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Unveiling the Mathematical Tapestry: A Comparative Journey of Bharatvarsh and the World

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Abstract

The study aims to investigate the fundamental knowledge of the number system and its evolution, particularly in the context of Bharatvarsh (the Indian subcontinent) and its historical regions such as Awadh, Mithila, Pandecherri, Nepal, Gandaki desh, Bajhang, Tamsaling, Goa, Sindh, Delhi, and Gwalier.The research compares the mathematics developed in Bharatvarsh or South Asia with that of the European Union, drawing insights from the field of Jyotish Shastra (Astrology), where mathematics plays a crucial role. The findings highlight the unique aspects of mathematics in Bharatvarsh, revealing its distinct applications and development within the framework of Jyotish Shastra. The study emphasizes the importance of studying mathematics for undergraduate students and provides suggestions to facilitate their understanding of this subject. The research offers a fresh perspective on the evolution of the number system and of mathematical concepts, contrasting the approaches taken in Bharatvarsh and the European Union while underscoring the significance of Jyotish Shastra in shaping the mathematical traditions of South Asia.

Key Words: Arithmetic, platonism, decimal number system, Pythagoras theorem

Introduction

The decimal numeral system is the most widely used system of numerals today. Indian mathematicians are credited with developing the integer version, known as the Hindu–Arabic numeral system. Aryabhata of Kusumapura developed the place-value notation in the 5th century, and a century later, Brahmagupta introduced the symbol for zero. This system slowly spread to other surrounding regions like Arabia due to commercial and military activities between India and those regions.

Various numeral systems have been used throughout history, ranging from the simplest unary system, where numbers are represented by a corresponding number of symbols (e.g., seven as ///////), to more complex systems like the Egyptian and Roman numeral systems, which employed different symbols for certain values and repetitions of symbols. The number systems of spoken languages often use mixtures of bases and features, as seen in examples from French and Welsh.

The positional system, also known as place-value notation, is considered more elegant. In the base 10 system, ten different digits (0, ...9) are used, and the position of a digit signifies the power of ten that the digit is to be multiplied with (e.g., 304 = 3×102 + 0×101 + 4×100).

The Hindu–Arabic numeral system, which originated in India, is a positional base 10 system and is now used worldwide.

While the contributions of Indian mathematicians to the development of the decimal numeral system and the concept of zero are well-documented, a comprehensive comparative analysis is needed to fully appreciate the distinct trajectories and cross-cultural exchanges that shaped the global understanding of number systems and calculations. The contributions of Bharatvarsh (the Indian subcontinent) to the evolution of mathematical concepts have often been understudied or overshadowed in comparison to the developments in Europe and the Greco-Roman world.

The primary objective of this research was to study the basic knowledge of number systems and their development in Bharatvarsh, with a particular focus on the interconnection between mathematics and Jyotish Shastra (astrology). It aims to compare and contrast the advancements in mathematics within Bharatvarsh with those in the European sphere, shedding light on the unique contributions and influences of each tradition. Furthermore, the study seeks to provide insights and recommendations for undergraduate students on the importance of studying the origins of mathematics from a global and inclusive perspective.

Materials and Methodology

This research draws upon a comprehensive review and analysis of historical texts, archaeological findings, and existing scholarly literature related to the development of mathematics in Bharatvarsh (the Indian subcontinent) and Europe. The study employs the following materials and methods:

Primary Sources

- Ancient Indian texts such as the Vedas, Sulba Sutras, Siddhanta texts, and works by renowned mathematicians like Aryabhata, Brahmagupta, Varahamihira, Mahavira, and Bhaskaracharya.
- Classical Greek and European texts on mathematics, including works by Pythagoras, Euclid, Archimedes, Diophantus, and others.

Secondary Sources

- Scholarly literature, research papers, and academic publications exploring the history and development of mathematics in Bharatvarsh and Europe.
- Archaeological reports and findings related to numeral systems, mathematical inscriptions, and other relevant artifacts from ancient civilizations.

Research Methodology

- Comparative analysis techniques were employed to identify similarities and differences in the mathematical concepts, number systems, and problem-solving approaches adopted in the two distinct cultural spheres of Bharatvarsh and Europe.
- Particular attention was given to the interconnections between mathematics and the study of Jyotish Shastra (astrology) in Bharatvarsh.

- The research also involved a critical examination of the cross-cultural exchanges and influences that facilitated the dissemination of mathematical knowledge between different regions.

Pedagogical Insights

- To provide insights for undergraduate students, the research explored the pedagogical implications of studying the origins of mathematics from a global perspective.
- Educational theories and best practices in interdisciplinary learning were consulted to develop recommendations for incorporating diverse mathematical traditions into undergraduate curricula.

Data Analysis

- The collected data from historical sources, archaeological findings, and scholarly literature were analyzed using qualitative research methods.
- Thematic analysis and content analysis techniques were employed to identify key patterns, trends, and themes related to the research objectives.
- The analysis focused on uncovering the unique contributions, influences, and interconnections between mathematical developments in Bharatvarsh and Europe.

By combining a rigorous analysis of primary and secondary sources with comparative and pedagogical research methods, this study aims to provide a comprehensive understanding of the development of number systems and mathematical knowledge in Bharatvarsh and Europe, while also offering valuable insights for undergraduate education in mathematics.

Literature Review

The evolution of mathematical concepts and number systems has long been a subject of scholarly interest, particularly regarding the contributions of different cultures. The current study, "Unveiling the Mathematical Tapestry: A Comparative Journey of Bharatvarsh and the World," endeavors to address the historical trajectory of mathematical thought in the Indian subcontinent (Bharatvarsh) in comparison to that of the European Union. This literature review synthesizes existing research on the development of number systems, the role of significant mathematicians in Bharatvarsh, and the broader implications of cross-cultural mathematical exchanges.

1. Historical Development of Number Systems: The study of number systems reveals a rich tapestry of development, with various cultures contributing to the evolution of mathematics. The Hindu-Arabic numeral system, credited to Indian mathematicians such as Aryabhata and Brahmagupta, represents a significant milestone in this evolution. O'Connor and Robertson (1996) highlight the pivotal role of Indian scholars in the formulation of the positional decimal system, which incorporated the revolutionary concept of zero (Filliozat, 2004). This numeral system eventually spread to the Arab world and subsequently to Europe, reshaping mathematical practices globally (Smith & Karpinski, 1911).

2. Contributions of Indian Mathematicians: Literature underscores the contributions of various mathematicians from Bharatvarsh. Aryabhata (476–550 CE) introduced fundamental concepts in trigonometry and algebra, while Brahmagupta (598–668 CE) provided early formulations of rules for arithmetic operations with zero (Chowdhury, 2014). The works of mathematicians like Varahamihira and Bhaskaracharya further advanced mathematical understanding in areas such as combinatorics and calculus. Their texts, preserved in ancient manuscripts, demonstrate a sophisticated grasp of mathematics that parallels developments in the European tradition (Ifrah, 1999).

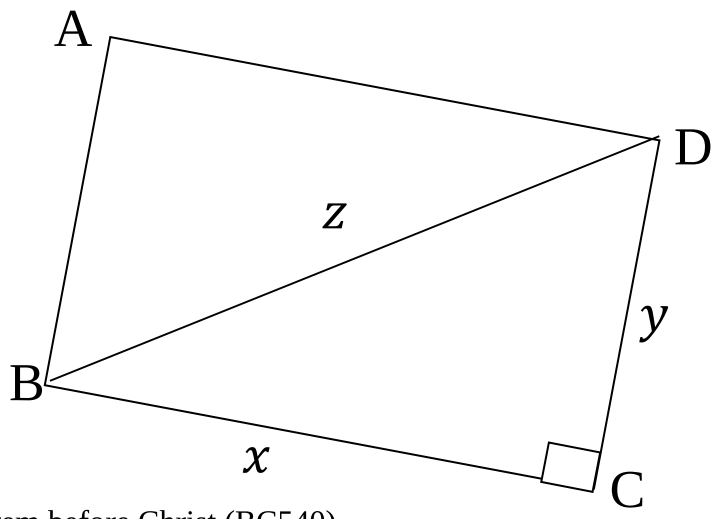
3. Comparative Analysis with European Mathematics: Comparative studies reveal striking parallels and divergences between Indian and European mathematical traditions. Scholars have often noted that the European approach, heavily influenced by the Greco-Roman mathematical canon, developed along different lines, particularly in the realms of geometry and algebra (Knuth, 1998). The introduction of concepts such as the Pythagorean Theorem and the study of Diophantine equations in Europe find parallels in the works of Bodhayan and Aryabhata, respectively (Chowdhury, 2014). The literature suggests that while these traditions emerged independently, they were not devoid of mutual influences, especially through trade and the exchange of ideas.

4. Interconnections Between Mathematics and Jyotish Shastra: An important aspect of this research is the intersection of mathematics and Jyotish Shastra (Indian astrology). As noted by various scholars, the mathematical techniques developed for astronomical calculations in Jyotish Shastra reflect a unique application of mathematical principles in Bharatvarsh (Filliozat, 2004). The literature highlights that the use of mathematical algorithms for astrological predictions not only showcases the mathematical prowess of Indian scholars but also underscores the cultural significance of mathematics in society (Georges Ifrah, 1999).

5. Pedagogical Insights and Recommendations: The literature also emphasizes the importance of integrating a comparative approach to mathematics education. Scholars advocate for the inclusion of diverse mathematical traditions in curricula to provide students with a broader perspective on the subject (Chowdhury, 2014). By incorporating historical context and cross-cultural comparisons, educators can foster a deeper appreciation for the universality of mathematical inquiry, as recommended in the current study.

Results and Discussion

We discuss Comparative Reality in Mathematics and its Sciences. We are introducing Pythagoras theorem before Christ comparing with Bodhayan. It is shown in a rectangular figure ABCD as follows:



1) Pythagoras theorem before Christ (BC540),

Comparing with $h^2 = p^2 + b^2$
Bodhayan (BC800)
For worship -rectangle/square shape
In Buddhism we use it.
$z^2 = x^2 + y^2$

2) Diophantine equation (500AD)

Any equation like $ax + by = c$ which has an integer solution is a diophantine equation. Comparing with Aryabhat's (499AD), Kuttakarya (कुत्ताकार्य). It means algebraic equation, Brahmagupta (6th century) .Any equation like $ax + by = c$ which has an integer solution.

3) Pascal triangle (1623-1662)

$(a+b)^0 = 1$
$(a+b)^1 = a + b$
$(a+b)^2 = a^2 + 2ab + b^2$
$(a+b)^3 = a^3 + 3a^2b + 3ab^3 + b^3$
$(a+b)^4 = a^4 + 4a^3b + 6a^2b^2 + 4ab^3 + b^4$
$(a+b)^5 = a^5 + 5a^4b + 10a^3b^2 + 10a^2b^3 + 5ab^4 + b^5$

1
1 1
1 2 1
1 3 3 1
1 4 6 4 1
1 5 10 10 5 1

Pierre Herigone French-European Union (1580-1643)

Comparing with Varahamihir (488-587 AD)बराहमिहिर
Trilostaka (त्रिलोत्सका),
पुर्वेनपूर्वेनगतेनयुक्तंस्थानमविनायकप्रदन्तिसमख्यं।ईच्छाविकल्पक्रमसोसविनयनितेनिवृत्तपुनर्नयानीति।
combinatorics

$$n_{C_r} = \frac{n!}{r!\,(n-r)!}$$

Mahavir महावीर (800AD)-Kerala केरल
about combination
"एकाद्येकोत्तरतःपदमूध्र्वाधर्यतःn_{C_r}
क्रमात्क्रमषःस्थापत्यप्रतिलोमध्नेनभारितसार" (प्रस्तारयोगभेदस्यसूत्र)

4) John Pell
Pell's equation (1610-1685 AD)

$$Nx^2 + 1 = y^2$$
$$Nx^2 + K = y^2 \qquad x, y \in \boldsymbol{Z}$$

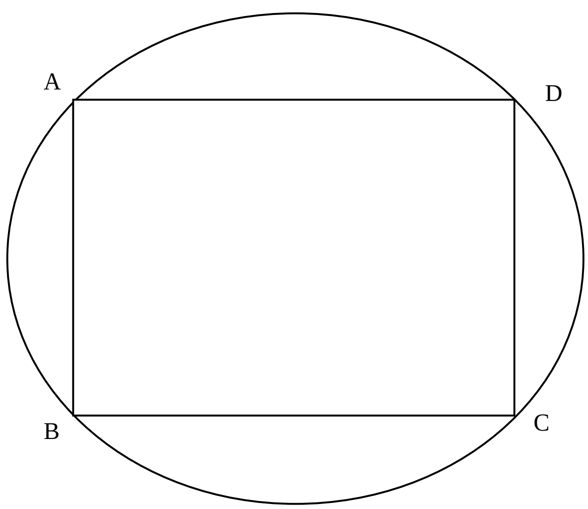
Comparing with Brahmagupta ब्रह्मगुप्ता Rajastan राजस्तान (628 AD) $Nx^2 + 1 = y^2$
Integer solution

$$Nx^2 + K = y^2 \qquad x, y \in \boldsymbol{Z}$$

5) Wshell's (European Union) (1619AD)
Rediscovered area of cyclic quadrilateral

A = $\sqrt{(s-a)(s-b)(s-c)(s-d)}$

Heron's (Egyptian Mathematician, 50-100 AD)
Area of triangle = $\sqrt{(s-a)(s-b)(s-c)(s-d)}$
Comparing with
Brahma Gupta, ब्रह्मगुप्ता Rajastan राजस्तान



Comparing with

Brahma Gupta, ब्रह्मगुप्ता Rajastan राजस्तान

Formula for area of cyclic quadrilateral (628AD)

$$\sqrt{(s-a)(s-b)(s-c)(a-d)}$$

6) Fibonacci Series (1175-1250 AD)

1,1,2,3,5,8,13,21,

Full Name: Leonardo Fibonacci

Comparing with

Virahanka series विरहांक (600AD)

1, 1, 2, 3, 5, 8, 13, 21,..............

7) Rolle's Theorem (Michel Rolle) European Union

(1652-1719 AD)

Comparing with भास्कराचार्य

Bhaskaracharya (1114-1185 AD)

Formula for relative difference

(Retrograde motion)

8) $x = \tan x - \frac{\tan^3 x}{3} + \frac{\tan^5 x}{5} - \ldots\ldots\ldots\ldots$

Gregory series (1668)

(1638-1675), James Gregory

Comparing with

Madhav of kerala (1340-1425AD) केरलकामाधव

Madhav's Theorem

$x = \tan x - \frac{\tan^3 x}{3} + \frac{\tan^5 x}{5} - \ldots\ldots\ldots\ldots$

9) Leibnitz Expansion (1646-1716)

Leibnitz formula for $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \ldots\ldots\ldots\ldots\ldots$

Comparing with

Madhav's Series $\frac{\pi}{4} = 1 - \frac{1}{3} + \frac{1}{5} - \frac{1}{7} + \frac{1}{9} \ldots\ldots\ldots\ldots\ldots$

(1350-1425AD)

10) Fermat's Result (1601-65)

Divisors of a number

Pierre de Fermat

Comparing with

Narayan Pandit (1356AD) नारायणपंडित, of Bengal, Bihar, Gandaki.

Factorisation, Ganit kaumudi, karma padhati.गणितकौमुदी, कर्मपध्दति, खंडिकरण. ऊत्तरप्रदेश, बंगाल, बिहार, गंडकीदेश .

11) Similar result by Huilers formula (1782 AD)

Simon Antoine Jean Lhuilier (1750-1840) European Union

Comparing with Parmeshwar वातासेरीपरमेश्वरनम्बुदरी (1380-1460), केरल

Formula for finding circum-radius of a cyclic quadrilateral (1360 AD)

12) Leonhard Eulers

Similar results (1707-1783 AD)

Comparing with

Nilkantha Somyaji-kerala नीलकण्ठसोमयाजी- केरल

(1444-1545), summations

13) Euler's (Leonhard Euler) (1707-1783)

$$2R = \frac{a}{\cdot \sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

R is circumradius of triangle ABC

Comparing with

Nilkantha Somyaji-Kerala (1444-1545) नीलकण्ठसोमयाजी- केरल

Sine rule: $\frac{a}{\cdot \sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

14) Johannes kepler (1571-1630)

German, European Union

Comparing with

Brahma Gupta ब्रह्मगुप्ता (628AD) Rajastan राजस्तान

Volumes of Frustum of cone and pyramid

15**)** Leibnitz (1646-1716)

Similar results by method of integration

Comparing with

Jyestha Deo (1500AD)- Kerala केरल

Volume and surface area of a sphere

16) Newton (1642-1726)- leibnitz (1646-1716) (European Union)

d (siny) = cosydy

d (cosy) = -sinydy

Comparing with

Bhaskaracharya II, Instantaneous motion, भास्कराचार्यद्वितीय

siny'-siny = (y'-y) cosy

Concept of place value of Zero is given by Maya Civilization (250-900 AD) of central America (Mexico Region)

Most of the ancient Bharatiya literature in Mathematics is in Sanskrit language or in Modi manuscript.

Conclusion

This comparative exploration of the mathematical tapestry woven across Bharatvarsh and the world reveals a fascinating interplay of independent discoveries and cross-cultural influences. While both regions developed unique approaches to number systems and mathematical concepts, the underlying principles often converged. From the ingenious place-value system with zero to groundbreaking advancements in geometry and algebra, mathematicians from both hemispheres contributed significantly to the rich legacy of mathematics. Understanding these historical threads not only fosters appreciation for the intellectual achievements of the past but also sheds light on the universality of mathematical inquiry.

Studying the mathematical heritage of both Bharatvarsh and other cultures offers a more holistic and enriching educational experience. Here are some recommendations to integrate this comparative approach:

Incorporate historical context into undergraduate mathematics courses. Highlight the contributions of mathematicians from Bharatvarsh alongside their European counterparts.

Utilize primary sources and scholarly works that explore the mathematical traditions of Bharatvarsh alongside traditional Western texts.

Design problem-solving exercises that encourage students to explore alternative approaches used by mathematicians from different cultures.

Explore the connections between mathematics and other disciplines like astronomy and Jyotish Shastra (Indian astrology) in Bharatvarsh, fostering a deeper understanding of both fields.

By embracing this comparative perspective, we can cultivate a richer appreciation for the global tapestry of mathematics and inspire future generations to build upon this shared intellectual legacy.

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