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HISTORY OF MATHEMATICS OF INDIA AND ITS IMPORTANCE IN THE LEARNING OF MATHEMATICS

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ABSTRACT :

History of mathematics is the history of civilization. The mathematical heritage of India is very rich. Though ancient India has contributed a lot in the field of mathematics, unfortunately, the history of Indian mathematics is still inaccessible to most of the students. Despite of mathematics being a compulsory subject in school curriculum, most of the students consider it to be a dull and uninteresting subject. Researches claim that to enhance interest of the students in the learning of mathematics, they must be acquainted with knowledge of related history of the topics. Students must know that behind the present status of mathematics in today's world there is dedicated and sustained work of some great Indian mathematicians. The aim of the present paper is to review some of great work done by Indian mathematicians from ancient times so that it can inspire the students and make them motivated to learn mathematics with great enthusiasm. On the other hand, a brief discussion on why to help students to acquire knowledge of history of Indian mathematics has been introduced.

Keywords: *History of Indian mathematics, interest of students, learning of mathematics*

I. Introduction:

It is well said that the history of mathematics is the history of civilization. Ancient India had extra ordinarily rich cultural and mathematical heritage. A

significant role has been played by the subject Mathematics in the development of Indian culture. Behind the present status of mathematics in today's world there is dedicated and sustained work of some great Indian mathematicians. Indian mathematics has its roots in Vedic literature which is nearly 4000 years old. There is no doubt about that mathematics today is the result of great contributions made by Indian mathematicians over many hundreds of years.

Indian civilization more appropriately called as Hindu civilization was spread over several countries like Bangladesh, Pakistan, Bhutan, Burma, Srilanka and so on. Many of these countries are once part of the greater India.

History of Indian mathematics:

The Vedic civilization flourished between the 1500 B.C. and 500 B.C. Geometry, arithmetic and algebra were the areas where more emphasis was given in ancient India. The Vedic Sulva Sutras show that, to fulfil certain requirements of ancient Indians' religious rituals the earliest geometrical mathematical investigations arose.

Geometry is the science that deals with the characteristics of space. The concept of space was there in the Vedas. The Rig Veda refers to three regions of space such as lower (avama), central (madhyama), upper (parama) . It is well known that geometry was pursued in India in the context of construction of 'Vedis' for the 'Yajnas' of the Vedic period.

The Sulva sutras contain elaborate descriptions of constructions of 'vedis' and also enunciate various geometric principles. Some scholars of vedic period formulated these sutras. Some of great formulators were Baudhayan, Apastamba, Pratyayan, Manav, Matrayan, Varah and Bandhul.

In India, vedic mathematics did not develop on the lines of Euclid. Baudhayan sulva sutra is similar as pythagoras theorem. But, he discovered his theorem independently prior to pythagoras in context of the fire altars. The Pythagoras theorem is stated as, 'in a right angled triangle, the square of the hypotenuse is equal to the sum of the squares of the other two sides of the triangle'. The Baudhayana Sulva Sutra gives a special case of the Pythagoras theorem. In this case, the definition was given as, 'the rope which is stretched across the diagonal of a square produces an area double the size of the original square'. The Katyayana Sulva Sutra gave a more general version as, 'the rope which is stretched along the length of the diagonal of a rectangle produces an area which the vertical and horizontal sides make together'. The Sulva sutras are appendices to the Vedas. Both the Apastamba and Katyayana Sulva Sutras gave the approximation to $\sqrt{2}$ up to nine places which is 1.41421568, whereas the correct value of $\sqrt{2}$ is 1.414213562. Sulva sutras did not contain any proof of those. It can be said that Sulva Sutras are construction manuals for geometric shapes such as squares, circles, rectangles etc.

Again Jyotish Shastra (astrology) was developed to find appropriate timing for yagna. It is known from the book 'Bedanga Jyotish' that ancient astrologers knew about addition, subtraction, multiplication etc. Depending on yagnas,geometry,mensuration,astronomy etc. developed in the vedic age. In this context the Satapatha Brahmana and the Taitiriya Samhitadiscovered rectangles and properties of circles.

Religion played a major role in astronomical investigations too in India for accurate calendars had to be prepared to allow religious observances to occur at the correct times. Ancient Hindus were first to suggest to a heliocentric solar system. Speed of light was calculated as 1,85,016 miles/sec. They had even

calculated the distance between earth and moon to be 108 diameters of moon and that of earth and sun to be 108 diameters of the sun. Surprisingly,these figures are very close to the modern day values. All these were stated several thousand years before the famous scientist Galileo postulated in the west that sun was the centre of the planetary system and the earth is round rather than flat. The modern estimate of the age of the earth is 4.5 billion years. But the ancient Hindus calculated it to be 4.3 billion years.

Vedas contain many astronomical references. There are two Ayans in a year, namely, Uttarayana and Dakshinayana marking the period of Northward and Southward motion of the sun. An equinoxal day was also mentioned between the two Ayans. At the vedic age a year consisted of twelve months namely, Madhu, Madhava, Shukra, Shuchi, Nabha, Nabhasya, Isha, Urja, Sahas, Sahasya, Tapas and Tapasaya. Later with the discovery of Nakshatras, the names of the months changed to their present names Chaitra, Vaisakh, etc. The twelve months were spread over six seasons such as Vasanta,Grishma,Varsha, Sharad, Hemanta and Shishira.

There are a number of books on astronomy written by outstanding mathematician and astronomer. For example, Arya-bhatiya by Aryabhatta I,Brahma Sphuta Siddhanta by Brahmagupta, Baswati Karan by Shatanand, Siddhanta Shiromoni by Bhaskaracharya, Grahalagyam by Ganes etc.

Indian astronomy has influenced more on the development of modern western astronomy than Greek or Babylonian systems. There are five Sidhanta books which were edited by famous astronomer Varaha Mihira in his famous work Pancha Sidhantika. These Sidhantas studies solar and lunar eclipses, conjunctions of planets ,conjunctions of planets with nakshatras, rising and

setting of planets, creation of the Universe etc. The five Sidhantas are – Paithamaha or Brahma Sidhanta,Vashishtha Sidhanta,Romaka Sidhanta, Paulisa Sidhanta and Surya Sidhanta.

The credit of inventing a practically useful notation for writing with numbers goes to some Hindu school of thinkers. It is an amazing fact of history that long before these notations were used, probably even before the time of the Mahabharata, Sanskrit literature had already been using the numbers. They used unique single word-names for powers of 10 up the seventeenth. These names have been freely used both in literary and scientific writings ever since the Mahabharata times.

Our present notation system in the form of numerals 1,2,3,4,……etc., was originated by Hindus. As it was transmitted to the west through Arabs ,hence it got the name Hindu-Arabic number system. Arabs also made some modifications of these numerals. The early Hindus had no symbols for zero. But they had different symbols for 10,20,30 etc. At the later stage the Hindu mind evolved the symbol for '0'. Zero was derived from the concept of nothingness or void. This concept exists in Hindu philosophy. '0' is not only a numeral but also a concept which is fundamental. In the absence of the concept zero, there could have only been only positive numbers in computation. But the invention of '0' in mathematics has opened a new concept of negative numbers.

During 13th century the Hindu-Arabic numerals became popular in the west and virtually spread all over the world. The binary digits of '0' and '1'are so vital for present day digital world.

In India around 5 th century A.D. a system of mathematics that made astronomical calculations easy was developed. In those times its applications were limited to astronomy as its pioneers were astronomers.

In ancient India conventional mathematics termed 'Ganitam' was known before the development of algebra. The techniques of algebraic computation were developed in India in earlier times. While Indian 'Beez Ganit' reach Arab, they called it Algebra. After evolution through several stages, algebra has now come to play a key role in modern mathematics both as an independent area as well as an indispensable tool in other fields.

Jainism is a religion and philosophy founded in India in the period of 500 B.C. to 100 B.C. It is the bridge of the gap between ancient Indian mathematics and the classical period of Indian mathematics. Some of its contributions were – evolution of elementary formulae for mensuration, approximate values of square roots correct to 13 places of decimals, approximation of π,introduction of some concept of infinity, introduction of laws of indices, formulation of formulae for permutation and combination, works on sequences and progressions.

Some of the text written in that period was Surya Pranjnapti, Jambudvipa Pranjnapti, Bhagabati Sutra, Sthananga Sutra.

Some ancient Indian mathematicians:

Aryabhata:

By about 500 AD the classical era of Indian mathematics began with the work of Aryabhata. He wrote Aryabhata Sidhanta, Aryabhatiya etc. His writing consists of mathematical theory and astronomical theory which was viewed to be perfect in modern mathematics. He was aware that the earth rotates on its axis, the earth rotates round the sun and the moon moves round the earth. He is the

first known astronomer to have initiated a continuous counting of solar days, designating each day with a number.The Greeks and the Arabs developed some of his works to suit their present demand. He was the man, who created the formula $(a+b)^2 = a^2 + b^2 + 2ab$.

His Aryabhatiya is a summary of Hindu mathematics up to his time, including astronomy, spherical trigonometry, plane trigonometry, arithmetic and algebra. He introduced trigonometry in order to make his astronomical calculations based on the Greek epicycle theory. It consists of a collection of astronomical tables. It is Aryabhata who learnt the use of letters to represent the unknown.

Brahmagupta:

Born on 598 A.D. He lived at Ujjain, the site of great astronomical observatory, in the seventh century. He was particularly concerned with series and permutations. The rule of three in ratio and proportion was also known to him. From his knowledge of quadratics it is known that, he solved the equations by a rule which is equivalent to the quadratic formula. He had lots of contribution toward the development of mathematics. He gave 22/7 as the value of π and suggested 3 as a practical value. He also gave the usual rules for negative numbers. i.e. negative multiplied by or divided by negative gives affirmative . He wrote Brahmasidhanta at the age of thirty, which was an astronomical work in twenty –one chapters. Brahmagupta tried to give the rules for arithmetic involving zero and negative numbers in the 7thcentury. His rules were-"the sum of zero and a negative number is negative, the sum of a positive number and zero is positive, the sum of zero and zero is zero". He also said that, any number when multiplied by zero is zero.

Bhaskaracharya:

Bhaskaracharya lived in Ujjain in the twelfth century. He was well known for his treatment of negative numbers and treatise on arithmetic and measurement. He was also concerned with series, permutations, linear and quadratic equations, mensuration and astronomy. He also gave a method for deriving 'Sines' for angles of every degree.

His most celebrated work 'Lilavati' includes notation, the operations with integers and fractions, the Rule of Three, the most common commercial rules, interest, series, permutations, mensuration and a little algebra. He also wrote 'Bija Ganita', a work on algebra. Another work of importance written by him is the 'Sidhanta Siromani' , wherein he systematized mathematics known at that time. It was written when he was of 36 years.

Besides, he draws right triangles four times in the square of the hypotenuse, so that in the middle there remains a square whose side equals the difference between the two sides of the right triangle. He also made some contributions to the subjects of differential calculus and trigonometry.

S.Ramanujan:

Discussions about Indian mathematics and mathematicians are incomplete if contribution of Ramanujan in the field of mathematics is not mentioned. He was a real genius. He put India on the map of world mathematics in his own times. He was born in December 22,1887 in a village in Tamil Nadu. He lived only for 33 years. His most outstanding contribution was in the field of theory of numbers. Goldbach's conjecture is one of the important illustrations of Ramanujan's contribution. The statement is that every even integer greater than two is the sum of two primes, that is numbers having no divisors. Thus 4 is the

sum of two primes 2 and 2, 6 is the sum of two primes 3 and 3 and so on. Again the partition theory of Ramanujan has many applications to physics and statistics.

Importance of history of mathematics in the learning of mathematics:

Many researchers found that students are lacking interest in mathematics day by day. It becomes a major problem for the teachers of mathematics to maintain the interest of students in learning mathematics. One of the principal causes of failure of students in mathematics is the loss of interest in the subject. Students do the tasks most effectively in which they are genuinely interested. Interest in mathematics can be effectively aroused and maintained with the help of different activities. Introduction of historical background of different mathematical terms and concepts may be a good start for that. It will help them to be creative in learning mathematics. So, there is a tremendous need for popularization of mathematical heritage and for spreading the mathematical culture and mathematical temper in society.

Knowledge of history of Indian mathematics will help students to know the Indian culture, as mathematics is said to be the mirror of civilisation. Reading and hearing about how and who discovered different mathematical facts will encourage the students to know more about them and also to contribute something to it.

From this point of view, history of evolution of mathematical concepts is not just only desirable, but is an essential part of mathematics education, without which mathematics education is incomplete. Moreover, ancient Indian astronomy and ancient Indian mathematics are our great heritages and every Indian should know about these.

Conclusion:

There are many misunderstanding s about the history, growth, culture and relevance of mathematics, even among the educated members of the society. Common people think that mathematics is an abstract and dull subject. This misunderstanding about mathematics should be removed. History of each and every topic included in the course should be mentioned in the book and teachers have to introduce these in their teaching of mathematics. Our contribution to the studies in history of mathematics is not even one percent of world's contribution in this field.

The manuscripts need to be cared for to prevent deterioration and catalogued properly with the updates. Above all the most important is to be studied properly.

It should be made an essential component of the education of every child. Media should be used widely to popularise the knowledge to the adults as well as the children. Courses on history of mathematics should be introduced in Universities. More research work should be initiated in this field and thereby rediscovering the contribution of Indian mathematicians in the field of mathematics.

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