



Ancient Indian Education System And Scientific Temper: A Historical Analysis

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ABSTRACT

The scientific temper is embedded in the formal and informal education system that developed in Ancient India. It is aimed at giving a holistic experience to humanity, in the material and spiritual dimension both. In material sphere; chemistry, astronomy, physics and mathematics was highly developed. In health sciences apart from Yoga and Pranayama, that contribute to the physical and mental health, there are textual evidences of surgery. The system of validation of knowledge was also evolved like, *pratyksha* and *anumana*. The tribes of the North East India had evolved the traditional system of water conservation. Though that some of the practices are often dismissed as mere ritualism actually contain profound scientific understanding of human physiology, psychology, and environmental dynamics.

Keywords: Ayurveda, Indian traditions, meditation, Scientific temper, yoga

1. Introduction

The scientific temper, represents a fundamental approach to understanding reality through empirical observation, rational inquiry, and evidence-based reasoning. This integration of scientific temper in Indian traditions goes back by millennia. Ancient Indian knowledge systems demonstrate sophisticated understanding of natural phenomena, human physiology, and environmental dynamics that align with modern scientific principles. This study examines how traditional Indian practices embody scientific methodology through systematic observation, experimentation, and validation. Importance of engaging with Indian Knowledge system (IKS) to resolve the contemporary issues is being recognised by the Government of India (GOI) and academia in general. GOI established an organization exclusively for promoting research in IKS (<https://iksindia.org/>).

As the GOI and academia is promoting IKS, there is plethora of works that is being published now. Ancient Indian treatises like the *Charaka Samhita*, *Sushruta Samhita*, and *Aryabhatiya* are often cited as evidence of scientific thinking. Pingree, D. (1981), in *Census of the Exact Sciences in Sanskrit* emphasizes the mathematical sophistication of Indian astronomers such as Aryabhata and Brahmagupta, whose models influenced Islamic and European astronomy. Dharampal's (1971) *Indian Science and Technology in the Eighteenth Century* is based on colonial archives, suggests that indigenous Indian knowledge systems in agriculture, medicine, and metallurgy were not only advanced but systematically practiced with an empirical base before colonial disruptions. The colonial period marked a critical turning point in the perception and evolution of Indian traditional knowledge. Gyan Prakash (1999) in *Another Reason: Science and the Imagination of Modern India* critiques the colonial framing of Indian science as inferior or mystical, as a European conspiracy. In response, the nationalist movement also adopted scientific temper and started discovering scientific temper in the Indian traditions. Meera Nanda in *The God Market: How Globalization is Making India More Hindu*, however is critical about the post-independence tendency to link modern science with ancient practices, warning against pseudoscientific claims that misuse the legitimacy of traditional knowledge. Amartya Sen in *The Argumentative Indian: Writings on Indian History, Culture and Identity* argues for a nuanced approach that appreciates India's dialogic traditions and recognizes the coexistence of faith and reason. B. Mahadevan et al. (2024) take a bird's eye view of the IKS in *'Introduction to Indian Knowledge System'*, where he gives space to philosophy and science both. Jayawardena et al.

(2020) in '*The Benefits of Pranayama: A Systematic Review*.' conducted a systematic review of pranayama (yogic breathing) benefits, finding substantial evidence for physiological and psychological improvements. Similarly, Jamil et al. (2023) in '*Terminalia Arjuna Wight & Arn.—A Useful Drug for Cardiovascular Disorders*' documented extensive health benefits of meditation through neuro imaging and clinical studies. Patwardhan (2014) in '*Ayurveda: Need to Develop a Scientific Temper*' emphasizes the need for bridging Ayurveda with evidence-based scientific approaches. Mukherjee et al. (2016) in '*Scientific Validation of Ayurveda: Opportunities and Challenges*' advocate for evidence-based validation of Indian traditional medicine as essential for global acceptance and integration with modern healthcare. The integration of traditional and modern knowledge systems faces both opportunities and challenges. Balasubramanian (2004) in '*Traditional and modern sciences and technologies in India: trading new paradigms for old*' discusses the fascinating range and array of knowledge systems in India, emphasizing the need for new paradigms that respect both traditional wisdom and scientific rigor.

2. Evolution of Scientific inquiry

The roots of scientific temper in India can be traced back to the Vedic period (1500-500 BCE), where systematic observation and experimentation formed the foundation of knowledge acquisition. The Rigveda and the Yajurveda refers to the heliocentric universe. (Verma, 168) The Vedic approach to knowledge emphasized direct observation (pratyaksha) and inference (anumana) as valid means of understanding reality. (Radhakrishnan Vol 2, 48-75). Atharvaveda discusses various problems relating to health and diseases alongwith its remedies (Adhyapok, 4989). This tradition of systematic inquiry established the foundation for later developments in Indian science and philosophy.

The classical period (500 BCE - 500 CE) witnessed the systematization of various knowledge domains. Texts on health like *Charak Samhita*, *Sushruta Samhita* and the texts on Yoga like, *Yogsutra* reached to its final stage.

3. Mathematical and Astronomical Achievements

Ancient Indian mathematicians made revolutionary contributions to global scientific knowledge. Aryabhata's (476-550 CE) *Aryabhattiya* is a commentary on mathematics and astronomy. It gives an insight into the comprehensive knowledge about trigonometry. It appears that he was familiar with the notion of relativity of motion and described a geocentric model of solar system. He also theorised that the earth rotates on its axis daily (Basar, 118- 120).

The Kerala School of Astronomy, pioneered by Madhava in the fourteenth century, made remarkable contribution to the development of calculus. (Ramasubramanian, 2001) These achievements demonstrate the sophisticated mathematical and observational capabilities of ancient Indian scholars.

4. Health Sciences.

Ayurveda, literally meaning "science of life," represents one of the world's oldest medical systems with a history spanning over 5,000 years. The system is based on the fundamental principle of maintaining balance between mind, body, and environment through natural means. This holistic approach aligns with contemporary understanding of psychosomatic medicine and preventive healthcare.

The Ayurvedic diagnostic system involves systematic observation of physical signs, behavioral patterns, and environmental factors to determine individual constitution (prakriti) and disease state (vikriti). This personalized approach anticipates modern concepts of precision medicine and individualized treatment protocols. The *Charaka Samhita* (400-200 BCE) and *Sushruta Samhita* (600 BCE) represent pinnacles of medical knowledge, containing detailed descriptions of surgical procedures, anatomical understanding, and therapeutic principles.

Charak Samhita is a foundational Ayurvedic text that outlines medical principles, pharmacology, and therapies like Panchakarma, aimed at maintaining health and curing diseases. It was authored by Acharya Agnivesha under Punarvasu Atreya's guidance, redacted by Charak, and completed by Dridabala. The text is divided into eight sections, covering areas such as diagnosis (Nidanasthan), anatomy (Sharirasthan), treatment (Chikitsasthan), and prognosis (Indriyasthan). It integrates methods for teaching, clinical research, debates, and preventive healthcare strategies, emphasizing holistic well-being. (Dass, 24-26)

Sushruta Samhita is written around 600 B.C. by Acharya Sushruta known as the "father of surgery," He wrote and recorded many medical procedures. The text is divided into six sections and describes in detail the various branches of surgery. (Abhinav Kumar and Nirmal Kumar, 1)

Modern scientific research has validated numerous Ayurvedic formulations and therapeutic approaches. Turmeric has been used for four thousand years to treat variety of ailment, like fighting infection and cancers, reducing of inflammation and treating digestive problems (Bhaumik & others, 87).

Arjuna (*Terminalia arjuna*) is used for treating heart ailment, ulcers, diabetes and cancer (Shede and others; 259) and *ahwagandha* is a proven potent regenerative tonic possessing several properties (Gupta S. and others, 129). These validations demonstrate the empirical foundation of traditional pharmacological knowledge. Rasayana treatment is used for rejuvenation and revitalizing body. (Mante and Joshi, 81)

Contemporary healthcare increasingly recognizes the value of integrative approaches combining traditional and modern medicine. Research institutions worldwide are investigating Ayurvedic principles for drug discovery, treatment protocols, and preventive healthcare strategies. This integration represents a paradigm shift toward evidence-based traditional medicine.

The World Health Organization has recognized traditional medicine as an important component of healthcare systems, emphasizing the need for scientific validation and quality control. This recognition validates the scientific foundations of traditional medical systems while ensuring safety and efficacy standards.

Different yogic postures help in managing chronic pain, cardiovascular disease, diabetes, and mental health disorders. The integration of yoga into healthcare systems worldwide reflects growing recognition of its therapeutic value. Empirical evidence has proven the positive effect of Yoga and Meditation on physical and mental health. Meditation has a positive effect on metabolism, respiration, cognitive abilities, stress, and hypertension. It is effective in pain management and enhances the immune system. It increases the level of happiness, self-confidence, and general effectiveness. (Hussain and Bushan, 443-446). Paranyama is beneficial in pulmonary and heart diseases as proven by the empirical studies (Kupuswamy and others, 11-16). These findings validate traditional understanding of breath i.e. *prana* as a therapeutic tool. Studies on mindfulness meditation reveal changes in brain structure and function associated with improved mental health.

The ancient practice of mindfulness, rooted in Buddhist and Hindu traditions, has been validated through extensive clinical research. Mindfulness-based interventions are now widely used in psychotherapy, stress reduction programs, and educational settings. This integration demonstrates the scientific validity of contemplative practices.

5. Mathematics and Astronomy

Ancient Indian mathematicians made fundamental contributions to global mathematical knowledge. Geometric construction of the fire altars mentioned in the Vedic texts indicates the knowledge of mathematical operation and the Buddhist text, 'Lalitvitsara' also gives information of the numerical system. Aryabhatta devised a positional number system in the 5th C.E. Brahmgupta defined zero as the result of subtracting a number from itself, postulated negative numbers and discussed their properties under arithmetical operation. (Sangle and Sanap, 828-831). Indian mathematical and astronomical knowledge significantly influenced scientific development in other cultures. The decimal system and algebraic methods spread to the Islamic world and Europe, forming the foundation of modern mathematics. Indian astronomical texts were translated into Arabic and Latin, contributing to global scientific progress.

The Sulba Sutras (800-500 BCE) contain geometric principles including the Pythagorean theorem, demonstrating advanced mathematical understanding. (<https://www.britannica.com/topic/Sulba-Sutra>)

Indian astronomers developed sophisticated mathematical models for planetary motion, eclipse prediction, and calendar calculation. There are five Siddhanta books that give information about the astronomy and mathematics;

1. Paithamaha or Brahma Siddhanta.
2. Vashistha Siddhanta.
3. Romaka Siddhanta.
4. Paulisa Siddhanta.
5. Surya Siddhanta.

Out of these Surya Siddhanta was considered as the most scientific, having remarkably accurate measurements of celestial phenomena and very good understanding of astronomical mechanics. There are evidences of instruments used for navigation, timekeeping, and agricultural planning, demonstrating practical applications of astronomical knowledge.

There are seven sulva sutras known by the name of Bodhayana, Apasthamba, Katyayanam, Manava, Maitrayana, Varaha and Vishnuta. They belong to the period 800 BC to 500 BC. Information regarding geometrical constructions are given in these. (Hooda and Singh, 5)

Ancient Indian astronomers made detailed observations of celestial phenomena, developing accurate models of planetary motion and stellar positions. The concept of Earth's rotation was proposed by Aryabhata in the 5th century CE, centuries before Copernicus.

The Kerala School of Mathematics developed infinite series and calculus principles that influenced European mathematicians. This cross-cultural transmission of knowledge demonstrates the universal nature of scientific inquiry and the importance of diverse intellectual traditions.

6. Metallurgy and Chemistry

Ancient India demonstrated remarkable expertise in metallurgy, with evidence of iron working dating back to 1800 BCE. The famous Iron Pillar of Delhi, dating to the 4th century CE, remains rust-free after 1,600 years, demonstrating advanced understanding of metallurgical techniques. Indian metallurgists were the first to successfully extract zinc from its ores, achieving this complex process around 1000 BCE.

The development of wootz steel by sheer empirical practice in southern India by thermo-mechanical treatment is a remarkable tale of metallurgy. (Rangnathan and Srinivasan, 67). This technological achievement required sophisticated understanding of carbon content, heat treatment, and alloy composition. Archaeological evidence from Zawar, Rajasthan, reveals large-scale zinc production facilities with advanced furnace designs.

There are evidences of the development of Rasayana Shastra, as the chemistry is known in the Indian tradition. Rasaratna Samuchaya is a book written in 1300 to 1400 A.D. by Rasa Vagbhatta and it contains important knowledge of alchemy. (Dr Suman Puri and others, 67-69). It describes chemical laboratory equipment and procedures for purifying metals and preparing medicinal compounds. This text documents 32 different instruments used in chemical operations, demonstrating systematic approach to chemical experimentation.

Nagarjuna, the renowned alchemist, developed methods for purifying mercury and other metals for medicinal use. His work on converting base metals and preparing elixirs shows advanced understanding of chemical transformations. The integration of chemistry with medicine in Ayurvedic practice demonstrates holistic approach to healing.

This chemical knowledge in Ancient India had extensive industrial applications including glass making, cosmetics, perfumes, and dyes. The Indus Valley civilization (3000 BCE) shows evidence of sophisticated chemical processes including faience production, metal working, and urban planning. These achievements demonstrate early understanding of material science and engineering.

The production of saltpetre, gunpowder, and various alloys shows chemical knowledge applied to military and technological purposes. Traditional processes for leather tanning, cotton dyeing, and soap making demonstrate practical applications of chemical principles in daily life.

7. Traditional Water Conservation and Environmental Science

Traditional water conservation systems in India demonstrate sophisticated understanding of hydrology, geography, and environmental science. The stepwell (baoli) system in Rajasthan represents architectural and engineering marvels that efficiently harvested and stored rainwater. These structures incorporated principles of groundwater recharge, evaporation control, and community management.

The johad is a wonderful historical system of rainwater harvesting and conservation of Shkhevati region of Rajasthan (Singh, 145). It involves constructing earthen dams to capture rainwater, leading to groundwater recharge and ecosystem restoration. This demonstrates the effectiveness of traditional water conservation methods.

Different regions of India developed water conservation systems adapted to local geographical and climatic conditions. The Apatani tribe in Arunachal Pradesh developed terraced water harvesting systems that integrate agriculture with water conservation. (Vikhepu,77). The Eri system in Tamil Nadu functions as flood control and groundwater recharge, demonstrating understanding of watershed management principles. These diverse systems show sophisticated adaptation to local environmental conditions and community needs. (Nandini and Shanmuga, 1-10).

8. Ecology

Traditional water conservation systems were integrated with broader ecological management practices. Sacred groves protected by communities conserved biodiversity and maintained watershed functions. The cultural and spiritual significance of water bodies ensured their protection and maintenance by communities. Women played crucial roles in water conservation, with traditions of constructing, maintaining, and protecting water bodies. Songs, dances, and rituals associated with water conservation created cultural frameworks for environmental stewardship. These practices demonstrate holistic understanding of environmental management. According to Vandana Shiva, women and closely related to the nature (Dash,1-5). In Vaishnva tradition too, the earth is equated with goddess and mother. "*Samudrevasane devī, parvata stanamaṇḍale. Viṣṇupatni! Namastubhyam pādasparsaṁ kṣamasva me!*" (O ocean-clad goddess earth, with mountains as your nurturing-breasts. O wife of Viṣṇu! I bow to you and ask for forgiveness as I touch you with my feet) (Jain 41).

9. Epistemology

Indian philosophical traditions developed sophisticated frameworks for knowledge acquisition and validation. The Nyaya school established logical methods for inference and reasoning, creating systematic approaches to scientific inquiry. The emphasis on *pratyaksha* (direct perception) and *anumana* (inference) as valid means of knowledge parallels modern scientific methodology. (Radhakrishnan S Vol 2 48-75).

The Vaisheshika school developed atomic theory, proposing that matter consists of indivisible particles (*paramanu*). (Radhakrishnan S Vol 2 176-247). This ancient understanding of atomic structure predates modern atomic theory by over two millennia. The school's emphasis on observation and logical analysis demonstrates scientific approach to understanding reality.

Indian philosophical traditions uniquely integrated empirical observation with metaphysical inquiry. The Samkhya school developed systematic analysis of consciousness and matter, creating frameworks for understanding psychological and physical phenomena (Radhakrishnan S Vol 2 248-335). This integration provides holistic perspectives on human experience and natural phenomena.

The Yoga philosophical system emphasizes experiential knowledge through disciplined practice and systematic observation of consciousness ((Radhakrishnan S Vol 2 336-373). This approach combines empirical methodology with direct experience, creating unique pathways to understanding reality. The integration of practical and theoretical knowledge demonstrates sophisticated epistemological framework.

Traditional Indian inquiry methods emphasized systematic observation, logical analysis, and practical application. The tradition of debate (*tarka*) and discussion (*vaada*) created frameworks for testing ideas and validating knowledge claims. These methods parallel modern peer review and scientific discourse.

The emphasis on *guru-shishya* (teacher-student) tradition ensured systematic transmission of knowledge while allowing for innovation and adaptation. This approach combined respect for traditional wisdom with openness to new discoveries, creating dynamic knowledge systems.

10. Contemporary Relevance

Contemporary research increasingly focuses on validating traditional Indian knowledge systems through rigorous scientific methodology. The AYUSH (Ayurveda, Yoga, Unani, Siddha, and Homeopathy) research portal documents over 4,000 clinical trials and 8,000 pre-clinical studies investigating traditional medicine. This extensive research database demonstrates growing scientific interest in traditional knowledge validation.

Modern validation studies employ sophisticated techniques including pharmacological analysis and clinical trials, and systems biology approaches. These studies aim to understand mechanisms of action, establish safety profiles, and determine therapeutic efficacy of traditional practices. The integration of traditional knowledge with modern scientific methods creates new paradigms for medical research.

Contemporary research involves interdisciplinary collaborations between traditional knowledge holders and modern scientists. The Honeybee Network documents over 50,000 innovations and traditional practices, facilitating collaboration between communities and researchers. These initiatives respect intellectual property rights while promoting knowledge sharing.

International collaborations study traditional medicine systems, with institutions worldwide investigating Indian knowledge systems. The global interest in traditional medicine reflects growing recognition of its potential contributions to healthcare and environmental management.

Modern technology enhances validation and application of traditional knowledge. Bioinformatics approaches analyze traditional formulations, identifying active compounds and mechanisms of action. Artificial intelligence and machine learning techniques help map traditional knowledge and identify research priorities.

Digital platforms document and preserve traditional knowledge, making it accessible to researchers worldwide. These technological tools support validation efforts while ensuring preservation of traditional wisdom for future generations.

Validating traditional knowledge systems presents methodological challenges. Traditional practices often involve complex, multi-component interventions that resist conventional research designs. The holistic nature of traditional systems requires new research paradigms that can accommodate complexity and individual variation.

Standardization of traditional practices for research purposes may compromise their essential characteristics. Developing appropriate research methodologies that respect traditional epistemologies while meeting scientific standards requires careful consideration of cultural and methodological factors.

Integrating traditional and modern knowledge systems faces institutional, regulatory, and cultural barriers. Educational systems need reform to accommodate indigenous knowledge alongside conventional curricula. Healthcare systems require frameworks for integrating traditional and modern therapeutic approaches.

Protecting intellectual property rights of traditional knowledge holders while promoting research and development presents ongoing challenges. Developing ethical frameworks for traditional knowledge research ensures fair benefit-sharing and community participation.

Future research should focus on developing appropriate methodologies for validating traditional knowledge systems. Systems biology approaches may provide frameworks for understanding complex traditional interventions. Personalized medicine concepts align with traditional emphasis on individual constitution and treatment.

Climate change and environmental degradation create urgent needs for traditional environmental knowledge. Traditional water conservation, sustainable agriculture, and biodiversity conservation practices offer valuable solutions for contemporary challenges.

The integration of traditional knowledge with modern technology creates opportunities for innovation in healthcare, agriculture, and environmental management. Artificial intelligence and digital platforms can enhance traditional knowledge preservation and application.

11. Conclusion

This comprehensive analysis demonstrates that Indian traditions embody sophisticated scientific temper through systematic observation, empirical validation, and practical application. The scientific foundations of practices including Ayurveda, yoga, meditation, mathematics, astronomy, metallurgy, and environmental management have been increasingly validated through contemporary research.

The integration of traditional wisdom with modern scientific methodology creates new paradigms for understanding and addressing contemporary challenges. Traditional knowledge systems offer valuable insights for healthcare, environmental management, and sustainable development. The growing body of validation research confirms the scientific validity of traditional practices while respecting their cultural and spiritual significance.

The concept of scientific temper, as enshrined in the Indian Constitution, finds profound expression in traditional knowledge systems. These systems demonstrate that scientific inquiry and spiritual wisdom are not contradictory but complementary approaches to understanding reality. The continued validation and integration of traditional knowledge with modern science holds promise for addressing global challenges and advancing human knowledge.

Future research should focus on developing appropriate methodologies for validating traditional knowledge while respecting its cultural context. The integration of traditional and modern knowledge systems requires collaborative approaches that honor both scientific rigor and traditional wisdom. This synthesis offers pathways for creating more holistic, sustainable, and effective solutions to contemporary challenges.

The scientific temper inherent in Indian religious traditions provides valuable models for integrating empirical inquiry with holistic understanding. This integration offers hope for addressing the complex challenges facing humanity while preserving the wisdom of traditional knowledge systems for future generations.

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