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Incorporating Ancient Sciences And Mathematics

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Abstract
The mathematics of classical Indian civilization is an intriguing blend of the familiar and the strange. For the modern individual, Indian decimal place-value numerals may seem familiar and, in fact, they are the ancestors of the modern decimal number system. Some historians of mathematics have deplored these aspects of the Indian tradition, seeing in them merely a habit of rote memorization and an inability to distinguish between true and false results. In fact, explanations and demonstrations were frequently added by later commentators not so much as solid foundations for a student's understanding but as pedagogical crutches for a student's potential lack of understanding. The Indian concept of *ganita* (Sanskrit: "computation") was a form of knowledge whose mastery implied varied talents: a good memory, swift and accurate mental arithmetic, enough logical power to understand rules without requiring minute explanations, and a sort of numerical intuition that aided in the construction of new methods and approximations.

Keywords - Mathematics, Indian civilization, decimal number system,decimal place value,pedagogy.

Introduction

Mathematics on the Indian subcontinent has a rich and long history going back over 5,000 years and thrived for centuries before advances were made in Europe. Its influence spread to China, Southeast Asia, the Middle East, and Europe. Apart from introducing the concept of zero, Indian mathematicians made seminal contributions to the study of geometry, arithmetic, binary mathematics, the notion of negative numbers, algebra, trigonometry, and calculus among other areas. The decimal place value system that is employed worldwide today was first developed in India. Classical period (400–1600) This period is often known as the golden age of Indian Mathematics. This period saw mathematicians such as Aryabhata, Varahamihira, Brahmagupta, BhaskaraI,Mahavira, Bhaskara II, Madhava of Sangamagrama and NilakanthaSomayaji give broader and clearer shape to many branches of mathematics.

Planetary knowledge

The Vedic planetary model is given in Figure 1. The sun was taken to be midway in the skies. A considerable amount of Vedic mythology regarding the struggle between the demons and the gods is a metaphorical retelling of the motions of Venus and Mars (Frawley 1994). The famous myth of Vishnu's three strides measuring the universe becomes intelligible when we note that early texts equate Vishnu and Mercury. The myth appears to celebrate the first measurement of the period ofMercury (Kak 1996a) since three periods equals the number assigned in altar ritual to the heavens. Other arguments suggest that the Vedic people knew the periods of the five classical planets.

Concept of Zero: 'Zero' was discovered by an anonymous Indian. The concept of zero in India holds significant historical and mathematical importance. The numeral zero, as we understand it today, is an integral part of the decimal numeral system, and it was developed in ancient India.

Concept of Pi: The concept of π (pi), which represents the mathematical constant approximately equal to 3.14159, has a long history in India, as well as in other ancient civilizations. In India, pi was known and calculated by mathematicians and astronomers in various ways over the centuries.

1. Ancient Texts: Indian mathematicians and astronomers in ancient times made references to pi in their texts. For example, the "Shulba Sutras," which are a collection of ancient Indian texts dealing with geometry and construction, include approximations of the value of pi

2. Madhava: The mathematician Madhava of Sangamagrama, a prominent figure of this school, developed series expansions for trigonometric functions, including pi. The approximate value of π is 22 7 or 3.14159265359.

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Number System: India has a rich history of number systems, with significant contributions to the development of various numeral systems. One of the most influential contributions is the decimal numeral system, which is now the most widely used number system globally.

Vedic Mathematics: Vedic Mathematics is a system of mathematics that claims to be based on the ancient Indian scriptures known as the Vedas. It is often attributed to a scholar named Swami Bharati Krishna Tirtha, who published a book titled "Vedic Mathematics" in 1965, where he introduced and popularized this system.

1. Sutras: Vedic Mathematics is said to be based on a set of 16 Sutras (aphorisms) and 13 Upa-sutras (sub-sutras) extracted from the Vedas. These Sutras are claimed to provide efficient and unconventional methods for performing various mathematical operations, such as addition, subtraction, multiplication, division, square roots, and cube roots.

2. Mental Calculation: Vedic Mathematics emphasizes mental calculation and claims to offer techniques that allow individuals to perform complex mathematical computations in their heads quickly. Proponents of Vedic Mathematics argue that these techniques can lead to faster and more efficient calculations compared to traditional methods.

Mahaviracharya: Mahavira, also known as Mahaviracharya or Mahavira II, was a renowned mathematician and Jain philosopher who lived in India in the 9th century CE. He made significant contributions to the field of mathematics, particularly in the area of number theory. Key contributions:

2. Number Theory: Much of Mahavira's work focused on number theory, including the study of prime numbers, factors, divisibility, and algebraic equations. He made important contributions to understanding the properties of numbers.

3. Prime Factorization: Mahavira developed a novel method for prime factorization, which involved a systematic procedure for finding the prime factors

Contributions:

1. Mathematics: Bhaskaracharya made important contributions to mathematics, particularly in the areas of algebra, arithmetic, and calculus. His work "Lilavati" is one of his most famous mathematical treatises.

2. Astronomy: Bhaskaracharya was also an accomplished astronomer. He wrote the astronomical treatise known as the "SiddhantaShiromani." This work is divided into four sections: Lilavati (arithmetic and geometry), Bijaganita (algebra), Grahaganita (mathematics of the planets), and Goladhyaya (spherical trigonometry). In the Grahaganita section, he made significant contributions to understanding planetary motion and eclipses.

3. Bijaganita: Bhaskaracharya's "Bijaganita" is a comprehensive work on algebra. It covers topics like solving equations, indeterminate equations, and algebraic methods for finding square roots.

4. Calendar Reform: Bhaskaracharya proposed calendar reforms and made adjustments to the Indian calendar system. His insights into the calculation of leap years and the adjustment of months contributed to the accuracy of Indian calendars. Bhaskaracharya's works, especially "Lilavati" and "SiddhantaShiromani," remain important sources for understanding the mathematical and astronomical knowledge of his era.

Contribution of Ancient India to Modern Science

India has been contributing to the fields of science and technology since ancient times. Even today, what we term as 'traditional knowledge' is actually based on scientific reasoning. Technology is today defined as applied science, but early humans **developed technologies such as** stone-working, agriculture, animal husbandry, pottery, metallurgy, textile manufacturing, woodcarving, boat-making, and sailing.

- The first stone tools in the Indian subcontinent go back more than two million years.
- The **Neolithic revolution** saw the development of agriculture in parts of the Indus and the Ganges valleys, which in turn triggered the need for pots, water management, metal tools, transport, etc.
- **Metallurgy** brought about significant changes in human society as it gave rise to an entirely new range of weapons, tools, and implements.

Metallurgy

Metallurgy may be defined as the extraction, purification, alloying, and application of metals. **Mehrgarh** in Baluchistan provides the first evidence of metal in the Indian subcontinent**.**

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- **Wootz steel:** Wootz steel, first produced in South India around 300 BCE, was created by carburising iron under controlled conditions.
- The products made of this Indian steel came to be known as **Damascus swords.**
- Wootz steel is primarily iron containing a high proportion of carbon (1.0-1.9%).
- It also spurred developments in **modern metallographic studies** and also qualifies as an advanced material in modern terminology since such steel are shown to exhibit super-plastic properties.
- **Iron Pillar of Delhi:** It consists of about six tons of wrought iron**.** The **rust-resistant quality** is chiefly due to the presence of **phosphorus** in the iron and this element, together with iron and oxygen from the air, contributes to the formation of a thin protective passive coating on the surface, which gets reconstituted if damaged by scratching.

Chemistry

- **RasaratnaSamuchaya:** Vagbhaṭa in his RasaratnaSamuccaya gives a systematic exposition of the principal metals in a well-known text of alchemy.
- Each metal's properties and medicinal uses are clearly brought out within the alchemical framework of the times.
- **Rasashaastra :** It literally means the **"Science of Mercury"**.
- It is a specialized **branch of Ayurveda** dealing mainly with materials which are known as **'Rasa dravyaas'.**
- Its evolution is traced to the **Sage Nagarjuna.**
- Naagaarjuna proclaimed that the objective of the science of mercury is not limited to **Alchemy (Dhaatuvaada)** but also to maintain health and strengthen the body for achieving **Mukti i.e. ultimate salvation.**
- **The Ramayan and the Mahabharata** mention weapons with arrowheads coated with a variety of chemicals, indicating their knowledge of Alchemy.
- **Kanad's atomic theory** was the very first atomic theory ever proposed.

Medicine

- **Ayurveda:** Ayurveda is a science of life that emphasizes a holistic approach to **health and personalized medicine.**
- The ancient schools of **Hindu Philosophical teachings** known as **Vaisheshika** and the school of logic known as **Nyaya** laid the groundwork for Ayurveda.
- According to Ayurveda all objects in the universe including the human body are composed of five basic elements (Panchamahabhutas) namely, Akash, Vayu, Agni, Jala and Prithvi.
- **Siddha:**The **Siddha system of Medicine**, provides preventive, promotive, curative, rejuvenating and rehabilitative health care by adopting a scientific and holistic approach.
- **Yoga:** It was developed as an allied science of Ayurveda for **healing without medicine** at the physical and mental levels.
- The credit for systematically presenting this goes to **Patanjali**.
- **Veterinary Science:** There is evidence of the existence of **veterinary hospitals and dis- pensaries** under the **Mauryan Empire**.
- Veterinarians were called **salihotriya**, after the famous horse medicine authority **Salihotra**, in ancient times.

Astronomy and Space

- **VedangaJyotisa:** It is the earliest astronomical text attributed to **Maharishi Lagadha** dating back to the **6th century BCE.**
- It is part of the **Vedangas**, and it covers a wide range of topics, including the phases of the Moon, the solar and lunar calendars, and the positions of the planets.
- **Maharajah Sawai Jai Singh II** of Jaipur constructed five astronomical observatories in northern India (New Delhi, Jaipur, Ujjain, Mathura and Varanasi).

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- The observatories, or **"JantarMantars"** incorporate multiple buildings of unique form, each with a specialized function for **astronomical measurement.**

Aeronautics

- **Mysorean Rocket:** Rockets or 'fire-arrows' are noted to have been in use in Europe way back in the 15th century itself. However, rockets developed during Tipu Sultan's reign, known as **Mysorean rockets**, were far more advanced, "primarily due to the **use of iron** tubes for holding the propellant."
- These rockets used a special type of gunpowder, which produced a fierce bursting, odour, and smoke, as well as a terrifying noise.

Mathematics

- **Shulba Sutras:** Baudhyana is credited with the writing of the earliest Sulba sutras which are appendices to the Vedas performing the role of manuals enunciating rules for the construction of **Vedic altars** (site preparation for Vedic sacrifices).
- **Arithmetic:** Most of the standard results in basic arithmetic were of Indian origin like the decimal system, place-value, zero, square, and cubic-roots.
- **Trigonometry:** It evolved as an essential component of astronomy. Most astronomical texts include reasonably accurate sine tables to facilitate quick calculations of astronomical elements.

Ancient Indian Scientists

In ancient India great luminaries cultivated sciences with their personal curiosity under active royal patronization. Following are some notable Indian scholars:

Baudhayana (800 BCE- 740 BCE)

- Baudhayana was the **mathematician**, is also known as the '**Father of Geometry'.**
- He was a great scholar of philosophy, religion, mathematics, and language.
- **Books:** Shulba Sutra and Shrauta Sutra.
- He is considered one of the first to discover the **value of 'pi'.**
- **Baudhayana Theorem:** This is considered an earlier statement of the Pythagorean theorem.

Sushrutha

Sushrutha is recognized as the **'Father of Plastic Surgery'.**

- He was a surgeon and philosopher who compiled a monumental treatise on surgery, '**Susrutasamhita**'.
- India was the first place where **rhinoplasty** (developed by Sushrutha) was invented and used.
- He took surgery in ancient India to admirable heights and that era was later regarded as the **Golden Age of Surgery**.
- **Contribution:**
  - His ***Samdamsayantras*** were the first forms of the modern surgeon's spring forceps and dissection and dressing forceps.
  - Classified bones and their reaction to injuries.
  - Recognized diabetes and defined it as **Medhumeha**.
  - First person to do an **autopsy**.

Kanada

- Kanada was the first proponent of the **'atomic theory'** and stated that the atom is indivisible and the world is made up of atoms.
- He also added that there are varieties of atoms that are as different as the different classes of substances.
- In 200 BCE, he wrote about **gravity**, and in **Vaishesika Sutras** he describes the **Laws of Motion.**
- He founded the **Vaisheshika school of Indian philosophy**, which embodied the oldest forms of Indian science.

Charaka-

Charaka is known as the **"Father of Ayurveda".**

- He appears to have been a pioneer in the **"prevention is better than cure"** philosophy.
- He wrote **CharakSamhita** (treatise on ayurveda) the description of a large number of diseases, causes and their treatment.

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- He described the **Fundamentals of Genetics** andwas the first physician who stated the concepts of **digestion, metabolism, and immunity.**

Aryabhatta (476-550 CE)

- Aryabhatta was **mathematician-astronomers**
- **Books:**
  - **Aryabhatiya** (mathematics and astronomy)
  - **Arya-siddhanta** (astronomical computations).
- **Contribution in Mathematics:**
  - The mathematical part of the Aryabhatiya covers arithmetic, algebra, plane trigonometry, and spherical trigonometry.
  - **Zero**, according to Aryabhatta, was not only a numeral but also a **symbol and a concept.**
- **Contribution to Astronomy:**
  - He believed that the earth was rotating and also gave a scientific explanation for the **occurrence of eclipses** as opposed to the prevailing ideas that **Rahu and Ketu** caused eclipses.
  - The discovery of zero enabled Aryabhatta to calculate the **exact distance between the Earth and the moon.**

Aryabhata II

Aryabhata II was a mathematician and astronomer.

- **Books:** The Mahasiddhanta or Aryasiddhanta, is an astronomical compendium based on the orthodox tradition of *Smṛti*s.
  - Detailed derivations cover planetary longitudes, solar and lunar eclipses, eclipse projections, lunar crescents, and more etc.
- He played a vital role in constructing a **sine table,** which was accurate up to **five decimal places.**

Brahmagupta (598-668 CE)

- Brahmagupta, a most accomplished mathematician, was responsible for creating good mathematics in the form of **geometrical theorems** and **number theory.**
- He was the **first to introduce zero as a digit.**
- He was believed to be a court astronomer to emperor **Vyaghramukha (Chavda Dynasty)**.
- **Notable work:** Bahmasphutasiddhanta (theory of "the opening of the universe"), Khandakhadyaka (astronomical calculations).

Bhaskara I

- Bhaskara I, was a mathematician and astronomer (7th century CE)
- **Contribution to Mathematics:**
  - His greatest contributions lie in the realms of **calculus and trigonometry.**
  - He developed innovative methods and algorithms that simplified the process of finding solutions.
- **Books:**
  - **"AryabhatiyaBhashya"** covers a wide range of topics, including arithmetic, algebra, geometry, and trigonometry.
  - **Laghubhaskariya** and the **Mahabhaskariya** which follow Aryabhata's system of astronomy.

Varahamihiri (505–587 CE)

- Varahamihira was a renowned astronomer, mathematician, and astrologer.
- **Notable works:**
  - **BrihatSamhita** (comprehensive work on astronomy, astrology, architecture, gemology, agriculture, mathematics, and gemology).
  - He wrote about **chief aspects of Jyotisha** (astrology) like horoscopy.
  - He was the first to state **Panchasiddhantika** (book on mathematical astronomy) that the **ayanamsa** (precession of the equinoxes) lasted for **50.32** seconds.

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- He first described **gravity** as an attractive "Force", which binds various things together.

Bhaskara II/ Bhaskaracharya

- Bhaskara II was an Indian astronomer and mathematician (12th CE century)
- **Notable works:**
  - **SiddhantaShiromani** (It contains the essence of ancient Indian astronomy and mathematics).
  - He was aware of the **precession of equinoxes.**
    - He accurately calculated the apparent orbital periods of the **Sun** and orbital periods of Mercury, Venus, and Mars.

Nagarjuna

- He was a chemist and an **alchemist.**
- **Notable works:**
  - **Rasaratnakara** {It deals with preparing rasa (liquids, mainly mercury)}. It is a literary piece on alchemy composed around 7th-8th century CE.
  - Alchemy is an old study of changing basic substances (such as metals) to other substances.
  - Rashrudaya, Rasendramangal, Arogyamanjari, Kakshaputatantra, Yogasara, Yogasataka, and Uttaratantra (preparation of medicinal drugs).

- He for the first time, not only enunciated **cementation processes** but also propounded zinc production by a **distillation technique.** His efforts were focused on transforming base metals into gold.

Conclusion-

In conclusion, **ancient Indian wisdom offers a rich repository of knowledge** that can be integrated with contemporary science and technology to drive breakthroughs across multiple domains.This **integration could lead to sustainable, holistic solutions that address modern challenges**. Man is distinctly separated from the animal by his power of "thinking" or "reasoning". Not many countries of the world have contributed their share to the evolution of modern mathematics. The Indian contribution is among the most important, particularly during the ancient India. I present this thesis as a Mathematical models from the rules of Mathematics which have been given in the form of various Sanskrit verses by the Ancient Indian Mathematicians.

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