

## “LEARNING ABOUT THE IMPORTANCE AND EDUCATIONAL IMPLICATIONS OF THE NUMBER SYSTEM'S PROGRESSION”

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### ABSTRACT

The purpose of this study is to examine the development of the number system and its Educational implication & significance in depth. Beginning with the creation of zero and the birth of the decimal system, the research examines the evolution of counting systems throughout time. We also examine how many cultures and civilisations have played a part in developing our understanding of numbers. Next, the study moves on to examine the present-day school curriculum and its emphasis on the presentation of numerical concepts. This research investigates the efficacy of different approaches to educating students about the development of the numerical system, looking at a variety of teaching strategies and resources. Further, the paper explores how a deeper comprehension of the development of the numeric system may affect students' mathematical skills and academic performance. In its final section, the study calls attention to the gap in knowledge and makes suggestions for further research.

**Keywords:** Cultures and Civilisations, Strategies and Resources, Educational implication, Numerical Concepts

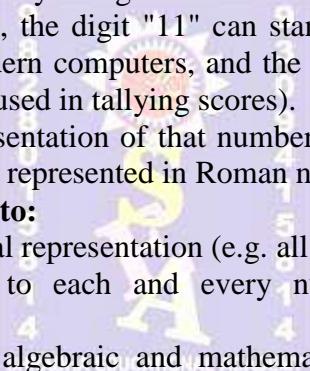
### INTRODUCTION

Using a uniform set of digits or symbols, a numeral system (or system of numeration) is a way of writing numbers. In mathematics, a numerical system is a way of writing down numbers. Different systems of numeration may assign different meanings to the same sequence of symbols. To give just one example, the digit "11" can stand in for the digits 11 and 3 in the binary numeral system used in modern computers, and the digits 2 and 1 in the unary numeral system used historically and today (used in tallying scores).

The value of a number is the representation of that number. For example, the number 0 in the Hindu-Arabic numeral system is not represented in Roman numerals and vice versa.

**It is ideal for a numbering system to:**

- Showcase a helpful numerical representation (e.g. all integers, or rational numbers)
- Assign a distinct symbol to each and every number (or at least a standard representation)
- Incorporate the underlying algebraic and mathematical structure of the numerical values.
- Every non-zero natural number can be expressed as a distinct sequence of non-zero digits in the common decimal notation.



..	:	:	:	:	:	:	:	:	:
0	1	2	3	4	5	6	7	8	9
ၦ	၁	၂	၃	၄	၅	၆	၇	၈	၉
·	၁	၂	၃	၄	၅	၆	ၷ	ၸ	ၹ
○	一	二	三	四	五	六	七	八	九
零	壹	貳	參	肆	伍	陆	柒	捌	玖
no	I	II	III	IV	V	VI	VII	VIII	IX
zero	A	B	G	D	E	S	Z	H	Theta

**Fig. 1 : Numbers written in different numeral systems.**

#### History of Development of Number System from Ancient Era to Modern Time

The Sumerians, the Egyptians, and the Greeks are just a few of the ancient cultures whose contributions may be traced to the earliest days of the evolution of modern number systems.

- Around 4000 B.C., the Sumerians, who resided in what is now Iraq, created a counting system based on making marks on clay tablets. They based their numbering system, from which we derive our own, on the number 60, which is also the foundation of our current way of calculating time (60 seconds in a minute, 60 minutes in an hour).

- In order to depict numerals, the Egyptians of circa 3000 BC created a system of hieroglyphics. They utilised a system of digits based on tens, which was very similar to our current decimal system.
- Around 600 B.C.E., the ancient Greeks created a numerical system in which letters stood in for whole numerals. Mathematicians like Pythagoras and Euclid of ancient Greece used this method, today known as the Greek numeral system.
- Numeral systems were independently formed in ancient India and China at roughly the same time. The introduction of a separate symbol for zero was a crucial innovation in the formation of our contemporary number system, and it was at the foundation of the Indian numeric system.
- The Maya devised a zero symbol for their base-20 numbering system approximately 250 AD. This civilization was located in what is now Mexico and Central America.
- The development of the Arabic numeral system by Indian mathematicians in the seventh century AD was a significant advance. The use of the numbers zero through nine in this system made mathematical calculations much simpler and more efficient than previous methods.
- The widespread usage of the decimal system in Europe may be traced back to the 12th century AD, when European mathematicians embraced the Arabic numeral system.
- Gottfried Wilhelm Leibniz, a mathematician and philosopher, and George Boole, a logician, were instrumental in the invention of the binary system in the 18th and 19th centuries, respectively.
- Floating-point numbers, developed in the 20th century to represent extremely big or small numbers in scientific and technical applications, are one example of the new number systems made possible by the advent of electronic computers.
- Number systems have gained prominence in the modern era due to their widespread usage in the representation and manipulation of data in fields like computer science, encryption, and data science.

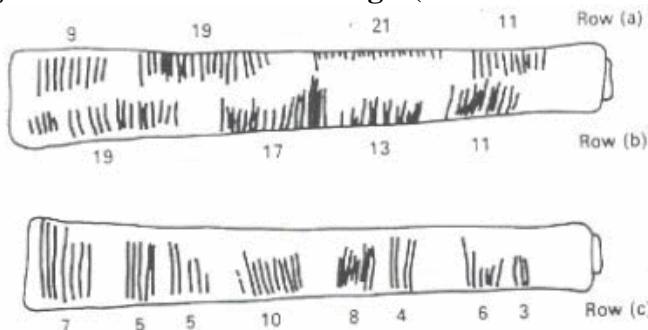
Ultimately, the history of the evolution of number systems has been a slow process that has evolved over thousands of years with contributions from various cultures and civilizations. The advancement of the present number system is largely attributable to these efforts, which in turn has improved the precision and efficiency with which mathematical computations and problems may be solved. The development and refinement of number systems is an ever-evolving field since it must meet the needs of a wide variety of disciplines and applications.

### Ancient Egyptian and Babylonian Mathematics

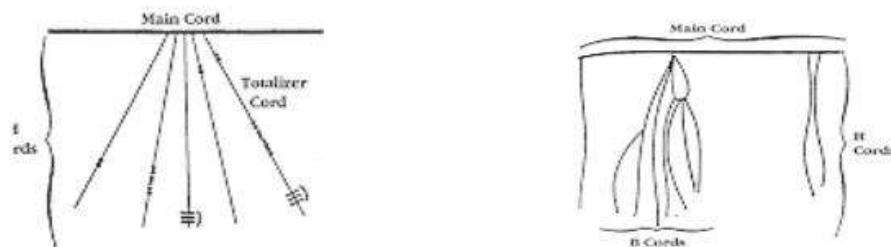
Ancient humans understood the measurements in terms of more or less, and this realisation necessitated the development of counting systems. While archaeological evidence dates the concept of numbers to around 50,000 years ago, the counting system's roots can be traced back to the early sense of abundance and scarcity in everyday life (Higgins 87). In addition, the requirement for straightforward counting by historical peoples resulted in the development of odd or even, more or less, and other sorts of number systems that evolved into the modern counting systems we use today. Population growth by births necessitated a system for keeping track of growing numbers of people, which led to the development of counting. Menninger adds that prehistorical activities like cow raising and barter trade necessitated counting and value determination (105).

In the past, for instance, cavemen used sticks to tally the number of cows. The total number of animals may then be determined with the use of the collected and distributed counting sticks. Making marks in rows on bones, keeping count, and recognising patterns all played a role in the development of mathematics and ultimately led to the invention of numerals. As can be seen below, the bones and forests were labelled.

**Fig.2: Wood and stones carvings. (Ifrah and Bello198).**



The Incas relied heavily on board counting to maintain accurate records. The Incas made use of the quip, an ancient tool for keeping track of possessions. The boards used for counting were painted in three distinct colours. The darkest area corresponded to the highest numerals, the lighter area to the next highest levels, and the white areas to the stone chambers (Havil 127). Quick calculations in mathematics were also accomplished with the aid of the quip (Zaslavsky 154). In most cases, the knots on the ropes were placed in a certain pattern to convey a numerical value. However, the quip information and record-keeping systems have been linked to a number of riddles, the resolutions of which remain to be determined. Below are some images of the finished knots.

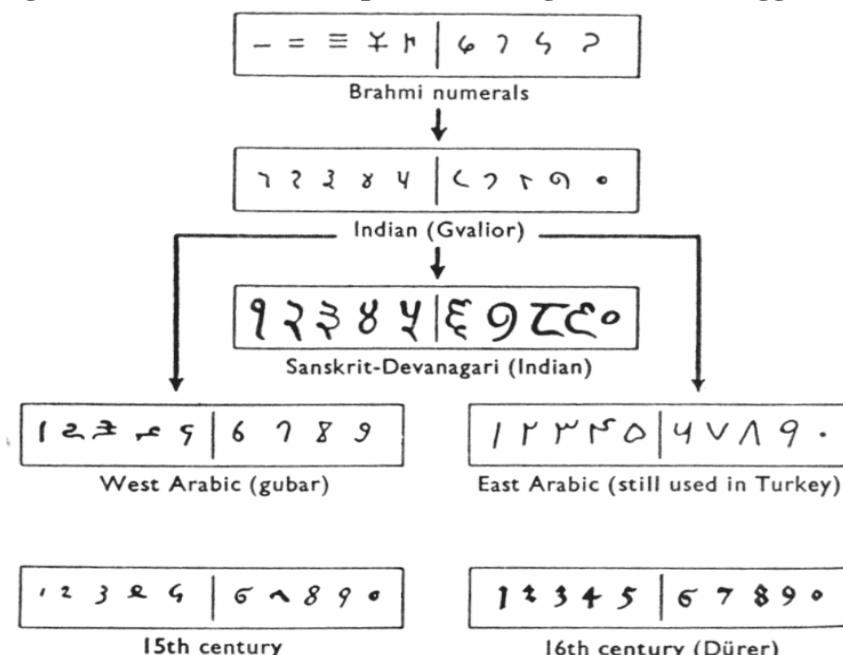


**Fig.3: Knots and cords used by the Babylonians (Havil 187).**

#### History of Hindu and Arabic Numerals

In the 21st century, this is the most prevalent way to write numbers. Al-Brahmi brought the digits 1, 2, 3, 4, 5, 6, 7, 8, and 9 to India (Menninger 175). As time progressed, so did the Brahmi numbers. Through give just one example, the following numbers were used from the fourth to the sixth centuries.

**Fig.4 The numerical developments through centuries (Higgins 189).**



Finally, over the course of history, the digits 1, 2, 3, 4, 5, 6, 7, and 9 were developed. Cambodia is

home to the earliest known zero-based system. During the Saka period, the first decimal point was added, using a system of three numbers and a dot in the middle (Hays and Schmandt-Besserat 198). The positional system, developed by the Babylonians, is largely responsible for establishing the concept of place value in number systems. In addition, the Babylonians advanced the foundations of the number system through the positional system, which was further refined by the Indians. Iterative refinements led to the present-day form of the Brahmi numerals (Higgins 204). The Gupta numerals were one stage along the path from the Hindu-Arabic number system to the numerals most widely used in the United States today. The origins and history of the Gupta numerals are still a matter of some debate among scholars.

Additionally, the Europeans adapted the Hindu-Arabic system via trade, with merchants using the Mediterranean Sea as a hub for their business dealings (Havil 190). European numerical development was largely shaped by the abacus and the Pythagorean theorem. Even though the two systems eventually faded apart, the Pythagorean still made use of what they called "holy numbers." Eventually, Europeans used the Hindu-Arabic number system as a model for their own developed mathematical notation (Ifrah and Bello 207). However, the specifics of how the Europeans came to embrace the Hindu-Arabic system remain unclear. According to popular belief, the Europeans relied extensively on the Hindu-Arabic number system when developing their own robust numbers (Higgins 210). For instance, the positional base system covers a wide range of numbers and requires the use of the numeral 10 in order to convert between multiple bases.

### Numbers in Mayan History

Counting and arithmetic were central to the Mayan religion and culture that arose in what is now Mexico. Both the priests and the laypeople followed their own ceremonial processes to calculate the dates on the calendar (Higgins 217). In the priestly calendar counting, for instance, a system of numerous bases was used. The foundation of mathematics is found in the Mayan number systems. The Maya numeral system also made use of number placement to assign value to sums of digits (Havil 223).

For arithmetic operations such as addition and multiplication, the Mayans relied on tables displaying the value of individual digits. Numbers ultimately owe more to the Hindu-Arabic and Mayan systems than they do to the Egyptian and Babylonian systems (Menninger 199). The Western system of counting and arithmetic, however, drew upon the best aspects of all previous developments to produce a uniformly robust standard. Most countries use a variant of the American system, which, among other things, employs decimal points, place value, base values, and the Roman numerals from 1 to 10. (Ifrah and Bello 225). Listed below is a sketch of the Mayan numeral table.

Number	Vertical Form	Number	Vertical Form
0	○	10	==
1	○	11	○=
2	○○	12	○○
3	○○○	13	○○○
4	○○○○	14	○○○○
5	—	15	—
6	—○	16	—○
7	—○○	17	—○○
8	—○○○	18	—○○○
9	—○○○○	19	—○○○○

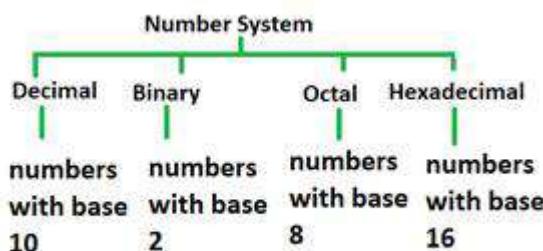
**Fig. 5: The tabulation of mathematical values used by Mayans for calculations (Havil 234).**  
**SIGNIFICANCE OF NUMBER SYSTEM**

Everyday life necessitates the constant need to symbolically portray numerical values through the use of a variety of items and concepts. For the simple reason that it's much simpler to make comparisons between similar things when you can put a number next to them. In the context of

grading student work, for instance, rather than labelling each paper with an adjective like "good," "better," "awesome," or "poor," etc., the teacher would assign a certain numerical value to that paper based on the student's performance to make it easy to assess the student's knowledge and preparation level. Because eventually the teacher will run out of appropriate descriptors, and then they'll all be utilised to rate the pupils' varied reactions. In such a case, it is necessary to use a novel approach to valuation that not only aids in determining the item's true value but also represents it fairly and without ambiguity. The number system is a set of rules and conventions for assigning numerical values to various objects and quantities.

**Number:** A word or symbol for a certain numerical value. Only with numbers have we been able to perform the myriad arithmetic operations necessary for our progress in physics and mathematics. Even the simplest of daily activities requires some knowledge of numbers. The value of the money used to buy goods can also be expressed numerically. The phone number of a person is typically a string of digits assigned to them. Numbers play such a huge role in our daily lives. For this reason, the following discussion of numbers and number systems is essential.

**Counting Numbers :** Numbers used to keep track of how many of something there are are known as "counting numbers." It's a sequence of numbers that begins with "1" and extends into infinity. Each "one" in this context stands for a single item. For instance, Mr. A was holding only one pencil and one pen, and I only consumed a single banana today. It's a fact that when you add two counting numbers together, you get yet another counting number. These are practical tools for everyday tasks like bartering, arithmetic, and other operations.



In computation and problem-solving, numerical values are represented and manipulated with the help of number systems.

Number systems use various bases, including binary (base 2), decimal (base 10), and hexadecimal (base 16). The number of possible digits for representing numbers in a given system is limited by the base used.

- Numerous fields rely on number systems for computation and data representation, including digital electronics, computer science, and programming.
- Number systems are used to represent and manipulate binary data as electrical signals in the field of digital electronics.
- Integers, floating-point numbers, and hexadecimal values are just some of the number systems used in computing and programming to represent and manipulate data.
- Similarly, number systems are essential in cryptography, as many encryption algorithms require the user to convert between different number bases.
- Various mathematical ideas, including those of arithmetic, algebra, and number theory, rely on number systems as their basis.
- Measurement units and physical quantities are just two examples of how engineers and physicists put number systems to work.
- The ability to efficiently and accurately manipulate numerical data necessitates familiarity with various number systems and the properties that make them unique.

## EDUCATIONAL IMPLICATIONS

Different number systems are introduced to students as a foundational notion in mathematics. This understanding is crucial for students to be able to go on to more complex mathematical ideas.

- Building a strong foundation in mathematical concepts and problem-solving skills

begins with early instruction in number systems.

- Students who have a firm grasp on the concepts of base conversion and place value might benefit greatly from learning about other number systems.
- Students of computer science and programming benefit greatly from a grasp of number systems since they lay the groundwork for working with binary, decimal, and other data representation and manipulation bases.
- Helping pupils learn to apply mathematical principles to real-world problems is another benefit of teaching number systems.
- Students who take the time to study about the characteristics of several number systems will be better equipped to think critically and analytically, as they will be able to weigh the merits and drawbacks of each system and choose the one most suited to a given situation.
- The fundamentals of number systems and how to convert between multiple bases are taught to children as early as the elementary school years.
- Students of science and engineering will find this knowledge useful as it is essential for the depiction of measuring units and physical quantities.
- Teaching pupils about number systems is a great way to help them practise abstract thinking, logic, and reasoning.

## CONCLUSIONS

A better comprehension of mathematical ideas, problem-solving abilities, and the development of mathematical cognition can all benefit from pupils knowing about the significance and pedagogical implications of the development of number systems.

- Students benefit from learning about the historical background of mathematics and the roles that many cultures and civilizations have played in the progression of mathematical understanding.
- Students can gain a deeper understanding of how mathematics has changed through time and how new number systems have been created to fit the demands of various disciplines by learning about this process.
- It helps students make educated judgements about which number system to utilise for a given problem or application by providing a greater grasp of the qualities and limits of multiple number systems.
- It's a great way to sharpen your mind's capacity for introspection, analysis, and deductive reasoning.
- It can also help people see the interconnectedness of math with other disciplines, such as computer science, engineering, and physics.

In archaeology, we find traces of counting and numerical systems that date back to the distant past. Researchers face a formidable obstacle while trying to determine the counting and number systems of the ancient world due to their work. Evidence for studies on numerical systems and counting has yet to be finalised. The Mayan, Hindu, and Babylonian systems, all of which relied on improvements made by the Incas, were ultimately the most effective number systems that led to the current dominant Western number system. Stones and wood carvings from prehistoric times reveal mathematical evidence, which in turn led to the development of counting methods, and therefore to the growth of mathematics as a discipline. When discussing the development of numbers, study and arguments might take a variety of different approaches. As a result, there are no agreed-upon findings from the study of the development of mathematical and numerical systems..In conclusion, studying about the history of number systems can offer students with a deeper knowledge of mathematical concepts and problem-solving skills, as well as a broader appreciation for the historical and multidisciplinary character of mathematics.

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