International Journal on Science and Technology (IJSAT)
E-ISSN: 2229-7677 ● Website: www.ijsat.org ● Email: editor@ijsat.org

Comparative Study of Mathematics in Ancient India, Greece, and Babylon

Dr. Prahlad Singh

Assistant Professor & Incharge
Department Of Mathematics
Govt Model College Kursanda Hathras (U.P)
prahladanora9@gmail.com

Abstract:
The evolution of mathematics is the history of the intellectual progress of mankind in numbers, geometry, astronomy, and logic. Some of the earliest civilizations that made remarkable contributions to mathematics included Ancient India, Greece, and Babylon. Each civilization had its own mathematical tradition that was shaped by various factors such as culture, religion, trade, and science. Babylonian mathematics was concerned with computations, astronomical calculations, and practical applications based on the sexagesimal numeral system. Greek mathematics concentrated on deductive reasoning, geometry, and proof, thus turning mathematics into a theoretical science. Mathematics in Ancient India featured the decimal place value system, zero, algebra, and trigonometry which were instrumental in shaping world mathematics. This paper provides an overview of the mathematics traditions of these civilizations in terms of numeral systems, methods, geometry, algebra, astronomy, and philosophy. Moreover, the paper examines the transmission of mathematical knowledge between civilizations as well as its lasting influence on modern mathematics. It will be shown that the modern tradition of mathematics resulted from cumulative contributions of several civilizations and not from any particular culture.

Keywords: Ancient Mathematics, Babylonian Mathematics, Greek Mathematics, Indian Mathematics, History of Mathematics, Geometry, Algebra, Astronomy.

1. Introduction

Mathematics is one of the earliest intellectual fields created by mankind. Counting, measuring, and geometry were employed from early days for commercial, agricultural, architectural, astronomical, and religious purposes. These pursuits gradually developed into mathematical knowledge[1, 2, 3].
Several ancient civilizations had significant mathematical achievements. Babylonian mathematics originated in Mesopotamia around 2000 BCE to 300 BCE and was heavily influenced by trade, government, and astronomy [4]. Greek mathematics thrived between sixth century BCE and fourth century CE and involved logical deduction and geometry [5]. Ancient Indian mathematics grew out of Vedas, ritual geometry, astronomy, philosophy, and finally contributed the decimal positional number system and zero [6].
The significance of ancient mathematics cannot be underestimated for studying the history of science as well as for appreciating the multicultural nature of current mathematics. Mathematics was transferred among civilizations thanks to trade relations, conquests, migration, and scientific interactions. Mathematical knowledge transfer from Babylon to Greece and India to the Islamic countries and then to Europe contributed to the formation of modern science [7]. The purpose of this research paper is to compare mathematics in Ancient India, Greece, and Babylon.

2. Historical Background of Ancient Mathematics

The progress of mathematics was associated with the social and economic needs of the time. Mathematical methods were needed in early civilizations for measuring land, taxation, construction, and astronomy.
Mathematics of the Babylonians originated from the Sumerian and Akkadian mathematical tradition of Mesopotamia. Clay tablets found in modern-day Iraq demonstrate advanced arithmetic operations and observations of the sky [8]. Mathematicians in Babylonia were educated in the art of calculation.
Greek mathematics progressed due to philosophical thinking and logic. Mathematicians in ancient Greece turned practical knowledge of mathematics into an axiomatic science [9]. Mathematics became closely associated with logic, metaphysics, and philosophy of nature.
Indian mathematics developed due to ritual practices, astronomy, commercial transactions, and philosophical thinking. The Sulba Sutras described geometric constructions for altar construction, while other mathematical works dealt with algebra, trigonometry, and infinite series [10].
Thus, despite the differences between the mathematical traditions of these civilizations, each civilization provided mathematics with new concepts.

3. Babylonian Mathematics

3.1 Numeral System

Babylonian mathematicians used a sexagesimal or base-60 numeral system [11]. The positional numeral system facilitated easy computations with fractions since the number 60 had many divisors. Time measurements that use 60 minutes per hour and circles divided into 360 degrees are based on the Babylonian numeral system.
Babylonians represented numbers with cuneiform marks made on clay tablets. The system originally had no symbol for zero although some scribes later used place-holding marks.

3.2 Arithmetic and Algebra

Multiplication, division, square roots, and cubic roots were well-known to Babylonians [12]. Procedures for solving linear and quadratic equations are described in mathematical tablets.
The Plimpton 322 tablet shows that Babylonians knew Pythagorean triples long before Pythagoras lived [13]. Babylonian algebra was more algorithmic and practical than symbolic.

3.3 Geometry

Practical applications were the main focus of Babylonian geometry including measurement of land areas and construction of buildings [14]. Babylonians calculated areas and volumes of geometrical objects as well as estimated π.
Babylonian geometry was different from Greek geometry since it did not rely on deduction.

3.4 Astronomy

One of the most important discoveries in Babylonian civilization was astronomy. Babylonian astronomers used numerical tables to predict eclipses and motion of planets [15]. Babylonian astronomical observations greatly influenced Greek astronomy.

4. Greek Mathematics

4.1 Philosophical Basis

Greek mathematics was very different from Babylonian mathematics since it focused on logical thinking and theoretical aspects [16]. The philosophers of Greece saw mathematics as the key to achieving universal truths. Pythagoreans believed that numbers governed the universe. According to Plato, geometry is crucial to education.

4.2 Geometry and Deduction

The ancient Greeks made tremendous achievements in geometry. In Euclid's Elements, geometry is presented systematically using axioms, definitions, propositions, and proofs [17].
The deductive approach used by the Greeks set mathematics apart as a logic-based science. It would serve as the basis for future scientific discoveries. Archimedes focused on areas, volumes, and infinitesimals, while Apollonius concentrated on conic sections [18].

4.3 Number Theory and Algebra
Greek mathematicians studied irrational numbers, proportions, and number theory [19]. Diophantus made great contributions to algebra by studying equations.
Greeks did not use symbols in their algebra like Indians.

4.4 Greek Astronomy
Greek astronomers such as Hipparchus and Ptolemy used mathematical models to explain celestial motion [20]. Greek trigonometry developed primarily for astronomical applications.

5. Ancient Indian Mathematics

5.1 Vedic Mathematics and Sulba Sutras
Indian mathematics dates back to the ritual geometry mentioned in Sulba Sutras [21]. These documents consist of geometrical constructions and formulas that resemble the Pythagorean theorem.
Geometry had various applications in building altars and performing religious rituals.

5.2 Decimal Place Value Notation
One of India's most significant contributions to mathematics is the decimal place-value numeral system [22]. This system facilitated calculations and laid the foundation of today's numerals.
The creation of the concept of zero marked a milestone in mathematics by facilitating computations.

5.3 Algebra and Arithmetic
Indian scholars made considerable advances in algebra. Brahmagupta established rules regarding zero and negative numbers and could solve quadratic equations [23].
Bhaskara II made significant contributions to algebra, arithmetic sequences, and indeterminate equations.

5.4 Trigonometry and Astronomy
Indian mathematicians were pioneers of trigonometric functions like sine and cosine [24]. Aryabhata created an astronomical model and performed planetary motion calculations.
The Kerala school anticipated some ideas that are fundamental to the theory of infinite series and calculus [25].

6. Comparative Analysis

6.1 Numeral Systems
The Babylonians used the sexagesimal system, the Greeks used the alphabetic numerals, and the Indians used the decimal system including zero [26].
Of the above numeral systems, the Indian numeral system had the most impact because of its simplicity and versatility.

6.2 Methodological Differences
The Babylonians were more focused on computation and algorithms, the Greeks on logic and proofs, and the Indians on efficiency and symbolism [27].

6.3 Geometry
The Greeks were unsurpassed in their deductive prowess in geometry through Euclid and Archimedes [28]. The Babylonians stuck to practical geometry, whereas Indian geometry was mainly for rituals and astronomy.

6.4 Algebra
The Babylonians applied algorithms to solve equations, but without using symbols. The Greeks dealt with algebra using geometry. The Indians, however, worked systematically on algebra and symbols [29].

6.5 Astronomy
The connection between mathematics and astronomy was common among all the civilizations. The Babylonians influenced Greek astronomy, and the Indians combined indigenous knowledge with that of foreign civilizations [30].

7. Transmission of Mathematical Knowledge

The transmission of mathematical knowledge between civilizations was accomplished via trade routes and scholarly interactions. Babylonian astronomy had an influence on Greek mathematical astronomy, while Greek mathematics influenced Islamic scholars.

Babylonian numerals and their algebra were transmitted to the Islamic world, and eventually to Europe via Arabic translations [7]. The exchange of mathematical knowledge among civilizations indicates that mathematics is the result of a collective effort rather than an independent one.

8. Impact on Modern Mathematics

Modern mathematics owes its development to contributions from all three civilizations.

- Babylonian civilization made contributions in positional numeration, astronomy, and numerical analysis.
- Greek civilization made contributions in deductive logic, geometry, and mathematical rigor.
- Indian civilization made contributions in zero, decimal numerals, algebra, and trigonometry.

9. Conclusion

Comparative study of mathematics in Ancient India, Ancient Greece, and Babylon shows different but related mathematical cultures. The Babylonians developed mathematics that was mainly concerned with calculation and astronomy. Ancient Greeks made mathematics into a deductive science. Ancient Indians invented groundbreaking ideas concerning numbers and algebra. All these civilizations laid the basis for modern mathematics. This shows that science advances through the cumulative contributions of various civilizations, not through isolated inventions. Knowledge about the history of ancient mathematics helps to realize how rich the scientific heritage of humanity is.

REFERENCES:

[1] Neugebauer, O. (1969). *The exact sciences in antiquity*. Dover.
[2] Heath, T. L. (1981). *A history of Greek mathematics*. Dover.
[3] Plofker, K. (2009). *Mathematics in India*. Princeton University Press.
[4] Robson, E. (2008). *Mathematics in ancient Iraq: A social history*. Princeton University Press.
[5] Boyer, C. B. (1991). *A history of mathematics* (2nd ed.). Wiley.
[6] Datta, B., & Singh, A. N. (1962). *History of Hindu mathematics*. Asia Publishing House.
[7] Joseph, G. G. (2011). *The crest of the peacock: Non-European roots of mathematics*. Princeton University Press.
[8] Høyrup, J. (2002). *Lengths, widths, surfaces: A portrait of old Babylonian algebra and its kin*. Springer.
[9] Kline, M. (1972). *Mathematical thought from ancient to modern times*. Oxford University Press.
[10] Sarasvati Amma, T. A. (1979). *Geometry in ancient and medieval India*. Motilal Banarsidass.
[11] Ifrah, G. (2000). *The universal history of numbers*. Wiley.
[12] Katz, V. J. (2009). *A history of mathematics: An introduction*. Addison-Wesley.
[13] Fowler, D. (1999). *The mathematics of Plato's Academy*. Oxford University Press.
[14] van der Waerden, B. L. (1983). *Geometry and algebra in ancient civilizations*. Springer.
[15] Pingree, D. (1978). The Mesopotamian origin of early Indian mathematical astronomy. *Journal for the History of Astronomy, 9*(1), 32–43.
[16] Wilder, R. L. (1981). *Mathematics as a cultural system*. Pergamon Press.
[17] Euclid. (1956). *The thirteen books of Euclid's Elements* (T. L. Heath, Trans.). Dover.
[18] Knorr, W. R. (1986). *The ancient tradition of geometric problems*. Birkhäuser.
[19] Weil, A. (1984). *Number theory: An approach through history*. Birkhäuser.

[20] Toomer, G. J. (1996). *Diocles on burning mirrors*. Springer.
[21] Seidenberg, A. (1978). The origin of mathematics. *Archive for History of Exact Sciences, 18*(4), 301–342.
[22] Cajori, F. (1993). *A history of mathematics*. Chelsea Publishing.
[23] Singh, P. (1985). The so-called Fibonacci numbers in ancient and medieval India. *Historia Mathematica, 12*(3), 229–244.
[24] Basham, A. L. (1967). *The wonder that was India*. Rupa Publications.
[25] Roy, R. (1990). Discovery of the series formula for π by Leibniz, Gregory, and Nilakantha. *Mathematics Magazine, 63*(5), 291–306.
[26] Burton, D. M. (2011). *The history of mathematics: An introduction*. McGraw-Hill.
[27] Youschkevitch, A. P. (1976). *History of mathematics in the Middle Ages*. Springer.
[28] Gillings, R. J. (1982). *Mathematics in the time of the Pharaohs*. Dover.
[29] Needham, J. (1959). *Science and civilization in China* (Vol. 3). Cambridge University Press.
[30] Staal, F. (1999). *Ritual and mantras: Rules without meaning*. Motilal Banarsidass.