

GROWTH OF MATHEMATICS IN EARLY INDIA AND ITS IMPACT ON SOCIETAL DEVELOPMENT

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ABSTRACT

The evolution of mathematical and scientific thought in ancient India reflects humanity's enduring effort to understand and control natural phenomena for societal advancement. From the prehistoric era, humans sought to harness nature to meet their needs, resulting in innovations that improved survival and ignited further intellectual inquiry. Ancient Indian civilization, particularly during the Indus Valley era, demonstrated a sophisticated understanding of geometry, architecture, and urban planning, as evidenced by the precise construction techniques used in their cities.

As civilization progressed into the Rig Vedic period (1500 BCE – 700 BCE), the Indo-Aryan people, transitioning from pastoralism to agriculture, made notable advances in science and technology, despite frequent conflicts. Their knowledge of astronomy, for instance, enabled the creation of calendars to regulate agricultural activities and religious rituals. This period, however, lagged the advancements seen in the Indus Valley, particularly in metallurgy and pottery.

The Yajurvedic period (700 BCE – 400 BCE) saw further agricultural and metallurgical advancements, as Aryans settled in the eastern parts of the subcontinent. These advancements laid the groundwork for the emergence of urban civilizations, marked by societal shifts and the formation of specialized professions, from medicine to trade. By the Gupta period (circa 320 CE – 550 CE), India had become a centre of scientific innovation. The empire fostered advances in agriculture, metallurgy, mathematics, and art. The Gupta rulers' open exchange of ideas with foreign cultures further stimulated intellectual and technological progress. However, following this golden age, political upheavals led to a period of stagnation in scientific development in northern India. Nonetheless, remarkable contributions, particularly in mathematics, persisted through individual efforts.

Keyword: *Indus Valley Civilization, Rig Vedic Period, Yajurvedic Period, Aryan Settlement, Gupta Empire*

1. INTRODUCTION

Science is known as the human endeavour and from the prehistoric period human has been attempted to control the natural phenomena for the welfare of the society by understanding and observing these natural phenomena. The understanding of nature helped human beings to fulfil his basic needs and this understanding also led to some applications, which were helpful to minimize the human struggle for his survival as well as opened new avenues of enquiry, further questions and increasing the knowledge. The power of knowledge, for the development of society, in ancient Indian thoughts is described by Debiprasad Chattopadhyaya in the following words:

“If anywhere in ancient Indian thought we permitted to see the real anticipation of the view that knowledge is power – which, when further worked out, assumes the formulation that freedom is the recognition of necessity – it is to be found among the practitioners of the healing art” [1 p.180].

The gradual process, with several ups and downs, of understanding the natural phenomena and applying this understanding to control nature may be known as ‘science’. The traces of modern science lie in the life of primitive human beings. The history of civilization exhibits that the progress in science has been a continuous process. Tremendous developments, particularly in mathematical sciences, sophisticated calculations and observations were made in India during ancient times [2 p. 7]. The man who first tried to grow plants, after his a very close observation, to grow plants from a seed may be reasonably considered as the first great scientist [3 p. 13].

2. SCIENCE IN INDUS VALLEY CIVILIZATION

The great cities in Indus Valley, now in Pakistan, were excavated in 1920 CE. The Indus Valley civilization is well known for its amazing town planning achievement which shows the advance knowledge of Architecture of the people of Indus Valley. The building construction and design of a superior quality observed in the Indus Valley indicates that the people of this civilization were good architects and technologists and they had known the techniques of the construction using a deep knowledge of proper utilization of space and geometrical layout of the houses. Historians of science concluded that the making of bricks perfect geometrical precision, fitting them together in different shapes and sizes, maintaining straightness and angles and in the big buildings as well as in the roads required a considerable amount of geometrical knowledge [56 p. 38]. The first urbanization in ancient India came to an end around 1750 BCE due to the various causes like floods, gradual decay in culture and the arrival of Aryans etc. [[4 p. 141] [5 p. 29]].

3. DEVELOPMENT OF SCIENCE IN RIG VEDIC PERIOD (1500 BCE – 700 BCE)

Indo-Aryans migrated from the Central Asian and Iranian steppes to Indian subcontinent in waves, probably the first wave reached around 1500 BCE. Indo-Aryans first moved towards the south-eastern part of Indian subcontinent and finally settled in the north- western region of India as pastoral-agricultural communities and kingdoms. The transformation of Indo-Aryans from pastoral to settled agricultural communities took in the duration of about five hundred years i.e., from 1500 BCE to 1000 BCE and the lasted about 600 BCE. The groups of Aryan people during their early settlement were always in constant conflict either with each other or with the non-Aryan people in their locality. Thus, during the early settlement of Vedic people, progress in science and technology was very limited as they were engaged in conflicts. They mostly developed the technology of the construction of chariots, weapons of wars and iron tools etc. The brick technology and technology of pottery was not developed as it was found in the Indus Valley civilization. The craftsmen of Vedic period like chariot-makers, wood workers, shipbuilders and metalworkers were the free members of the tribes. While the work of, spinning and weaving, was done only by women of the tribe. The astronomical knowledge of Rig Vedic people about the division of the whole universe was that it is divided into three regions viz. the earth (*prithvi*), the firmament (*antariksh*) and heaven (*dyaus*) however, it was not correct. Vedic priests were required calendars to perform sacrifices or rituals, which were performed at the positions of sun, moon and the planets. After tracking the motion of celestial bodies like the sun and the moon Vedic people prepared a calendar in which they divided time into days, months, years and probably also the seasons. Some stray descriptions of different planets, their classification and structure are found in the Rig Vedic hymns and verses [56 p. 46].

4. DEVELOPMENT OF SOCIETY DURING YAJURVEDIC PERIOD (700 BCE - 400 BCE)

Rigvedic people moved towards the eastern part of Indian subcontinent in search of fertile land and resources of metals used for different purposes. This period is known as Yajurvedic period which lasted for about three centuries. In Yajurveda, a description of ploughs pulled by six pairs of oxen, are found and these ploughs were necessary for driving deep furrows and rolling heavy soil. This was helpful in yielding crops and in retaining the fertility of land. A strong plough could be made of wood, and which trimmed down by tools which were made of bronze metal. However, the ploughshare for cultivating strong soil was made of iron. Copper tools like harpoons, shoulder-Celts and semi-human figures are excavated in the Gangetic plains and dated about 1000 BCE. These artefacts and tools imply that Vedic people knew how to refine copper by controlling fire in kilns. It was a development in metallurgy. Thus, the demand for a better-quality iron increased and then Vedic people motivated to explore new deposits of iron ores in other regions [2 p. 46-47].

5. EMERGENCE OF URBAN CIVILIZATION

The pictures of condition of society during Vedic period are found in the Vedic literature. During this period the structure of society was undergoing some radical changes. Priesthood was highly developed for sacrificial rites and Aryan and non- Aryan practices were combining this time. A system of the production of commodities had been established i.e., the labourers and craftsmen producing not only for own consumption, but also for, trade within the settlements of Aryan and non-Aryan people. Traders of this period were known as *Sarthavahas* i.e., caravaners. Descriptions of trade routes are also found in the Vedic literature. The excavated coins of this period imply that a regular system for coining had been come in practice by the end of the seventh century BCE. Professionals of the different fields like medicine, science and technology, also appeared. Specialised learning centres were also developed and these learning centres like Taxila attracted students of

several parts of the subcontinent. Around 800 BCE to 600 BCE an orderly societal structure was appearing, and this was not in shortage and an end of the conflicts of the society of the Vedic period. Small states were being formed which were headed by kings governed by codes and rules enacted by state powers. A mention of sixteen Janapadas around the seventh century BCE is found in Vedic literature. The income of state came from trade and agricultural products. These societies comprised of kings, priests, soldiers, scholars, peasants, craftsmen and labourers. However, to run the state efficiently and ensuring that the state powers remained with the wealthy people. Thus, the hierarchy of the society became rigid and divided into four categories, the Brahminas, the Kshatriyas, the Vaisyas and the Sudras and to maintain this hierarchy were invoked some divine sanctions [2 p. 47-48].

6. SOCIETAL DEVELOPMENT DURING 400 BCE TO 1200 CE

Magadha had emerged as a major power during seventh century BCE in northern part of Indian subcontinent and it considered as beginning of second urban civilization to flourish in this subcontinent after the decay of the Indus valley civilization. Although, this phase of urbanisation, had been started with the advent of the great Maurya king Chandragupta, in about the fourth century BCE. Asoka was the last great emperor of the Maurya dynasty who assumed the imperial throne about 270 BCE, and he extended his empire not only across the hole of northern India but in the greater part of south India also. Emperor Asoka was extended his empire with a main intention to hold the agricultural land. The imperial functionaries were supervised the local population of the conquered land who settled down to practise agriculture and then they started to apply new techniques of agriculture, which had been developed at that time, to increase the yield. The agricultural land was divided into two types as the following:

- (i) The first type of land yielded taxes for the state which was governed by a semi-autonomous local administration and a sixth part of the agricultural yield went to the state treasury.
- (ii) The second type of land, known as *sita* land, was directly under the control of crown and this land was cultivated by settlement units of hundred to five hundred *Sudras*. The fifth part of production was given to the crown.

The system of state governance was described in detail was found in Kautilya's Arthashastra, was discovered in 1909, who was prime minister of Chandragupta Maurya during 321 BCE to 300 BCE [6 p. 145]. Kautilya wrote in his Arthashastra that it was a highly centralised state, and the government was the chief owner of industry as well as the greatest producer of commodities. The commodities produced by the state government were sold and produced by traders who travelled by using the navigable rivers not only across the state but also overseas to Indonesia, Burma and Sri Lanka to sell their commodities. The prices charged by traders and practice of trading were strictly controlled by the state government and the rules of collecting revenue and the procedure for collecting revenue, from the merchants as well as from the land, were precisely accurate. The collected revenue from these sources was used to maintain a large army of half a million men. Since a large army was required to acquire land, protect the frontiers and land, and to maintain the law and order in the state. This revenue was also used to run welfare programmes for orphans, the old people, the physically weak people, widows and pregnant women who were helpless. Thus, the development of society can be characterised as the influence and application of science [2 p. 66-67].

7. DEVELOPMENT OF SCIENCE AND TECHNOLOGY DURING GUPTA PERIOD

During the Gupta period science and technology reached at a remarkable height in ancient India. New techniques and seeds were introduced in this period which made improvements in agricultural production. In this period different spices and paper were also growing for export as well as their consumption. The crops of different varieties like wheat, rice, barley, sesame, beans and pulses, vegetables such as onions, pumpkin, garlic and betel were produced. Some new fruits like peaches and pears were introduced first time in this period. Metallurgy and weaving crafts were rapidly stridden during this period. Articles for domestic use as well as weapons for military purposes were made of rust-proof iron and copper. Because of the good quality, these articles were exported even to some African countries. During the Gupta period the growing trade and commerce probably stimulated the interest in simple and compound interest, arithmetic and geometric series, thus Brahmgupta's description of negative numbers as debts and positive numbers as fortune to link between mathematics and trade [7 p. 27]. A unified style of Buddhist art was established during this period in north India [8 p. 202]. The perfect weaving techniques were used for making of silk and cotton goods and dyes were used for colouring the textiles [2 p. 70-

71]. The colours used in ancient India were long lasting and shining that it is still intact in the paintings of Ajanta [5 p. 242]. The cave architecture is an important phase in the history of ancient India, about more than one thousand caves from second century BCE to tenth century CE have been excavated in different parts of India and most of them are Buddhist [7 p. 384] The broad vision of Gupta emperor described by historian V. A. Smith in the following words:

“The extraordinary intellectual vitality of the Gupta period undoubtedly was largely due to the constant and lively exchange of ideas with foreign lands in both East and West” [9 p. 283 and references therein].

The next period of about 250 years from 750 CE to 1000 CE witnessed as a period of struggle for domination. Thus, it was a period of stagnation and declination of science and technology in northern India. However, despite the political upheavals, great developments were made in mathematical sciences by several individuals. The mathematical and astronomical work of some of them is described in the fifth chapter.

8. CONCLUSION

The growth of mathematics in early India significantly influenced societal development, spanning from the Indus Valley Civilization to the Gupta Empire. The early civilizations demonstrated advanced mathematical understanding in fields like geometry, architecture, and urban planning. With the transition from the Rig Vedic to the Yajurvedic periods, further advancements were made in agriculture and metallurgy, laying the groundwork for societal and economic shifts. By the Gupta period, India had become a centre of mathematical and scientific innovation, fostering intellectual exchanges with other cultures. Despite later political upheavals, individual scholars continued making remarkable contributions to mathematics, cementing India's legacy in shaping global knowledge and societal structures.

9. References

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