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Vedic Mathematics- An Exploration of Indian Intellectual Tradition

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"It is tempting to think of them (Indians) as counter scientists….. Let us not forget that among the great accomplishments of the Indian thinkers were the invention of Zero, and of the Binary number system a thousand years before the West"- Briggs of NASA, California, in Journal of Artificial Intelligence, Spring, 85(Puri, 1988).

Vedic Mathematics presents innovative computational methods that aim to revolutionize current challenges in mathematics education (Puri & Weinless, 1988). It encompasses more than just a collection of novel computational methods but a different approach based on pattern recognition (Puri, 1991). This system applies to both elementary and advanced mathematics (Nicholas, Williams, & Pickles, 1984). The effectiveness of this system lies in the nature of the sutras, which often describe intuitive problem-solving methods (Puri & Weinless, 1988). For example, to find the sum of 267 and 98, instead of cumbersome arithmetic (Trafton, 1978), one might add 100 and subtract 2 to get 365. The Vedic system teaches such methods systematically, providing various strategies for any sum. This enhances strategic variety and keeps the subject engaging by focusing on underlying patterns and relationships (Starkey & Gelman, 1982; Stoddard, 1962).It is a mental system that keeps the mind alert and agile, developing our brain to high levels (Reyes, 1984).

Maths with smiles

Everything in nature has a perfect mathematical structure, from the rotation of the earth to the growth of plants and trees. Mathematics is inherent in all aspects of life, even in tasks like preparing a cup of coffee, which requires precise proportions. Despite this, traditional mathematics often lacks the variety found in everyday life, offering fixed and tedious procedures that can lead to math anxiety (Brooks & Brooks, 1988). Vedic Mathematics, however, introduces multiple methods for solving problems, making math playful and engaging, bringing joy and interest to students (Puri, 1991; 1986).

Vedic Mathematics- The Cosmic Software for the Cosmic Computer.

The Vedas, the oldest scriptures, introduced the decimal system "Dasmalva Padti" (Pathak, 2008) and developed early forms of algebra, trigonometry, and geometry. Thus, much of the math taught today originates from Vedic knowledge (Nidich & Nidich, 1990). Over time, this knowledge has fragmented. Brain specialists state that the left brain handles systematic information processing and logical conclusions, which is primarily developed by current math education (McLeod & Adams, 1989; Orme-Johnson & Haynes, 1981). The right brain, responsible for pattern recognition and intuition, remains underdeveloped in most students. Vedic Mathematics, with its multiple problem-solving methods, engages the right brain and fosters holistic brain development (Nicholas, Williams & Pickles, 1984). Vedic Mathematics serves as "Cosmic Software for the Cosmic Computer" (the human mind), preventing mental stagnation. It offers multiple approaches to arithmetic operations, enhancing multi-dimensional thinking (Williams, 1991). Thus, the Vedic system systematically trains both brain hemispheres, promoting balanced mental development.

Vedic Mathematics- Historical Overview.

The ancient system of Vedic Mathematics was revived by Sri Bharati Krsna Tirthaji (1884-1960), a distinguished scholar and advocate of Vedic spiritual teachings, between 1911 and 1918. Tirthaji meticulously extracted sixteen 'Sutras' and thirteen 'sub-sutras' from the Sanskrit texts known as Vedas, specifically from the 'Atharva Veda', the fourth Veda, which encompasses disciplines such as engineering mathematics, sculpture, medicine, and other sciences known today.

Sri. Bharati krsna Tirthaji

Sri Bharati Krsna Tirthaji was an eminent scholar proficient in Sanskrit, Mathematics, History, and Philosophy. He has his education at Thinnavelly and later he took his matriculation from Madras University at the age of fifteen. He took master degree in eight different subjects with honors at the age of twenty. He took pleasure in research in almost all branches of Science and Philosophy. In 1905, he was inspired by the National Education Movement initiated by Gopala Krishan Gokhala and he joined the National College at Raja Mahendri as its first principal in 1908. His deep urge towards philosophical research and Vedanta culminated in his becoming a sanyasin with the name Bharati krsna Tirtha. He became the Sankaracharya of Puri Govardhan Mutt in 1925. He devoted the rest of his life for research in Mathematics and social works. In 1953 he organized an association called World Reconstruction Association and entrusted it to the care of educational experts and statesmen. Among his various literary contributions stands "VEDIC MATHEMATICS" as the most important one. He reconstructed 16 Vedic sutras and prepared 16 volumes one for each sutra, but all the 16 volumes was lost due to the neglect of his disciple while he was abroad. However, during his last days he prepared a comprehensive volume which is currently available.

In the words of Swamiji,

"*The Sutras apply to and they comprehensively address every topic across all branches of mathematics, from arithmetic and algebra to plane and solid geometry, trigonometry, both plane and spherical, conics in both geometric and analytical forms, astronomy, calculus, and beyond. These sutras are designed to be easily comprehensible, applicable, and memorable, encapsulating their entire essence in the phrase "mental mathematics.""* (Tirtha, 1965)

Mathematical knowledge in India-Contributions

Undoubtedly, the rich history of Indian mathematics spans many centuries, with early evidence found in the mathematics of the ancient Indus Valley civilization. A significant legacy of this civilization lies in its innovative 'brick technology', which potentially influenced the construction practices required by the subsequent Vedic religion (Pathak, 2008; Haridas, 2004). Mathematical knowledge in the Vedas is documented in texts known as Vedangas, comprising six disciplines: Siksa (phonetics), Kalpam (ritualistics), Vyakaranam (grammar), Niruktam (etymology), Chandas (prosody), and Jyotisam (astronomy and astrology), which also encompassed 'ganitam' (Haridas, 2004). Geometry and arithmetic flourished during the Vedic era, and the later Sulba-Sutras represent a continuation and elaboration of this traditional mathematical knowledge (Pathak, 2008). Among the notable contributions from this period are the introduction of decimal symbols and a place value system, marking significant milestones in mathematical history. However, the Indians' primary contribution lies not in the creation of nine symbols to represent numbers from one to nine, but in the invention of the placeholder zero. (Datta & Singh, 1935; Cajori,1897). The Indians referred to zero as ' sunya' meaning void.

Contributions of Acaryas like Aryabhatta, the pioneer of the revival of Indian mathematics; Brahmagupta, the founder of an influential school of mathematics, Mahavira, Sridhara, Bhaskara and Srinivasa Ramanujan should be admired at this context. The remarkable contributions from Kerala led by Narayana Pandit, Shankara Variyar, Madhava, Ganesa, Parameshvara, Nilakantha Somayaji, Cita bhanu and Jyesthadeva should be remembered here. The sixteen sutras of Vedic Mathematics are taken from part of a parisista of the Atharvaveda.

The Vedic Mathematic Sutras
Sixteen Vedic Sutras with their applications

Sl.No	Sutra	Translation in English	Application
1.	Ekadhikena Purvena	By one more than the previous one	Converting vulgar fractions into their decimal equivalent
2.	Nikhilam Navatascaramam Dasatah	All from nine and the last from ten	Multiplication, Division, Subtraction, Converting Vinculums
3.	Urdhva-tiryagbhyam	Vertically and Crosswise	Multiplication, Adding fractions, Subtracting fractions, Areas of rectangles, multiplying with Vinculums.
4.	Paravartya Yojayet	Transpose and Adjust	Division, Division of fractions, solving equations, converting vinculums
5.	Sunyam-Samyasamuccaye	Sum equals zero	To solve algebraic equations
6.	Sunyamanyat	One root is zero	Solution of algebraic equations
7.	Sankalana Vyakalana	By addition and subtraction	Compound areas, on top of the flag, straight division, straight decimal division
8.	Puranapuranabhyam	By completion and Non-completion	Adding noughts for division
9.	Calana-Kalanabhyam	By differencing and integrating	In calculus, To solve quadratic equations
10.	Yavadunam	Cubing numbers	Multiplication, cubes
11.	Vyastisamastih	Individuality and totality	Principle of letters in algebra, finding the average
12.	Sesanyankena-Caramena	Remainders by last digit	Conversion of fractions into decimal equivalent
13.	Sphantyadvayamantyam	The ultimate and twice the penultimate	Multiplying by 12 Divisibility by 4 Divisibility by 8
14.	Ekanyunena-Purvena	By one less than the previous number	Multiplication wherein the multiplier digits consists entirely of nines. Advance astronomy.
15.	Gunitasamuccayah	The product of the sum of the coefficients in the factors is equal to the sum of the coefficients in the product	Factorization
16.	Gunakasamuccayah	The total in the factors equals to the total in the product	Multiplying with final noughts. Adding indices. Checking sums. Multiplying decimals.

Thirteen Sub-sutras (Corollaries) and their Applications

SL.No	Sub-Sutra	Translation in English	Applications
1.	Anurupyena	Proportionately	Division, LCM, Equivalent fractions, Decimal/Fraction conversions, working base multiplications, Ratio and proportions, Factors and multiples often, moving the decimal point, percentages.
2.	Sisyate Sesasamjnah	Remainder	Multiples and Submultiples
3.	Adyama-dyenantyamantyena	The first by the first and the last by the last	Indirect proportion ,Conics, Calculus
4.	Kevalaih Saptakam-Gunyat	In the case of seven, multiplicand should be 143.	Recurring decimals
5.	Vestnam	Osculation	Division of two numbers

6.	Yavadunam Tavadunam	Add the twice of big and find square and cube.	Squares, cubes, square roots, cube roots.
7.	Yavadunam Tavadunikrtya Vargamca Yojayet	Subtract the less and include its square	Squares, cubes
8.	Antyayordasake'pi	Sum of last digits equal ten	Multiplication of two numbers whose last digit together total 10 and whose previous part is exactly the same.
9.	Antyayoreva	Only the last digits	Multiplying by 11, Divisibility by 4, Decimal/Fraction conversions, Multiplying Decimals.
10.	Samuccaya gunitah	The product of the sum of the co-efficient in the factors is equal to the sum of the co-efficient in the product	Special cases of factorization
11.	Lopanasthapanabhyam	By elimination and retention	Casting out nines, Divisibility by 3, Multiple products, A module to find the average, Frequency tables.
12.	Vilokanam	By mere inspection	HCF, Prime factors, LCM, simple equations, Divisibility for 2,5 & 10, Ratios, Rectangles in circles, multiple products
13.	Gunitasamuccayah Samuccayagunitah	Same as Sutra Gunita-samuccayah	Factorization

An example of Operational Technique

As an example of such application, general multiplication is explained.

General Multiplication

The Sutra reads as Urdhva tiryagbhyam. As applied to two digit numbers, say,

2 3 ×
4 6

First step (Urdhva)

That is 6 x 3 = 18 and has to be shown as

2 3 ×
4 6
/18 Place 8 and carry 1

Second step

The second step starts with the first column. Perform the operation as shown.

6 x 2 = 12 2 3
4 x 3 = 12 4 6
Add up 24

The second step results in after adding 1 to 24.

2 3
4 6
25 18

Third step

The third step is the Urdhva Multiplication of 2 and 4.

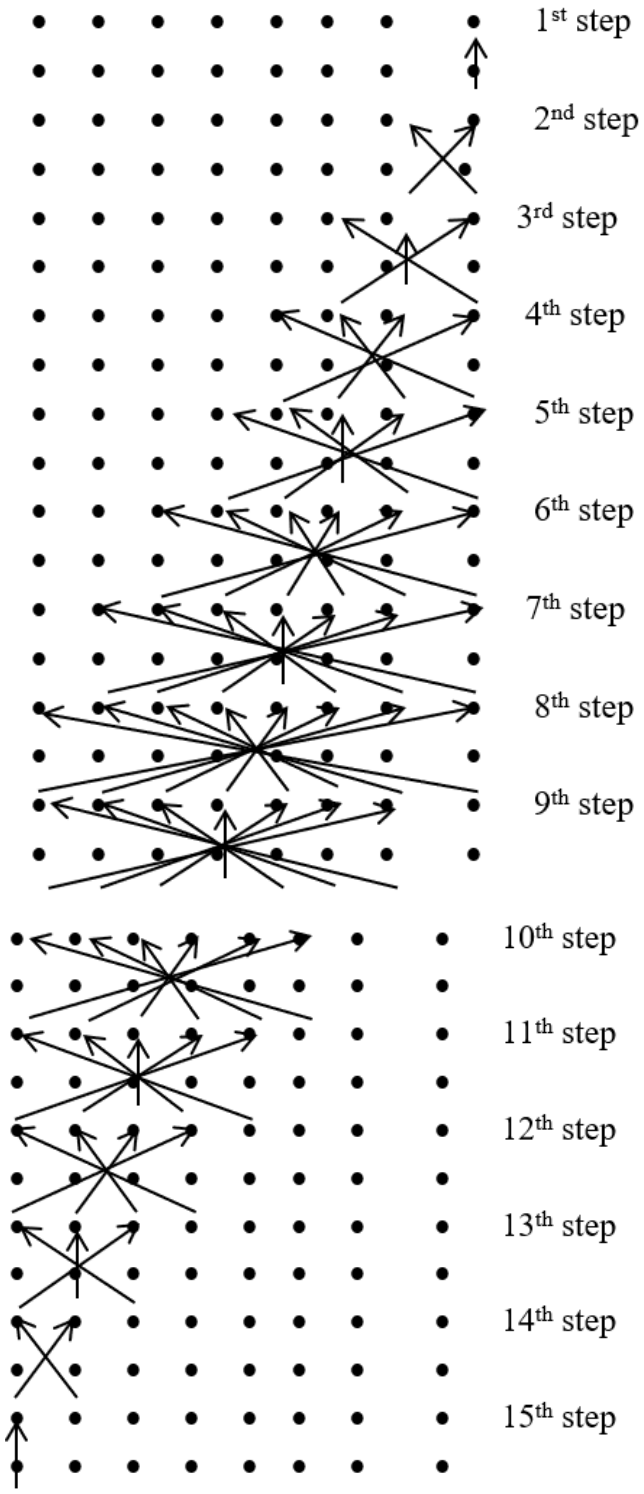
2 x 4 = 8

then is added to 2

2 3
4 6
1 0 2 5 18
This is one line method 1058

This can be generalized as follows. Considering an 8-digit by 8-digit multiplication given in figure below.

Urdhva tiryagbhyam (Vertically and Crosswise)



Usefulness of these Methods in the Calculator Age

Calculators are the fastest for large calculations, but pen-and-paper arithmetic prevents mental laziness and keeps our brains active. Relying solely on calculators, like using a car for all travel, can lead to mental stagnation. Just as walking exercises our body, doing arithmetic ourselves exercises our brain. While standard school methods for arithmetic can be tedious, Vedic methods offer a stimulating mental workout and can be twice as fast with practice. Therefore, although calculators are invaluable for

quick calculations, Vedic methods are essential for keeping our brains sharp and efficient in arithmetic. The essence of this concept lies in India's rich tradition of Vedic Mathematics. In an era dominated by Western civilization, there is a concerning neglect of our own cultural heritage, which diminishes our values and national spirit. Learning Vedic Mathematics serves as a reminder of India's once eminent cultural standards, highlighting the profound contributions of Indian mathematicians over centuries. What is ancient in India remains remarkably relevant to the modern world. The ancient Indian gift to humanity, dating back thousands of years—the invention of zero and the decimal system—is crucial to today's global silicon chip technology. This study aims to make India's treasure trove of profound mathematical knowledge accessible to all, enabling everyone to benefit from its wisdom.

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