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INDIAN MATHEMATICAL HERITAGE: HISTORICAL FOUNDATIONS OF GLOBAL MATHEMATICAL KNOWLEDGE

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ABSTRACT

Ancient India is a cultural heritage of all mathematics. A number of centuries of research by Indian mathematicians built up into a mathematical theory which has been used effectively in science around the world. From the mathematical formulas of the Sulbasutras in mathematics to the algebraic and astronomical treatises of the classical mathematicians that are written in mathematics, Indian mathematics is an integrated and innovative approach to theory. To the best of our knowledge, the greatest accomplishment of Indian mathematicians was to make decimal place-value number systems and the fact that zero is a symbol and mathematical concept. These were the early developments in numerical computation which brought the concept of numerical computation from the Islamic world to Europe and became the basic mathematics and science of modern day and modern math. Some of the key scholars who introduced the concept of Algebra, Trigonometry, and Number Theory were Aryabhata, Brahmagupta, and Bhaskara II. Their compositions such as Aryabhatiya and Brahma sphuta siddhanta were structured in the terms of solving equations, calculating planetary motion, and carrying out numerical work. Mathematical thought in the Kerala School of Astronomy and Mathematics developed over the centuries and so did infinite series and early versions of calculus in the past which were not possible in Europe. The evolution of Indian mathematics and its impact on world civilization and science across centuries is discussed in this paper. The reading points out classical and academic perspectives of Indian mathematics studies to bring out original, deep and interlocking Indian mathematics thought in textbooks as well as historical developments. Their findings suggest Indian mathematical thought was not just a tool for practical problem solving issues of astronomy, architecture and commerce, but also had the basic theoretical foundation of mathematics in all civilizations. It starts then with that heritage you can put down your head so we start to understand science is interrelated in history and that India's contribution to the broader mathematical tradition did not end but is still going on.

INTRODUCTION

For centuries now, mathematics has been known as one of the most significant intellectual achievements of mankind, considered very much one of the most advanced of human intellectual achievements is Mathematics. And that from mathematics came the science of science, technology, and rational thought. In the entire history of mathematics, there is a specific place in the history of India of mathematics. For the intellectually minded India, it dates back decades of observation and argument and scholarly debate, though mathematically-minded. But Indian mathematicians invented an entire new vocabulary of concepts and methods which transformed the intellectual dynamics of both the Indians and the global intellectual scene. Mathematical ideas are rooted in the Vedic period of India's history, by which the art of ritualism, astronomical observations, and geometric work began to align with one another. One of the earliest forms of mathematical knowledge is the Sulbasutras, a series of ancient

texts that contain some mathematical and geometric rules. The texts are very structured, and grasp spatial dimensions and proportional thinking extremely well. Indeed, some geometric ideas mentioned in these works are similar to what we now know to be the Pythagorean theorem, which means that Indian mathematicians had some advanced mathematical ideas long before the notions were widely accepted in the world. Hundreds of years later, Indian mathematicians continued working on the ideas of their ancestors and developed the theory of arithmetic, algebra, trigonometry, and astronomy. For the purposes of crossing cultures and the sharing of knowledge between scholars it is a massive leap in scientific knowledge from one country to another. We will elaborate on the evolution of Indian mathematics in this paper and its influence on global cognition of the form to this day.

EARLY MATHEMATICAL ORIGINS OF INDIAN MATHEMATICS

Mathematics is a product of the rich intellectual traditions of Vedic literature where mathematical knowledge was discovered. Ancient India: Mathematical thinking was not just a theory of an old Indian society, it was a reality in the modern world as it emerged from naturalistic thinking of the pragmatic environment where one was required to pray and to study and to create a prototype in the form of buildings and public works and for that basic reality was the basis for mathematics. Many of these early mathematical ideas can be found in the Sulbasutras, a group of ancient texts written between 800 BCE and 200 BCE. These are in very good shape in the Vedic literature in that they are essentially the rules and practices to build sacrificial fire altars in Vedic rituals - and for that reason, they are important in the Vedic literature. They knew geometry and what is “measured” by an instrument. They were used to establish a method of developing squares, rectangles, circles, and triangles in a scientific manner with precision. They were more than hypothetical: they were used to ensure that altars' exact dimensions and proportions were the prescribed size levels for the ritualistic use of the space. Most Indian scientists used geometric transformations to reconstruct forms in which the same shape was developed for the same area, suggesting a keen understanding of physical properties and mathematical equivalence. The Sulbasutras talk to the mathematics of the sky and the rules that describe these things are nearly identical with the Pythagorean theorem. These methods show that some old Indian mathematicians had already found some practical way of knowing what the sides of right-angled triangles were. These kinds of understandings indicate the kind of mathematics that was in the early Indian scientific discourse. All in all, these first steps provided an intellectual base that allowed the Indian mathematicians to go on to excel in arithmetic, algebra, astronomy, and many other fields of mathematics.

CLASSICAL PERIOD AND MAJOR MATHEMATICIANS

In fact, mathematical knowledge spread to the continent and beyond and most of it came from the brightest people as well in astronomy, computation, and science. Not only did they add to the theory of mathematics but they also determined formulas for solving problems that were very difficult of numerical notation. Some of the works of these mathematicians have been read over and over and all of them are good examples of arithmetic, algebra, geometry, and trigonometry which will help to influence the mathematics fields that will be developed far away from India. Aryabhata is a famous mathematician (476-550 CE). Aryabhata presented, in just a few pages, a very advanced approach to mathematical problems and to the calculations of astronomical phenomena. He was able to construct reliable trigonometric systems, develop methods

to find positions of planets, and develop some good algorithms for arithmetic calculations. His work is a perfect combination of mathematical insights and observations of the planets; it is the best example of the most sophisticated scientific thought of the time. Brahmagupta is also another important figure of the classical age (598-668 CE). His most important work is Brahmasphutasiddhanta (the Book of the Brahmasphutasiddhanta) - a book of both mathematics and astronomy. Brahmagupta is probably best known for his rules for calculating zero and negative numbers, which were groundbreaking in mathematics. He has also thought of solving quadratic equations and finding the area of cyclic quadrilaterals; he has had a very basic rule. His work is very much mathematical abstraction, logical clarity, and progress in algebra. Bhaskara II (1114–1185 CE) continued this tradition in the later classical times and brought back the Indian mathematical tradition. It employs poetic language for complex mathematical problems and puts technical concepts in a more graphic form. It is well-versed in many different kinds of mathematics from arithmetic to algebraic equations, geometry to practical problem-solving techniques. All these scholars collectively demonstrate how truly rich and creative the ideas of Indian mathematics were, in that respect. So in so doing, their foundational works helped make India one of the centers of mathematical experimentation and thus very much a major force in the development of computer science worldwide.

DECIMAL SYSTEM AND ZERO

Probably the most important and profound achievement of ancient Indian mathematics was the establishment of the Hindu-Arabic numeral system (the decimal place-value system) that had been proposed. This notation system suggested that numbers by the very efficient representation of ten symbols had to be represented and marked out according to the principle of positional notation. So on that model, the value of a digit can be determined not only by the symbol itself but also by the position of the number in which it occurs. Such a breakthrough made numerical representation faster and much easier to do than before in many ancient civilizations. And equally revolutionary was zero as a numeral and an idea. But Indian mathematicians saw zero not only as a placeholder but also as a number that could be used in arithmetic operations. We can say that this concept has made a huge contribution in mathematics as it enabled the scholars to do more systematic, accurate calculations. And over the centuries, commercial ties, scholarly exchanges, and intercultural exchanges would bring these numerical developments to the world outside India. The medieval Islamic world translated Indian mathematical works into Arabic, studied them further there, and spread them all over the world. Those concepts spread to Europe and were now all-around common. The decimal numeral system is the basis of all this nowadays common modern arithmetic, scientific computation, and technological development.

MEDIEVAL DEVELOPMENTS AND THE KERALA SCHOOL

Mathematical research in India was still in a process of evolution during the medieval period, and these medieval scientists were just one of the first scientific teachers working in mathematics, and the science that developed with them, such as astronomy, trigonometry and numerical analysis. In southern India the most radical and innovative intellectual movement that emerged from the Kerala School of Astronomy and Mathematics was the work of mathematicians in the fourteenth century. The school of thought which is the greatest was led by the great mathematician Madhava of Sangamagrama. The Kerala School, led by his protégés, produced a lot of important research which was very much to the fore in mathematics. They developed highly

sophisticated methods in trigonometry and even created infinite series for trigonometric functions. They expanded series for sine, cosine and arctangent functions and understood mathematical patterns well and made numerical approximations. This indicates not only the originality of Indian mathematical thought but also the scientific curiosity that had been prevalent in medieval India. The Kerala School is still one of the best examples of the richness of India's mathematical heritage.

INDIAN MATHEMATICS COMMUNICATION WITH THE WORLD

Indian mathematics was not limited to the Indian subcontinent but spread throughout the world in a global exchange of cultural exchanges, trade routes, exchanges between countries and discoveries. India was still connected to other civilizations at the time of the medieval world, particularly to the Islamic world and the Islamic world was one of the primary bridges of communication to spread scientific knowledge. And from this interaction, Indian scholars' mathematically inspired ideas began to reach outside their own country. In the medieval period, scholars working in the great centers of learning in the Islamic world translated Indian mathematical texts into Arabic. The translation of Indian mathematical texts into Arabic, which was the most effective tool with which to communicate and manipulate numbers, was one of the most important innovations. Since then, translations in Arabic were carried to Europe through Spain and other parts of medieval Europe representing the cultural crossroads. The notation and algebraic methodologies based on Indian numerical and trigonometry were important in the progress of Western mathematics and science, and this came to the attention of European scientists, who gradually adopted the notation.

SIGNIFICANCE OF INDIAN MATHEMATICAL HERITAGE

The Indian Mathematical Heritage has shown the great history of science in India. In the case of our research context, we have proved that not only does interdisciplinary academic philosophy, along with its cultural diversity and cultural exchange of information, have a positive contribution to human wisdom, if one is able to enhance it. The writings of Indian mathematicians highlight the fact that mathematical ideas derive not only from science itself, but the practical needs of society such as time, land measurements, construction and knowledge about celestial motions. These pragmatic solutions began to develop into advanced theoretical models which have made maths increasingly intricate.

Indian mathematical theory also points out that we should integrate different disciplines as well. Mathematics was rarely studied in isolation in ancient and medieval India. It grew in line with astronomy, architecture, commerce and religion. In astronomy math calculations were used to map planet movement, merchants used arithmetic to trade and in finance, architects used geometry for temples and urbanization. The cooperation of mathematics and other fields has made for innovative thinking and practical problem solving. Indian mathematicians had an important impact on the world of mathematics. The Hindu-Arabic numeral system, algebra and trigonometric methods spread to other civilizations in the long run and eventually they became the bedrock of mathematical thinking. Realizing it is relevant also helps us to learn about India's intellectual heritage and see more in a holistic way how science is connected to India. And Indian mathematics, in turn, inspires scientists to work hard and human curiosity and effort are common.

CONCLUSION

History of Indian mathematics is an intellectual heritage which has been developed continuously and a historical perspective of the Indian mathematician and has brought us closer to the world of mathematics. Indian scientists have been extremely creative, logical, and scientific in their work in mathematics since the beginning of civilization and so have every nation on earth. Following the geometric knowledge of the Sulbasutras for a long time, the early Indian mathematicians made tangible mathematical methods which were related to religious rituals and design. In fact, these concepts first developed into theories, as early as the first century BCE, by classical and medieval mathematicians who introduced mathematics in a wide variety of fields (arithmetic and astronomy). These works had direct and indirect links to mathematical practice. This made the numerical calculation much easier and changed the way mathematics was used in every society. Moreover, the early scholars in Kerala School of Astronomy and Mathematical thought had argued for some very important mathematical ideas in infinite series and later these ideas went on to become fundamental in calculus. Indian ideas in mathematics were also passed on from India to the Islamic world and Europe as well as cultural exchanges with language and translations and also a vast amount of intellectual thought would come in the medieval & renaissance age. To study Maharshi's ancestry in India's history of mathematics, we learn something very precious about the inter-related science of the world. It tells us that to know is to know globally, goes over cultures, crosses borders and it is the intellectual heritage of all of us that we can still aspire to. And Indian mathematicians were also at the forefront of world mathematics. Such concepts - Hindu-Arabic numeral systems, complicated algebraic methods and trigonometric methods - later became essential to other civilizations and are still relevant to modern mathematics. Those observations help us to understand more well our great intellectual tradition of India and how the relationship between science and civilization is key. Indian mathematics has always obsessed those who try to learn and proves that human peculiarity and discovery are universal.

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