Contribution of indian mathematics history essay

Mathematics is the study of numbers, and counting, and measuring, but that is only the beginning. Mathematics involves the study of number patterns and relationships, too. It is also a way to communicate ideas, and perhaps more than anything, it is a way of reasoning that is unique to human beings. Mathematics plays a vital role in the modernization of this civilization. It is everywhere and affects the everyday lives of people. Although it is abstract and theoretical knowledge, it emerges from the real world. It is also a way to communicate and analyze ideas, a tool for organizing and interpreting data and above all, perhaps a method of logical reasoning unique to man. Mathematics is a necessary part of other sciences. In the words of Physicist Richard Feynan (2002) " Nature talks to us in the language of mathematics that is numbers, mathematical rules and equations help us to make sense of the world around us (The Book of Popular Science). Mathematics in some form or other has been since the early age of human civilization. But its use in today's world has assumed great importance, since without its application higher technology cannot be mastered and harnessed for increasing production of goods and services and promoting human welfare. Over the centuries there has been spectacular progress in the development of mathematics as a branch of knowledge. And without the application of mathematics on a wide scale no country can march forward in line with the general progress of human knowledge and thought. Therefore learning of mathematics and promoting the horizons of knowledge by advanced researches in mathematics should be over emphasized. Thus, mathematics is an important and inseparable part of human life. It has been existed and developed since the ancient era and the aim of this article is to give a brief review of a few of the outstanding innovations introduced by Indian

mathematics from ancient times to modern as India’s contribution in the field of mathematics is immense and it should always be studied from a thoughtful perspective.

Key Words:

INTRODUCTION:

“ India was the motherland of our race and Sanskrit the mother of Europe’s languages. India was the mother of our philosophy, of much of our mathematics, of the ideals embodied in Christianity… of self-government and democracy. In many ways, Mother India is the mother of us all.”

– Will Durant, American Historian 1885-1981

Mathematics is an important field of study. Mathematics is vital as it helps in developing lots of practical skills, in fact study of mathematics itself include the concepts related to the routine lives of human. It not only develops mathematical skills and concepts, it also helps in developing the attitudes, interest, and appreciation and provides opportunities to develop one’s own thinking. So, mathematics is undoubtedly a discipline which is imperative to know and study.

Fig. 1, Importance of MathematicsC: UsersnaveenDesktopUntitled. png

Mathematics has played a very significant role in the development of Indian culture for millennia. Mathematical ideas that originated in the Indian subcontinent have had a thoughtful impact on the world. In ancient time, mathematics was mainly used in an auxiliary or applied role. Thus mathematical methods were used to solve problems in architecture and

construction (as in the public works of the Harrappan civilization) in astronomy and astrology (as in the Jain mathematicians) and in the construction of Vedic altars (as in the case of the Shulba Sutras of Baudhayana and his successors). By the sixth or fifth century BCE, mathematics was studied for its own sake, as well as for its application in other fields of knowledge. In fact there does not seem to have been a time in Indian history when mathematics was not being developed. Recent work has unearthed many manuscripts, and what were previously regarded as inactive periods in Indian mathematics are now known to have been very active. The picture is yet not complete, and it seems that there is much more to do in the field of the history of Indian mathematics. The challenges are twofold. First, there is the task of locating and identifying manuscripts and of translating them into a language that is more familiar to modern scholars. Second there is the task of interpreting the significance of the work that was done. The time is ripe to make a major effort to develop as complete a picture as possible of Indian mathematics.

The importance of mathematics in India can be seen by a well-known verse in Sanskrit of “ VedangJyotish” (written 1000 BC) as:

This verse means that “ As the crown on the head of a peacock and as the gem on the hood of a snake, so stands Mathematics crowned above all disciplines of knowledge.”

This fact was well known to intellectuals of India that is why they gave special importance to the development of mathematics, right from the beginning. Indian mathematicians made great strides in developing

arithmetic, algebra, geometry, infinite series expansions and calculus. Indian works, through a variety of translations, have had significant influence throughout the world.

Mathematics in ancient times (3000 to 600 BCE)

The oldest evidence of mathematical knowledge to Indians is being found in Indus Valley Civilization. The metallic seals found in the excavations of Mohan-Jo-Daro and Harrapan indicates that the people of this civilization had the knowledge of numbers. It is also clear from the pottery and other archaeological remains that they had the knowledge of measurement and geometry even in crude form. The Indus valley civilization is considered to have existed around 3000 BCE. Two of its most famous cities, Harappa and Mohenjo-Daro, provide evidence that construction of buildings followed a standardized measurement which was decimal in nature. Here, we see mathematical ideas developed for the purpose of construction. This civilization had an advanced brick-making technology (having invented the kiln). Bricks were used in the construction of buildings and embankments for flood control.

The study of astronomy is considered to be even older, and there must have been mathematical theories on which it was based. Even in later times, we find that astronomy motivated considerable mathematical development, especially in the field of trigonometry.

Much has been written about the mathematical constructions that are to be found in Vedic literature. In particular, the Shatapatha Brahmana, which is a part of the Shukla Yajur Veda, contains detailed descriptions of the

geometric construction of altars for yajnas. Here, the brick-making technology of the Indus valley civilization was put to a new use. Supplementary to the Vedas are the Shulba Sutras. These texts are considered to date from 800 to 200 BCE. Four in number, they are named after their authors: Baudhayana (600 BCE), Manava (750 BCE), Apastamba (600 BCE), and Katyayana (200 BCE). The sutras contain the famous theorem commonly attributed to Pythagoras. The Shulba Sutras introduce the concept of irrational numbers, numbers that are not the ratio of two whole numbers.

It is interesting that the mathematics of this period seems to have been developed for solving practical geometric problems, especially the construction of religious altars. However, the study of the series expansion for certain functions already hints at the development of an algebraic perspective. In later times, we find a shift towards algebra, with simplification of algebraic formulate and summation of series acting as catalysts for mathematical discovery.

Jain Mathematics (600 BCE to 500 CE)

Just as Vedic philosophy and theology inspired the development of certain aspects of mathematics, so too did the rise of Jainism. Jain cosmology led to ideas of the infinite. This in turn, led to the development of the notion of orders of infinity as a mathematical concept. By orders of infinity, we mean a theory by which one set could be deemed to be ‘ more infinite’ than another. In modern language, this corresponds to the notion of cardinality. For a finite set, its cardinality is the number of elements it contains. However, we need a more sophisticated notion to measure the size of an infinite set. In Europe, it

was not until Cantors work in the nineteenth century that a proper concept of cardinality was established.

Besides the investigations into infinity, this period saw developments in several other fields such as number theory, geometry, computing, with fractions. In particular, the recursion formula for binomial coefficients and the ‘ Pascal’s triangle’ were already known in this period.

The period 600 CE coincides with the rise and dominance of Buddhism. In the Lalitavistara, a biography of the Buddha which may have been written around the first century CE, there is an incident about Gautama being asked to state the name of large powers of 10 starting with 10. He is able to give names to numbers up to 10 (tallaksana). The very fact that such large numbers had names suggests that the mathematicians of the day were comfortable thinking about very large numbers. It is hard to imagine calculating with such numbers without some form of place value system.

Brahmi Numerals, The place-value system and Zero

No account of Indian mathematics would be complete without a discussion of Indian numerals, the place-value system, and the concept of zero. The numerals that we use even today can be traced to the Brahmi numerals that seem to have made their appearance in 300 BCE. But Brahmi numerals were not part of a place value system. They evolved into the Gupta numerals around 400 CE and subsequently into the Devnagari numerals, which developed slowly between 600 and 1000 CE.

By 600 CE, a place-value decimal system was well in use in India. This means that when a number is written down, each symbol that is used has an

absolute value, but also a value relative to its position. For example, the numbers 1 and 5 have a value on their own, but also have a value relative to their position in the number 15. The importance of a place-value system need hardly be emphasized. It would suffice to cite an often-quoted remark by La-place: ‘ It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position as well as an absolute value; a profound and important idea which appears so simple to us now that we ignore its true merit. But its very simplicity and the great ease which it has lent to computations put our arithmetic in the first rank of useful inventions; and we shall appreciate the magnificence of the achievement the more when we remember that it escaped the genius of Archimedes and Apollonius, two of the greatest men produced by ancient times.

A place-value system of numerals was apparently known in other cultures; for example, the Babylonians used a sexagesimal place-value system as early as 1700 BCE, but the Indian system was the first decimal system. Moreover, until 400 BCE, The Babylonian system had an inherent ambiguity as there was no symbol for zero. Thus it was not a complete place-value system in the way we think of it today.

The elevation of zero to the same status as other numbers involved difficulties that many brilliant mathematicians struggled with. The main problem was that the rules of arithmetic had to be formulated so as to include zero. While addition, subtraction, and multiplication with zero were mastered, division was a more subtle question. Today, we know that division by zero is not well-defined and so has to be excluded from the rules of

arithmetic. But this understanding did not come all at once, and took the combined efforts of many minds. It is interesting to note that it was not until the seventeenth century that zero was being used in Europe.

The Classical Era of Indian Mathematics (500 to 1200 CE)

The most famous names of Indian mathematics belong to what is known as the classical era. This includes Aryabhata I (500 CE) Brahmagupta (700 CE), Bhaskara I (900 CE), Mahavira (900 CE), Aryabhatta II (1000 CE) and Bhaskarachrya or Bhaskara II (1200 CE).

During this period, two centers of mathematical research emerged, one at Kusumapura near Pataliputra and the other at Ujjain. Aryabhata I was the dominant figure at Kusumapura. One of Aryabhata's discoveries was a method for solving linear equations of the form ax + by = c. Aryabhata devised a general method for solving such equations, and he called it the kuttaka (or pulverizer) method. It should be noted that Aryabhata's studied linear equations because of his interest in astronomy. Amongst other important contributions of Aryabhata is his approximation of Pie to four decimal places (3. 14146) and work on trigonometry.

The other major centre of mathematical learning during this period was Ujjain, which was home to Varahamihira, Brahmagupta and Bhaskaracharya. The text Brahma-sphuta-siddhanta by Brahmagupta, published in 628 CE, dealt with arithmetic involving zero and negative numbers.

As with Aryabhata, Brahmagupta was an astronomer, and much of his work was motivated by problems that arose in astronomy. He gave the famous

formula for a solution to the quadratic equation. Brahmagupta also studied quadratic equation in two variables and sought solutions in whole numbers.

This period closes with Bhaskaracharya (1200 CE). In his fundamental work on arithmetic (titled Lilavati) he refined the kuttaka method of Aryabhata and Brahmagupta. The Lilavati is impressive for its originality and diversity of topics.

Brahmagupta discovered a method, which he called samasa, by which; given two solutions of the equation a third solution could be found. Brahmagupta's lemma was known one thousand years before it was rediscovered in Europe by Fermat, Legendre, and others.

This method appears now in most standard text books and courses in number theory. The name of the equation is a historical accident.

Mathematics in South India

Mahavira is a mathematician belonging to the ninth century who was most likely from modern day Karnataka. He studied the problem of cubic and quartic equations and solved them for some families of equations. His work had a significant impact on the development of mathematics in South India. His book Ganita- sara- sangraha amplifies the work of Brahmagulpta and provides a very useful reference for the state of mathematics in his day.

Another notable mathematician of South India was Madhava from Kerala. Madhava belongs to the fourteenth century. He discovered series expansions for some trigonometric functions such as the sine, cosine and arctangent

that were not known in Europe until after Newton. In modern terminology, these expansions are the Taylor series of the functions in question.

Madhava gave an approximation to Pie of 3. 14159265359, which goes far beyond the four decimal places computed by Aryabhata. Madhava's work with series expansions suggests that he either discovered elements of the differential calculus or nearly did so.

Mathematics in the Modern Age

In more recent times there have been many important discoveries made by mathematicians of Indian origin. We shall mention the work of three of them: Srinivasa Ramanujan, Harish-Chandra, and Manjul Bhargava.

Ramanujan (1887- 1920) is perhaps the most famous of modern Indian mathematicians. Though he produced significant and beautiful results in many aspects of number theory, his most lasting discovery may be the arithmetic theory of modular forms. In an important paper published in 1916, he initiated the study of the Pie function. Ramanujan proved some properties of the function and conjectured many more. As a result of his work, the modern arithmetic theory of modular forms, which occupies a central place in number theory and algebraic geometry, was developed by Hecke.

Harish-Chandra (1923- 83) is perhaps the least known Indian mathematician outside of mathematical circles. He began his career as a physicist, working under Dirac. In his thesis, he worked on the representation theory of the group SL2 (C). This work convinced him that he was really a mathematician, and he spent the remainder of his academic life working on the representation theory of semi-simple groups. For most of that period, he was

a professor at the Institute for Advanced Study in Princeton, New Jersey. His Collected Papers published in four volumes contain more than 2, 000 pages. His style is known as meticulous and thorough and his published work tends to treat the most general case at the very outset. This is in contrast to many other mathematicians, whose published work tends to evolve through special cases. Interestingly, the work of Harish-Chandra formed the basis of Langlands's theory of automorphic forms, which are a vast generalization of the modular forms considered by Ramanujan.

CONCLUSION:

The present mathematical knowledge has not dropped as a bolt from the blue, nor a product of some magical tricks. The apparently ready-made knowledge and results have been achieved after centuries of efforts, often painful, by hundreds of mathematicians and historians through the ages. Lots of discoveries and inventers contributed to the fruits, facilities and luxuries which we enjoy today were the contribution of Indian mathematicians. From the notion of zero to the modern concept of computational number theory, their contribution is significant. It is without doubt that mathematics today owes a huge debt to the outstanding contributions made by Indian mathematicians over many hundreds of years. What is quite surprising is that there has been a reluctance to recognize this and one has to conclude that many famous historians of mathematics found what they expected to find, or perhaps even what they hoped to find, rather than to realize what was so clear in front of them.

Kim Plofker from Netherland says that " Indian mathematical science is extremely important and has a significant effect on the world's knowledge as

it is today. The lack of available resources has kept us under informed about the developments that have taken place in India.” It is the need of the hour to carry forward the legacy of great mathematicians so as to encourage and nurture the glorious tradition of the country in mathematics. The ingenious method of expressing every possible number using a set of ten symbols (each symbol having a place value and an absolute value) emerged in India. The idea seems so simple nowadays that its significance and profound importance is no longer appreciated. Its simplicity lies in the way it facilitated calculation and placed arithmetic foremost amongst useful inventions. The importance of this invention is more readily appreciated when one considers that it was beyond the two greatest men of ancient times, Archimedes and Apollonius.