History of Science in Ancient India

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Abstract

India is renowned for being one of the world's oldest countries and possessing an incredibly ancient civilization. In the realm of dance, music, sculpture, painting, and fine arts, as well as philosophical literature, India has achieved unparalleled excellence across the globe. The country also boasts a rich history of scientific thought and discovery, having generated and developed scientific ideas without external influence. Modern technology is built upon yesterday's science, and tomorrow's technology will be based on today's science. The efforts of institutions such as the Indian Council of Historical Research, Indian National Science Academy, and Indian Council of Social Science Research have brought attention to India's scientific development throughout history.

The research has demonstrated that India has been a scientific nation from the Vedic era to the present day. This brief review aims to shed light on India's early advancements in various areas of science and technology, as well as to highlight significant accomplishments that are vital for spreading knowledge to a broad audience. This is not only a source of pride for Indians, but also for the wider educational and scientific community.

Keywords: India, Science, Technology, Mathematics, Surgery, Metallurgy, Astronomy

Introduction

India has a rich history of scientific and technological pursuits that date back centuries. In 1930, Chandrasekhara Venkata Raman, also known as CV Raman, became the first Indian to receive a Nobel Prize in science for his discovery of the "Raman effect". Raman was a prolific researcher who published 475 peer-reviewed articles during his career. His legacy continued with his nephew Subramanian Chandrasekhar, who won the 1983 Nobel Prize in Physics for his theoretical studies on the physical processes that contribute to the structure and evolution of stars. Despite the challenges posed by globalization, Indian civilization endures and remains alive today. Furthermore, India is currently a rapidly growing nation in the fields of science and technology, with a particularly strong performance in engineering, which is the most cited field in India, followed by material science.

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Terms Related to Science in Ancient India

- The term Ganita refers to mathematics in general, encompassing disciplines such as Arithmetic, Geometry, Algebra, Astronomy, and Astrology.
- Arithmetic is known as Pattin Ganita, which involves calculations using boards, while Anka Ganita involves numeral-based calculations.
- Geometry is referred to as Rekha Ganita and Bija Ganita refers to Algebra. The term Jyotisa encompasses both Astronomy and Astrology.
- India has a rich history of scientific and technological advancements, and the pursuit of science can help reduce our dependence on nature. In ancient India, science and religion existed alongside each other.

Mathematics and Astronomy in Ancient India

During Vedic times, special attention was paid to geometry and astronomy, which were the two main branches of mathematics. Geometry problems from this period laid the foundation for the science of geometry, which was later developed and cultivated for its own sake. This review will delve into the history of mathematics in ancient India, specifically focusing on three major contributions: the decimal system, the use of zero, and the notation system. The term Ganita, which means "the science of calculation" was used to describe mathematics in ancient India. Initially, Ganita included arithmetic, astronomy, and algebra, but not geometry, which was part of a different group of sciences known as kalpa. In the West, geometry was initially viewed with amazement, while in Europe during the Middle Ages, it was considered "satanic" by Christian clerics. One of the most renowned mathematician-astronomers of all time was Aryabhata, who lived in Kusumapura (modern-day Patna, capital of the Indian state of Bihar) and wrote the Aryabhatiya, a short but extremely significant Sanskrit treatise on mathematics and astronomy at the young age of 23 in 499 BCE.

The town planning of Harappa suggests that its inhabitants were knowledgeable in measurement and geometry. By the third century AD, mathematics had developed into a distinct field of study, with the Sulvasutras being considered the source of Indian mathematics. In the second century BC, Apastamba introduced practical geometry, which was applied in constructing fire altars for sacrificial purposes. The most significant contributions of Indian mathematics were the notation

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system, the decimal system, and the concept of zero, which was discovered in India in the second century BC. The Arabs introduced these notations and numerals to the West, replacing Roman numerals. Brahmagupta is credited with discovering zero and explaining how to use it with other numbers in his book, Brahmasputa Siddhanta. Aryabhatta's discoveries include algebra and the area of a triangle, which led to the development of trigonometry. Surya Siddhanta and Brihatsamhita by Varahamihira were seminal works in astronomy in the sixth century AD. Varahamihira's discovery that the moon revolves around the earth and the earth revolves around the sun was widely accepted and paved the way for further discoveries. When mathematics and astronomy were combined, it led to an interest in time and cosmology, and these discoveries became the foundations for further research and progress.

Aryabhatta

Aryabhatta, a prominent mathematician and astronomer, made significant contributions to Indian mathematics and astronomy during the classical period. He authored various mathematical and astronomical treatises, including the Aryabhatiya and the Arya-siddhanta. The Aryabhatiya gained widespread popularity in South India, where many mathematicians wrote commentaries on it over the centuries. This remarkable work is primarily written in verse couplets and focuses on mathematics and astronomy. The Arya-siddhanta, on the other hand, was primarily circulated in northwestern India and played a crucial role in the development of Islamic astronomy throughout Iran. It is one of the earliest astronomical works to assign the start of each day to the end of midnight.

Varahamihira

Varahamihira is renowned for his extensive work, the Brihat Samhita, which is an encyclopedia-like study covering a wide range of topics including astrology, planetary motions, timekeeping, eclipses, architecture, agriculture, gemology, and many others. While summarizing earlier works on astronomy and temple architecture, he claimed that his own explanations of architectural principles and models were some of the earliest that have survived. Varahamihira was also a skilled mathematician, and he is credited with discovering trigonometric equations and improving the accuracy of Aryabhata's sine tables. He was also instrumental in defining the algebraic properties of zero, negative numbers, and positive and negative numbers.

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Baudhayana

The Pythagoras theorem was discovered by Baudhayana more than a millennium before Pythagoras was even born, as per a shloka from the Sulbasutra. Unlike Ahmes, who was merely a copyist, and not a mathematician in the modern sense, Baudhayana was not just a scribe. Although he probably received a high level of education, his interest in mathematics was most likely limited to its use in supporting his religious beliefs rather than for its own sake.

Brahmagupta

Brahmagupta's main work, the Brahmasphutasiddhanta, was written around 628. This book covers a broad range of mathematical topics and provides a deep understanding of the concept of zero. Brahmagupta composed this treatise, which is known as an improved version of the Brahmaraksha school's approved siddhanta when he was thirty years old. In chapter eighteen of the Brahmasphutasiddhanta, he proposed the solution to the general linear equation.

Bhaskaracharya

Bhaskaracharya belonged to the Hindu Deshastha Brahmin family of philosophers, mathematicians, and astronomers and was the head of a cosmic observatory at Ujjain, ancient India's principal mathematical center. He authored Siddhanta-Siromani, which is divided into four parts- Lilavati, Bijagaita, Grahagaita, and Goladhyaya, addressing arithmetic, algebra, planetary mathematics, and spheres, respectively. These four parts are often considered as four separate works.

Chakravala System of Algorithms

Brahmagupta, a renowned mathematician from the 7th century CE, developed a cyclic algorithm known as the chakravala method for solving indeterminate quadratic equations, such as Pell's equation, and obtaining integer solutions. Later, Jayadeva, another mathematician, extended the application of this method to a wider range of equations, and this was further refined by Bhaskara II in his treatise, Bijaganita.

Idea of Space, Time and Matter

The Yoga-Vasishtha is an ancient Indian text that contains over 29,000 verses and is traditionally attributed to Valmiki, the author of the Ramayana. However, internal evidence suggests that it was

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either authored or compiled later. The dating of the text varies, with some scholars dating it as early as the 6th century AD and others dating it as late as the 13th or 14th century. Dasgupta (1975) dated it to the 6th century AD based on a verse that appears to be copied from one of Kalidasa's plays. The traditional date of Kalidasa is 50 BC, but new arguments support an earlier date. The YV may be viewed as a book of philosophy or a philosophical novel, describing the instruction given by Vasishtha to Rama. Its premise is radical idealism, with many parallels to the notion of a participatory universe argued by modern philosophers. The text contains interesting passages related to the nature of space, time, matter, and consciousness. Similar ideas can be found in Vedic texts, Puranas, and Tantric literature, and the Vedic conception is to view reality in a monist manner.

Time

According to the Yoga-Vasishtha text, time cannot be analyzed and it uses the sun and moon as a means of entertainment. The world is compared to a potter's wheel, appearing to be still but actually revolving at a fast pace. Time, like space and creation, is illusory, with no fixed span and moments and epochs are mere appearances. The concept of time was created by infinite consciousness, starting with a unit of time equal to a millionth of a blink of an eye and evolving into a time scale up to an epoch that spans the lifespan of one cosmic creation. However, infinite consciousness itself is not involved in this, as it is beyond the notions of beginning, middle, and end, and rising and setting.

Space

The book Yoga-Vasishtha discusses three different types of space: psychological space, physical space, and the infinite space of consciousness. The infinite space of undivided consciousness is present both inside and outside of all beings, while the finite space of divided consciousness creates the divisions of time and is present in all beings. Physical space is where the elements exist, but it is not independent of the first two types of space. The book also describes other universes existing within solid rocks on distant mountain ranges, with their own inhabitants and celestial objects. Finally, it suggests that the entire universe can be contained within a subatomic particle or within a single strand of hair.

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Matter

Every single atom contains numerous nested worlds. There exist innumerable universes, having diverse compositions and space-time structures, each with their own continents, mountains, villages, and cities, inhabited by individuals who experience their own time-space and life-span.

Experience

All proofs are based solely on direct experience. This foundation is the intelligence that experiences and becomes both the experiencer and the experience itself. Every individual possesses two bodies: the physical and the mental. The physical body lacks consciousness and is driven towards self-destruction, while the mind is finite but organized. Through extensive investigation and observation of the entire self, one cannot find anything that can be identified as "I". The true "I" is the all-encompassing consciousness that cannot be objectified or known and is free from individuality.

It is indivisible, nameless, unchanging, and beyond all concepts of unity and diversity. Once, there was nothing on the earth, including trees, mountains, and plants. For 11,000 years, the earth was covered with lava, and only the polar region had illumination, while demons governed the earth. They were misled, mighty, and thriving, using the earth as their playground. Except for the polar region, the rest of the earth was flooded, and it was covered with forests for an extended time. Later, mountains emerged, but they were without any human inhabitants. For 10,000 years, the earth was filled with the demons' corpses.

Mind

The infinite self has the capacity to conceptualize the duality of oneself and the other within itself. Mind and thought are one and the same, with no differentiation between them. The body is incapable of experiencing pleasure or pain, as it is solely the mind that undergoes these sensations. The mind is formless and unsupported yet it has the power to consume everything in the world. This paradoxical concept is a great mystery, as someone who claims to have been destroyed by the non-substantial mind is like saying their head was crushed by a lotus petal. The mind is a more formidable foe than any external enemy, capable of destroying even the bravest warriors. The mind is composed of the intelligence beyond self-awareness.

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Complementarity

The absolute reality is the only entity that exists presently and will continue to exist eternally. The perception of the absolute as a void arises due to a feeling that it is not empty, while the perception of it as non-empty arises due to a sense of void. The fundamental components interacted with each other as both the observer and observed, resulting in the creation of the entire universe. These elements are intricately intertwined and combined in such a way that they cannot be separated from one another until the ultimate dissolution of the cosmos.

Consciousness

The only existing entity that is permanent and eternal is the absolute reality. The perception of this absolute as a void is due to the sensation that it is not empty, and the perception of it as non-empty is due to a sense of void. The fundamental components of the universe interacted with each other as both the observer and observed, leading to the formation of the entire cosmos. These components are so intricately woven together that they cannot be separated from each other until the final dissolution of the universe.

Medicine in Ancient India

The Atharva Veda was the first to discuss diseases, their remedies, and medicines, including fever, cough, consumption, diarrhea, dropsy, sores, leprosy, and seizures. The ancient belief was that these diseases were caused by demons and spirits entering the body and the suggested remedies involved magical charms and spells. The period of rational sciences began around 600 BC, with Takshila and Taranasi becoming prominent medical and educational centers. The Charaka Samhita and the Sushrutsamhita are two significant texts in this field, which have been translated into various languages and have reached as far as China and Central Asia. The Charaka Samhita lists medicinal plants and herbs, and Sushruta pioneered surgery, considering it as the “highest form of healing art” and describing 121 surgical instruments and techniques such as bone setting and cataract removal. Plastic surgery to repair noses, ears, and lips was also performed. Sushruta mentions 760 different plants, and dietary restrictions were also emphasized. These texts served as precursors to the development of Indian medicine. However, surgery suffered during the early medieval period due to barbers taking over the act of dissection with a razor.

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Sushruta

By the time of Sushruta, surgery had become a well-established medical discipline in India, although not as advanced as it is today. Sushruta's major contribution to this field was the development of many surgical techniques, including the use of an ant's head to create sutures, and more notably, plastic surgery. His book provides guidance on surgical procedures for future surgeons.

Charaka

Regarded as a prominent figure in Ayurveda and traditional Indian medicine, he is recognized for his creation of the Charaka Samhita, which is considered a fundamental work in the field. Although he studied all aspects of medicine, including the logic and philosophy underlying the Indian medical system, Charaka believed that Ayurveda was a comprehensive medical system that dealt with both preventive and curative aspects of healthcare.

Jivaka

He was a contemporary of Bimbisara and Ajatsatru and learned Ayurvedic medicine under the guidance of Atreya. He was also the personal physician of Lord Buddha and the Sangha.

Geography

The interplay between humans and nature necessitated the study of geography. Although people had a basic understanding of their own physical geography and that of China and Western nations, they were unaware of their position on the earth and the distances between countries. In ancient times, Indians were not knowledgeable about voyages and navigation, but the discovery of a dockyard at Lothal in Gujarat indicates the thriving sea trade of the period. During the early medieval period, the concept of tirtha and tirtha yatra led to the accumulation of a significant amount of geographical information, which was eventually compiled as Puranas. In many cases, separate sthala puranas were also compiled.

Chemistry

The study of chemistry in India was motivated by three factors: the need to know about substances with medicinal properties, the desire to experiment with metals and alloys to obtain stronger

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materials, and the belief that it was possible to turn other substances into gold through chemical processes. Indian studies in chemistry advanced in step with medical science and metallurgy. Susruta Samhita and Charaka Samhita provide information on the properties of metals, salts, and alkalis, and the preparation of alkaline substances for treating wounds. Later books describe the use of mercury, zinc, and sulfur. A process that produces substances with different properties from those of the original metal, is also mentioned in some books. Although chemistry became a part of mystic practices of tantra vidya in later periods, many books on chemistry were written between the 11th and 14th century AD.

Metallurgy

Metallurgy had a rich tradition in India, and the extraction of metals and the mixing of different metals to obtain brass and steel of the required strength demanded experimentation with various ingredients and processes. The famous iron pillar of Qutub Minar in Delhi was made during the Gupta dynasty and has not rusted due to the excessive amounts of phosphorus in the iron. However, this iron cannot be used to make swords because it is too brittle. The technology of producing Wootz steel, which was renowned for making swords with exceptional sharpness and toughness, originated in India and was exported to Europe and the Middle East where it was known as Damascus steel. Zinc was also isolated, distilled, and used in India, with evidence of zinc ore mining at Zawar in Rajasthan dating back to the 5th century BC and the earliest confirmed evidence of zinc smelting by distillation dated back to the 9th century from Zawar.

Conclusion

The study of ancient science in India has been largely neglected, as evidenced by the significant number of untranslated and unpublished manuscripts in Kerala and Tamil Nadu. Additionally, the history of science is not recognized as a fully fledged academic discipline in the country. Despite this, India boasts a rich cultural heritage in science and technology from the ancient period and has made rapid advancements in certain marginal areas like atomic energy and space science research. It currently possesses a strong foundation in all areas of modern science and technology and boasts the third-largest technical and scientific human resource base in the world. The country has produced many brilliant mathematicians, astrologers, and scientists who have revolutionized the world of science, and the term ‘boson’ is named after the Indian physicist S.N. Bose. However,

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India has struggled to develop technologies that meet the needs of the growing population, particularly for the poorer sections of society. While scientific advances in space and nuclear research are impressive, they do not benefit the downtrodden. Therefore, it is crucial to work towards developing low-cost technology that meets the needs of those who lack housing and to raise the standard of living for all. India should strive to contribute to the global arena of science and technology, as it did in ancient times, while also working towards achieving equality for all.

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