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## **The Methods of Communication in Ancient Indian Science**

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### **Abstract:**

*After a brief recollection of the contributions to sciences by ancient Indians, this study examines the evolution of communication methods in ancient India from the Vedic period to the destruction of Nalanda University in 1193 CE by the Muslim zealot Bakhtiyar Khilji. The study identifies key systems including oral traditions, script-based manuscript culture, messenger networks, royal edicts, guild communication, maritime exchange, and monastic scholarly networks. Nalanda is highlighted as a transcontinental intellectual hub that fostered academic communication across India, China, Tibet and Southeast Asia. The destruction of Nalanda marked a major rupture in India's long-standing communication infrastructure along with the mammoth loss of accumulated knowledge over thousands of years.*

### **1. Introduction**

In this article we will dwell briefly on the contributions of the Indian subcontinent to science and then elaborate on the communication methods to disseminate the discovered knowledge.

A legacy of colonialism is the widespread belief that scientific rational thinking originated with the Greeks around the seventh century BCE and flourished there for about 800 years. Greek philosopher-scientists such as Thales (624–546 BCE), Pythagoras (562–500 BCE), Democritus (460–370 BCE), Hippocrates (460–370 BCE), Plato (427–347 BCE), Aristotle (386–322 BCE), and Archimedes (287–212 BCE) are responsible for most of the basic ideas in science. The Dark Ages (475–1000 CE) or the Middle Ages (475 CE to the Renaissance) refer to the lack of intellectual and scientific activities in Europe. After the fourteenth century came the European Renaissance and we learn about Galileo, Faraday, Newton and Kepler. Scientists, discoveries or inventions that having any connection to Asia, Africa, and Latin America and Oceanic countries are never mentioned.<sup>1</sup>

A point to note is that in this article I have purposely avoided citing references from contemporary sources except a few. The reason is that I prefer original sources for factual purity that is free of socio-political bias.

### **2. Ancient India's Contributions to Science**

*“The first nation (to have cultivated science) is Hind. This is a powerful nation having a large population and a rich kingdom. Hind is known for the wisdom of its people. Over many centuries, all the kings of the past have recognized the ability of the Hindus in all branches of knowledge.... [t]he Hindus, as known to all nations for many centuries, are the metal (essence) of wisdom, the source of fairness and objectivity. They are peoples of sublime pensiveness, universal apologues and useful and rare inventions.”<sup>2</sup> Such was the assessment of ancient Indian science by Šā'id Andalusi, the first historian of science.*

Šā'id lived in Spain and compiled perhaps the first popular book on the global history of science. He ranked eight civilisations as per their scientific achievements: Hindu, Persian, Chaldean, Greek, Roman, Egyptian, Arab and Hebrew. Šā'id was a Muslim historian of science with expertise in mathematics, astronomy, medicine and chess. His student Azarquiel compiled the Toledan Tables in Astronomy used to predict the motions of the sun, moon and planets relative to the fixed stars. Šā'id's book was very popular during the medieval period but was suppressed during the colonial period because its contents did not fit well with the colonial agenda. It was re-introduced to the English-speaking world in 1991. Šā'id chose Hind to be the top nation in science and he was not the only one to do so. Roger

Bacon (1214–1294)<sup>3</sup> clearly established that India was the leader in science. His book, written under instruction of Pope Clement IV (1190–1268), was used to train Christian missionaries to be sent to the lands conquered.

Āryabhaṭa I, Head of Nālandā University, wrote *Āryabhaṭīya*<sup>4</sup> in 499 CE at the age of 23. This has 118 metrical verses subdivided into four chapters: *Gitika-pada* dealing with large units of cosmological time, *Ganita-pada* i.e. mathematics, *Kāla-kriyā-pada* i.e. time-reckoning and *Gola-pada* i.e. spherical astronomy. He is credited with the discovery of zero. Brahmgupta (born 598 CE) and Varāhamihira (505–587 CE) wrote extensively on his work. Āryabhaṭīya provides an account of the ancient sciences of the Hindus. Āryabhaṭa I did not take any credit and labelled the content of his book as “old knowledge.” He provided the value of  $\pi$  (pi) as  $\sim 3.1416$ , the solution of indeterminate equations and quadratic equations, a theory of planetary motions and calculations of the latitudes of planets. A millennium before Copernicus, he assigned axial motion to the earth in his astronomical model and kept the stars stationary.

The contributions of ancient India to science may be brutally summarised as follows:

### ***Place-value notation system (base 10) in mathematics***

This notation system made it possible to write very large numbers and simplified mathematical calculations and so prevailed over the other systems. Nicolaus Copernicus<sup>5</sup> (1473–1543) used Hindu numerals in mathematical computations to provide a heliocentric model of the solar system. Leonardo Fibonacci<sup>6</sup> (1170–1250) had introduced the Hindu numerals and methods of computation to the Western world several centuries earlier.

### ***Trigonometry***

Trigonometry became modern with the work of Āryabhaṭa I. He used the half chord of an arc and the radius of a circle to define the sine of an angle. Āryabhaṭa I called this *jya* in Sanskrit. Al-Khwarizmi borrowed this and used a similar sounding word in Arabic *geib* or *jaib* meaning *fold* or *pocket* whose Latin is *sinus*. This became *sine*.

### ***Algebra***

Al-Khwārizmī’s best known works<sup>7-9</sup> are all works of Indians. Algebra as we know it also originated in India<sup>10</sup>. The sum of a series, solution to a quadratic equation (in an application to a problem of simple and compound interest) and even the so called *Diophantine (Greeks) equations* were known to Indians centuries earlier.

### ***Geometry***

Indians used an elaborate knowledge of geometry for the construction of altars for religious purposes. This led to a massive birth of geometrical knowledge which included Pythagoras theorem. Perhaps the first applied text book of geometry in the world is the *Śulbasūtra*<sup>11</sup> dealing mostly with rituals. The word *śulba* means a chord, a rope, or a string and *Śulbasūtra* signifies geometry using strings.

### ***Astronomy and Cosmology***

Āryabhaṭa I assigned motion to the earth and planets and considered stars to be stationary. He used the analogy of a boatman in a river, observing objects on the shore moving backward to explain the apparent motion of the Sun and other stars. Interestingly, Copernicus<sup>5</sup> used the same analogy of a boatman to explain the apparent motion of the Sun.

*Heliocentric Solar System:* Most planetary models during the ancient period considered a geocentric system where the Earth remained stationary as in the Ptolemy’s model. Āryabhaṭa I, on the contrary, came up with a detailed and innovative model of the solar system in which the Earth was in axial motion.

*Greenwich of the ancient world:* The location of Ujjain played an important role in astronomy during the ancient and medieval periods. Ujjain was the Greenwich of the ancient and medieval world.

*Hindu Astronomy and Cosmology:* There exist a huge body of astronomical and cosmological concepts and precepts that have been substantiated by modern physics. These can be found scattered throughout the ancient Indian texts particularly in the Rig Veda<sup>12</sup> and Bhagwad Gita (Mahabharata)<sup>13</sup>. The R̥igveda raises questions about creation. According to the famous astrophysicist Carl Sagan<sup>14</sup>: “The Hindu dharma is the only religion in which time scales correspond to those of modern scientific cosmology. Its cycles run from our ordinary day and night to a day and night of Brahma, 8.64 billion years long and about half the time since the Big Bang.”

### **Physics and Chemistry**

These sciences were very advanced in ancient India.

- (1) There were defined standards for physical measurements of space (length), mass, and time. The smallest unit of time was of the order of  $10^{-4}$  second and the size of an atom was defined of the order of  $10^{-9}$  meter<sup>15</sup>.
- (2) Objects fall downwards to the earth because of gravity. Kanada used the word *gurutva* for heaviness or gravity<sup>16</sup>.
- (3) Oceanic tides as a result of the gravitational attraction of the moon was clearly understood "...in all oceans there is no increase or decrease of water .. but merely expansion or contraction depending on the phases of the moon<sup>17</sup>.
- (4) Kaṇāda (~ 600 BCE) was the first originator of atomic theory<sup>16</sup>. Henry Margenau<sup>18</sup>, Professor of Physics at Yale University wrote "*But the most remarkable feature ... which I have never seen in American textbooks on the history of science is the atomic theory of philosopher Kanada [Kaṇāda].*"
- (5) Caraka, Suśruta, and Kauṭilya documented chemical transformations where oxidation, reduction, calcination, distillation, and sublimation were explained<sup>19,20</sup>. Caraka lists gold, copper, lead, tin, iron, zinc, and mercury in making drugs.
- (6) The Kutb Minar iron pillar, 1600 years old is still rust-free. Hardened steel was also produced. Damascus steel was actually Indian made. King Poros gifted Alexander the Great 6,000 pounds of steel.
- (7) The science of fermentation was very advanced. Fermentation of barley, 84 different types of liquor with various fruits, sugar, honey, mahua flowers and molasses have been documented<sup>12,21,22</sup>.

### **Biology, Medicine, Environment:**

Biology, medicine and environment comprised the life sciences of ancient Hindu civilisation<sup>19</sup>. Systematic studies of various life forms (plant and animals) were done and their inter-dependencies and common aspects noted. About 739 plants and 250 animals were known in ancient Hindu literature. Heart, lungs, stomach, kidneys, circulation of blood, plastic surgery, cataract surgery and ecology (*paryavarana*) were all very well known<sup>20,23,24</sup>.

### **3. Communication Methods in Ancient India Until the Destruction of Nalanda University (1193 CE)**

Communication in ancient India evolved through a complex interplay of oral traditions, scriptural communication, administrative institutions, academic centres, trade networks, monastic systems and long distance diplomatic and scholarly exchange. From the Vedic age to the 12th century CE, India developed a vibrant communication ecosystem that was sophisticated, multilingual, and interconnected with much of Asia. The destruction of Nalanda in 1193 CE marked a rupture in this centuries-old system.

#### **Oral Communication :Vedic Oral Culture (1500 BCE – 600 BCE)**

The earliest communication was based on *memory-preservation systems*. Vedic priests used highly structured recitation techniques—*padapāṭha*, *krama*, *jaṭā*, *ghana pāṭha*—to preserve texts word-for-word. This formed a pan-Indian, standardised mode of transmitting philosophy, cosmology, and ritual knowledge.

#### **Bardic and Storytelling Traditions**

During 600 – 300 BCE, there emerged travelling teachers, bards and town criers who carried verbal knowledge and information for dissemination among the people (*Mahajanapadas*). Professional storytellers such as *sūtas*, *māgadhas*, *charanas* disseminated genealogies of kings, moral values, epics (Mahabharata, Ramayana), local histories and folklore. This created a shared cultural memory across regions and time.

#### **Rise of Written Scripts and Manuscript Communication**

During the Mauryan Period (322–185 BCE) Ashokan edicts, organised courier/postal systems and intelligence networks prevailed.

The Sunga–Kushan Period (200 BCE – 300 CE) led to expansion of trade routes; growth of Kharosthi and Brahmi scripts and Buddhist missionary movements.

The development of Gupta script, growth of academic networks and early Devanagari happened during the Gupta Period (320 - 550 CE).

Nalanda flourished between 500 CE – 1200 CE and international scholarly communications with China, Tibet, Sri Lanka and Southeast Asia were frequent.

During the Pala Era (800 – 1200 CE) manuscript reproduction peaked and intellectual correspondence between monasteries increased many fold.

The destruction of Nalanda in 1193 CE led to the total collapse of the monastic communication network.

### ***Early Scripts***

*Brahmi* (3rd century BCE onward) is the mother script of most modern Indian scripts while *Kharosthi* conquered northwest India. The derivative regional scripts were *Gupta script*, *Sharada (Kashmir)*, *Nāgarī/Proto-Devanāgarī*, *Tamil-Brahmi* and *Bengali script* (early form).

### ***Manuscript Culture***

The media used for writing: were *Palm leaf* (South, East), *Birch bark* (North, Himalayas), *Cloth manuscripts* (rare) and *copper plates* (administrative records). Monasteries like Nalanda ran *scriptoria*, where trained scribes copied manuscripts for scholars within India and abroad.

### ***Royal, Administrative and Political Communication***

Messenger Systems (*Dūtas*) existed and these are thoroughly described in Kautilya's *Arthaśāstra*<sup>25</sup>. The system consisted of fast couriers, relay stations on major highways, secret messengers, diplomatic envoys and emergency runners (*turaga, pattikaras*).

Messages could be oral, written, encoded or sealed with the king's signet ring.

### ***Edicts and Public Proclamations***

Ashoka's inscriptions are the earliest large-scale public communication projects in India. These comprised

- Pillar and rock edicts placed across the subcontinent
- Multilingual inscriptions (Brahmi, Kharosthi, Greek, Aramaic)

These were used for both moral and administrative communications.

### ***Town Criers and Heralds***

People were employed in villages and towns to announce royal orders, tax changes, festivals, and legal judgements.

### ***Trade, Guild, and Maritime Communication***

#### ***Merchant Guilds (Śrenis)***

There were merchant guilds which maintained written contracts, letters of trade, seals and insignia. These also had caravan leaders who communicated rules, prices, and supply routes.

#### ***Maritime Communication Networks***

Ports like Tamralipti, Kaveripattinam, Broach, Muziris communicated actively with Rome, Southeast Asia, China and the Arabian Peninsula. Letters, religious treatises, and commercial instructions moved through these networks.

## ***Religious and Monastic Communication Systems***

### *Buddhist Networks*

Buddhism created one of the first international academic communication routes . Monasteries were connected by pilgrimage circuits. Standardised texts were disseminated by monks and translation centres were set up in China, Tibet and Southeast Asia.

### *Jain and Hindu Institutions*

Temples and matthas preserved genealogies, astronomical calendars and religious commentaries.

## ***Pilgrim Communication***

Chinese pilgrims such as Fa-Hien, Xuanzang, Yijing recorded road networks, administrative postal stations, monastic libraries and debating halls. Their accounts themselves became important cross-cultural communication records.

## ***Secret and Diplomatic Communication***

### *Espionage*

Arthaśāstra describes a detailed spy network. Invisible ink (plant extracts), coded messages, disguised agents were frequently used for surveillance work. There was secure transport of intelligence reports.

### *Sealed Letters and Cipher Systems*

There is evidence of early cipher-like substitution seen in Kharosthi legal texts, Gupta-era copper plate formulas and Buddhist tantric instructions.

## ***Nalanda University: A Communication Hub***

### *Internal Communication*

Nalanda's administration looked after 10,000+ students, 100+ lecture halls , large monastic residences housing thousands of monks.

The daily communication involved bell-codes, announcements, lecture schedules and monastic rules.

### *External Academic Communication*

Nalanda exchanged letters and manuscripts with Vikramashila, Odantapuri, Somapura, Taxila, Valabhi, Chinese and Tibetan monasteries and also Sri Lankan and Southeast Asian Buddhist centres.

### *Library and Scriptorium*

Nalanda's library was known as Dharmaganja. The huge library had scribes, translators, indexers and manuscript couriers. It functioned like a knowledge distribution institution.

## ***Destruction of Nalanda in 1193 CE***

The invasion by Bakhtiyar Khilji led to the burning of manuscripts, death and displacement of monks, the collapse of scholastic communication networks and the loss of archives and records. The barbarism of religious bigotry destroyed about 9 million (90 lacs) books and manuscripts and the university burned continuously for 3-6 months. The Persian historian Minhaj-i-Siraj in his chronicle *Tabaqat-I-Nasiri*<sup>28</sup> reported that 1000 monks were burnt alive and 1000 beheaded.

The destruction signified the end of a millennium-long communication tradition centred on monastic and scholarly exchange.

## **Conclusion**

Ancient India's communication methods—from oral recitation to international scholarly exchange—were among the most advanced in the ancient world. Nalanda stood as the apex of this system. Its destruction marked a profound break in India's intellectual communication networks. Most of the knowledge was lost while some survived through the brave effort of Arabic scholars who were present at the time of destruction. These scholars took whatever they could salvage to their homeland in the Middle East from where this ancient knowledge made its way to Europe and was disseminated on a large scale during the Ottoman rule in Europe. The European Renaissance is substantially indebted to this ancient Indian knowledge.

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