INDIAN MATHEMATICIANS AND THEIR CONTRIBUTIONS: A STUDY

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Abstract: Indian Mathematicians made tremendous contributions to the entire world of Mathematics and science. Decimal number system and invention of zero are among the greatest contributions of Indian Mathematicians. Moreover, there are many more remarkable Indian Mathematicians who contributed to the origin of mathematical sciences. They have made several general contributions to mathematics that have significantly influenced scientist and mathematicians in the modern times.

The objective of the study is to find out Indian Mathematicians and their contributions towards in learning mathematics. A descriptive analysis method is used for the present study. The study revealed that the contribution of Indian Mathematicians to develop positive attitude among the learner is far more than Western Mathematicians.

Keywords: Contributions of Mathematicians, Indian Mathematicians, Western Mathematicians

Introductions: Mathematics is the science of measurement, equality, structure, space and change. Mathematics in real sense, is a science of space and quantity that helps us in solving the problems of life using numerical and calculations. In Hindi or in some regional languages such as in Assamese, Punjabi, etc , Mathematics is also called 'Ganita' which means the science of calculation. Mathematics is a systematized, organized and exact branch of science. According to English Philosopher Roger Bacon, 'Mathematics is the gate and key of all sciences' [8]. The book Vedang Jyotish (1000 BC) mentioned the importance of 'Ganita'(Mathematics) as: "Just as the feather of a peacock and the jewel-stone of a snake are placed at the highest point of the body (at the forehead), similarly, the position of 'Ganita' is the highest amongst all branches of the Vedas and Shastras" [9].

Mathematics has played a very important role in building up modern civilization by perfecting all sciences. Mathematics is a subject, which has no any geographical boundary for its development. Many countries have contributed so many for the development of the discipline of Mathematics. The development of mathematical concepts started dates back in thousands years, starting from prehistoric period to twenty first century, much development has taken place in field of mathematics. For the development of the subject mathematics, many mathematician from different countries have contributed such as Babylonian, Egyptian, Greek, Chinese and Indians, etc. to name a few – Pythagoras, Fibonacci, Euclid, Archimedes, Rene Descartes, Aryabhata, Brahmagupta, Ramanujan have contributed prominently in the field of mathematics in ancient times .

The concept mathematics itself originated on us, it has not come from any other world. It first initiated the need to do calculations in daily life and commercial activities, measurement of land around for crop and to predict astronomical events happening around us by observing day and night. So, mathematics is a science, because it is based on observations and recorded systematical in logical order. We can also say mathematics as: "A study of Structure, Space and Change".

The study of structure starts with numbers, first the familiar natural numbers, and integers and their arithmetic operations, which leads to elementary algebra. The investigation of methods to solve simple equations leads first the intervention of rational numbers, complex numbers and real numbers.

The study of space leads to development of geometry, first the Euclidean Geometry and trigonometry. The study of chances or uncertainty in certain terms in the mathematical theory of probability allows the description, analysis and prediction of phenomena.

Objective of the Study: The main of the study is to analyze the contribution of, mathematicians in the field of mathematics with special reference to Indian Mathematicians in the Classical Era and Modern Age of Indian Mathematics.

Methodology: A descriptive analysis method is used for the present study to achieve the above mentioned objective

Background and Results of the study: The Contributions of Indian Mathematicians

In India, since Vedic period Mathematics was given much importance as a branch of knowledge. Indian Mathematics emerged in the Indian Subcontinent from 1200 BCE until the end of 18th century.

The most significant contribution of Ancient Indian Mathematics is its invention of zero, decimal representation of numbers and infinity. Numeral denominations of powers of 10 up to 10^{12} called 'Paradha' is mentioned in the ancient text 'Yajurveda Samhita' which is contemporary work to the Greeks had knowledge of 10^4 as the highest power of 10.

The significant contributions in the field of mathematics by some prominent Indian Mathematician are enlisted below:

Sl.No	Period	Name of the Mathematician	Various Contributions
1	5th Century AD	Aryabhata also called Aryabhata I	i) In 5th century AD, Aryabhata, the great Indian Mathematician had gave approximate value of π correct to 4 decimal places as 3.1416 that is only approximate suggesting that π which is the ratio of circumference of circle to its diameter is not rational. Since it is in 18th century that Lamber could prove that π is irrational ii) Another important contribution of Aryabhata's was a method for solving linear equations of the form ax+by=c. iii) He was the first person to say that Earth is spherical in shape and revolves around the son and stated that the correct number of days in a year is 365. iv) He had a significant contribution to algebra and astronomy. v) The method for finding integer

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			solutions of Diophantine equations can be seen in Indian literature from the time of Aryabhata. vi) He also proposed the famous summation series, which include the sum of n squares and n cubes. $\sum_1^n n = \frac{n(n+1)}{2}$, $\sum_1^n n^2 = \frac{n(n+1)(2n+1)}{6}$ $\sum_1^n n^3 = \{\frac{n(n+1)}{2}\}^2$ vii) In his work 'Aryahatiyam' , he covers arithmetic, algebra, plane trigonometry and spherical trigonometry.
2	7th Century AD	Brahma Gupta	i) Brahma Gupta gave the formula used in G.P. series viz. $a + ar + ar^2 + \cdots + ar^n = \frac{a(r^n-1)}{(r-1)}$ ii) He also gave the well-known formula to the area of a cyclic quadrilateral whose sides are a, b, c, d, are $\sqrt{(s-a)(s-b)(s-c)(s-d)}$ where 2s= a+b+c+d iii) He had accurately given the formula for triangular area as $\sqrt{(s-a)(s-b)(s-c))}$, where 2s=a+b+c iv) Brahma Gupta established the basic mathematical rules for dealing with zero i.e. 1+0=0, 1-0=0 and 1x0=0. However, he thought that $\frac{1}{0} = 0$, that is considered correct for centuries. In 12th Century, almost 500 years later, another Indian mathematician Bhaskara-II was able to confirm that $\frac{1}{0}$ as infinity, not zero. v) In his work on arithmetic, Brahma Gupta explained how to find the cube and cube-root of

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				an integer and gave rules for computation of squares and square roots. He also gave five types of combinations of fractions. He also discussed the Pythagorean triplets. Thus he had a significant contributions to the world of mathematics.
3	7th Century AD	Bhaskara also called Bhaskara I	i) ii) iii) iv) v)	He was a 7th Century Indian mathematician and astronomer. Bhaskara had given geometrical treatment of algebraic formula. He was the first to write numers in the Hindu- Arabic decimal system. He claimed that dividing a number by zero makes infinity. The solutions of the indeterminate quadratic equations of the type $ax^2 + b = y^2$ was given by Bhaskara. Also the first general method used for finding all the solutions of the problem $x^2 - my^2 = 1$ (so called as the "Pell's equation") was given by Bhaskara. Bhaskara was also concerned with series, permutations, lnear and quadratic equations and mensuration. A work of importance written by Bhaskara is the ' Sidhanta Siromani', in which he treats with astronomy and asserts the sphericity of the earth. In his honuor , the satellite built by the Indian Space Research Organisation (ISRO) was named Bhaskara-I. He was also an author of two books 'Mahabhaskariya' and 'The Laghubhaskariya'. Thus he had a tremendous contribution to the world of mathematics.
4	9th Century AD	Mahavira (Also called Mahaviracharya)	i)	In 9th Century AD, great Indian mathematician Mahavira was one of the most brilliant mathematicians of the vedic era. He gave the formula for , the number of ways in which r

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			objects can be chosen from a collection of n objects. ii) He described a process for calculating for the volume of a sphere. iii) He gave the formula for calculating the cube root of a number. iv) He discovered algebraic identities like $a^3 = a(a+b)(a-b) + b^2$(a-b)+b^3 v) He asserted that the square root of a negative number does not exist. vi) He derived the formula to calculate the area and perimeter of an ellipse. Mahavira also attempts to solve certain mathematical problems which had not been studied by other Indian mathematician.
5	12th Century AD	Bhaskaracharya-II	i) Bhaskaracharya-II find the method of solution of equation of the form $Ax^2 + 1 = y^2$ ii) Bhaskaracharya studied Pell's equation p$x^2 + 1 = y^2$ for p=8,11,32,61 and 67. When p=61, he found the solutions x=226153980, y=1776319049. When p=67, he found the solutions x=5967, y=48842. iii) He studied man Diophantine problems and introduced the concept of derivative much before the two mathematicians Newton and Leibnitz;s who developed independently the calculus in the 18th Century. iv) Among the many interesting results given by Bhaskaracharya-II, include the well known result for sin(A+B) and sin(A-B) sin(A+B)=sinAcosB+CosAsinB sin(A-B)=sinAcosB-CosAsinB
6	19th Century	Srinivasa Ramanujan(1887)	There is not much contribution between 12th and 1119th century until the appearance

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			of the great Indian Mathematician Srinivasa Ramanujan (1887) in the early nineteenth century. Ramanujan is most popular for his contribution viz. i) Analytical theory of numbers, elliptic functions, continued fractions, infinite series and the properties of the partition of function. ii) His contribution includes hyper geometric series, the Riemann series, the elliptic series, the elliptic integrals, the theory of divergent series. iii) Goldbach's conjecture is one of the important illustrations of Ramanujan's contribution. The statement is that ever even integer greater than two is the sum of two primes, that is number having no divisors. Thus 4 is the sum of two primes 2 and 2,6 is the sum of two primes 3 and 3, 8 of the primes 3 and 5 and so on.[2]

Conclusion :

The outstanding contributions of Indian mathematicians in the field of mathematics have significantly influenced the scientist and mathematician in the modern times worldwide. The contributions of Indian mathematicians have changed markedly over the last few decades. Much more work needs to e done, indeed work is now being undertaken and we will have a better understanding of this important part of history of Indian mathematics.

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