself is smaller than ten, leave it in its place. If nothing remains, place a circle to avoid leaving a place empty. But the circle must remain there, as if it is left empty, the places will diminish and the second position will mistakenly be considered the first, leading to an error in your calculation." (*Muhammad ibn Musa al-Khwarizmi. Selected Works*. Tashkent, "Fan", 1983, pp. 63-64).

The Introduction of Zero to Europe

The concept of zero faced significant resistance in Europe for a long time. The shift from the Roman numeral system to one that accepted zero took time. In the 13th century, Leonardo Fibonacci introduced the concept of zero and the Hindu-Arabic numeral system to the European scholarly world in his book *Liber Abaci*. Ultimately, zero became the foundation of the modern decimal system and was widely adopted worldwide. During the Middle Ages, the Church opposed the use of zero, as it was associated with the idea of "emptiness" or "nothingness," which conflicted with religious beliefs.

The contribution of the Italian mathematician Leonardo Fibonacci (1170–1240) to the teaching of arithmetic introduced in Western countries is significant. He traveled to the East and studied the achievements of arithmetic and algebra from the works of Indian scholars and Muhammad Musa al-Khwarizmi, playing a major role in their widespread adoption in the West. His 1202 work, *The Book of the Abacus*, served as an excellent resource on arithmetic and algebra based on the decimal numeral system. The scholar expressed the Arabic word *as-sifr* as *zephirum* (from the Latin *zephyrus*, meaning "zephyr" or "west wind").

Zero was expressed in Latin with the word *nullius* (meaning "none"). In translations into many other languages, the term *sifr* became *sifra* and was widely used for a long time.

When Arabic treatises were translated into Latin in the 12th century, the symbol for zero ("0") was referred to as *circulus* (little circle) or *nulla figura* (no figure)

(Matvievskaya G., *The Development of the Doctrine of Numbers in Europe until the 17th Century*, Tashkent, "Fan", 1971, p. 72).

The use of zero as a number in mathematical operations was approached differently by scholars both before and after al-Khwarizmi. Jordanus de Nemore (13th century), a promoter of Indian and Arabic numerals in Europe, used zero in the form of *sifra*. In the works of Chuquet (15th century), zero was referred to as *nulla* and *chiffre*, influencing the terminology in France (*chiffre*) and in Italy, where *zephirum* evolved into *zero*. Similarly, the term *libra* ("pound") gave rise to *lira*. Later, the use of the form *zero* became standardized in France to denote zero.

Pacioli (15th century) recognized zero as a number, while the Dutch mathematician Girard (who died in 1632) acknowledged it both as a number and as the root of equations. Vallis, however, argued that "zero is not a number" (Depman I., *History of Arithmetic*, Moscow, "Prosveshchenie", 1963, pp. 110–111).

The role of zero in modern science and technology. Today, zero is fundamental in mathematical analysis, algebra, probability theory, and various technological advancements. It serves as the cornerstone of the binary system, which underpins computer science and digital technology. Zero is essential in defining limits, solving equations, modeling probabilities, and representing null states in data systems, highlighting its indispensable contribution to contemporary science and innovation.

Computer Technology: The concepts of zero and one (0 and 1) form the foundation of the binary system, which is the basis for the operation of all computers, smartphones, and programming languages. This binary system enables data storage, processing, and communication, making it the core of modern digital technology.

Physics and Cosmology: Zero plays a crucial role in concepts such as zero energy and vacuum. For instance, the concept of "absolute zero" is fundamental in thermodynamics, representing the theoretical temperature at which all molecular motion ceases. In cosmology, the idea of a vacuum, defined as a region with zero matter or energy density, is essential for understanding the nature of space-time and the universe's evolution.

The Philosophical Meaning of Zero: Zero is not merely a number but also a profound philosophical concept. It symbolizes "emptiness," "nothingness," and the boundaries of existence. In Eastern philosophy, the ideas of nothingness and emptiness represent deep reflections on human thought and the nature of being. These concepts challenge

our understanding of existence, emphasizing the interplay between presence and absence, and exploring the essence of reality itself.

In the mid-17th century, with the introduction of the coordinate system and the number line into mathematics by P. Fermat and R. Descartes, zero was recognized as a number. It was also proven that both positive and negative numbers correspond to specific points on the number line, with zero serving as the central reference point. This development provided a geometric interpretation of numbers, further solidifying zero's role in mathematics.

In his 1783 work, L. Euler used the term *sifra* instead of zero. In 1799, K. Gauss also adopted this term, and it continues to be used in England today. Starting from the early 16th century, scholars in Germany and other countries began to use zero in its current sense in their works. The recognition of zero as a number in mathematics was based on the concept of subtracting a number from itself, i.e., writing "a – a = 0." This recognition of zero as a number greatly facilitated arithmetic calculations.

In summary, zero is an integer. It is one of the digits in the decimal numeral system. With its use, operations such as addition, subtraction, and multiplication can be performed. However, division by zero is not possible. Since zero lies between two odd numbers (-1 and 1) on the number line, it is considered an even number. (Abbos Akmalov, Candidate of Pedagogical Sciences, *Tafakkur* Journal, Issue 1, 2020)

The concept of zero is one of humanity's most important discoveries. Initially starting as a simple symbol, today it has become the foundation of the development of science and technology. Throughout history, zero has evolved philosophically, mathematically, and practically, leading to the scientific breakthroughs we have today. Its impact spans across various fields, enabling advancements in mathematics, physics, computing, and many other disciplines.

List of References:

1. *Xudaykulova, S. (2024). DARAJALI GEOMETRIYA - KO'PHADLAR VA NORMAL KONUSLAR. Interpretation and Researches, 1(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/2496 Mathematical Analysis* (Yu. M. Geller, L. D. Faddeev).

2. Xudaykulova , S. (2024). TEXNIK IJODKORLIKNING HOZIRGI HOLATI. Research and Implementation. извлечено от https://rai-journal.uz/index.php/rai/article/view/520

3. Ne’matova , D. (2023). BOSHLANG‘ICH SINF O‘QUVCHILARIDA TANQIDIY FIKRLASH KO‘NIKMALARINI SHAKLLANTIRISHNING PEDAGOGIK-PSIXOLOGIK XUSUSIYATLARI. Interpretation and Researches, 2(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/973

4. Холмуминова, А. (2023). ОСОБЕННОСТИ И ПРЕИМУЩЕСТВА ФОРМИРОВАНИЯ КОМПЕТЕНТНОСТИ ПОДГОТОВКИ ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ У БУДУЩИХ УЧИТЕЛЕЙ НАЧАЛЬНЫХ КЛАССОВ. Interpretation and Researches, 2(1). извлечено от https://interpretationandresearches.uz/index.php/iar/article/view/1145*Algebra Textbooks* (S. I. Adishchev, Yu. L. Ershov).

5. Brahmagupta. *Brahmasphutasiddhanta*. India, 628 AD.
6. Al-Khwarizmi. *Al-Kitab al-Mukhtasar fi Hisab al-Jabr val-Muqabala*. Baghdad, 9th century.
7. Fibonacci, Leonardo. *Liber Abaci*. Europe, 1202.
8. Boyer, C.B. *A History of Mathematics*. Princeton University Press, 1968.
9. Menninger, Karl. *Number Words and Number Symbols*. MIT Press, 1992.
10. OzME. *First Volume*. Tashkent, 2000.