India invented zero – Really ? [1]

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1 Yet another enigmatic question

It is often important to sit and think about the origins of the many blessings which we enjoy today:

1. Who invented fire ?

2. Who invented the wheel ?

Add to that, yet another question which has no easy answer :

Where was the number zero invented ? Who invented it ? When ?

Read on, to know the answer to this fundamentally important question (or the many related questions).

2 How full is an empty box ?

"Numbers" are strange, invisible (abstract) objects which are ubiquitous and are used to quantify other objects. The concept of a number itself is a remarkable intellectual leap by mankind. In particular, the discovery of "zero" as a number, is perhaps the most dramatic and ground-breaking event in the history of mankind (after the invention of fire and the wheel). Numbers themselves are classified in various ways, since they have a large variety of properties [6].

The discovery of a concept called "number" and its evolution to today's modern number systems has a painfully long and tangled up history, with considerable contributions by Indian/Hindu mathematicians [3]. Zero, as we know and use today, could be a number by itself. Or it could be a "digit" in a

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[1]Texts marked in wine-red colour are click-sensitive hyperlinks

place-valued number system [1] . By 'digit" we imply a place-valued decimal number system, where any number can be represented by a combination of ten basic 'digits".

In the beginning, it was easy to imagine all numbers as "natural" numbers, since all we needed was a device to count. As man's wisdom grew, he/she started getting more curious and more adventurous. He could imagine "negative" numbers and included them also into the holy family of "numbers". Then came the incredible and largely contested step of finding something which was neither negative nor positive.

The enigmatic "zero"(aka nought, naught, nil, nul, sifr/cipher) is the name of a number which quantifies nothing [1]. It is also usual to denote "zero" symbolically by a graphic symbol: **0**. Zero is like a box which contains nothing. But why should anyone need such an empty box ? Or why should anyone care about it all ? The answer to this enigmatic question took several hundred years to resolve [2]. And even led to conflicts and bloodshed.

Take a simple example : Numbers like one, two, etc. can have a meaningful representation, like a car can honk once, twice and thrice. But how can we represent if no horn ? Does that make any sense ? No, except for mathematicians who think beyond what is visible to everyone else.

The search for "zero" and its acceptance was similar to the search by physicists for "vacuum" or void. Can there be something with "nothing" in it ? Does it make sense ? Does this idea have any use ? Nevertheless, reason won over curiosity and we eventually found and accepted "vacuum", just like we groped along till we got to zero. Zero is also similar to "rest", used in modern musical notation to denote silence/pause. Rests are intervals of silence/pauses in pieces of music, marked by symbols indicating the length of the pause. We do not know which came first (and where) – vacuum(physics), rest(music), zero (numbers). The search for zero was certainly long and adventurous [2].

3   India invented zero ?

The assertion "invented zero" in the title, implies "zero as we understand and use today". This leads to a few **criteria** which need to be to be considered while passing a judgement:

- Recognise that "nothing" is also a countable number.

- Use of the name "zero" (in English) to denote a number whose value

is nothing.

- Use of a symbol to denote zero

- Use of zero for creating any number, using place-valued decimal number system

- Define arithmetic operations which involve zero.

- Define a uniform and coherent set of properties and rules for numbers / arithmetic which involve zero

The truth behind the claim: "India invented zero" is a complicated one to resolve. "Zero" has no known birthday, or a birth place. Like a baby, it took a long gestation until the day it came to be "born". There were several people, and several places involved during its gestation and eventual birth/invention.

There are conflicting claims by the Chinese, Mayans, Greeks, Arabs to this discovery. Many ancient civilisations, like the Greeks and Romans, did not have a zero in their numeral system. Some ancient American civilisations like the Maya also used zero in their calendars, but their numbers systems did not survive colonisation. There is also an argument proposing to include Cambodia in this race. According to "Timeline of Mathematics" by Mathigon.org, the oldest known use of the number zero: dates back to the Khmer civilisation in Cambodia, around the year 683 CE. From Cambodia, the concept was probably passed to India, where the Hindu-Arabic numeral system originated. From there, it spread to the Middle East and Europe, and we still use it today.

The claim by India is perhaps the strongest. Supporters of this claim usually refer to a few Indian / Hindu names in this context. However, some people feel that India's claim to the invention of the zero is perhaps the most widely used and abused India fact. It arises out of a benevolent sense of patriotism and a concoction of religious loyalty and scientific speculation. At best, this claim can be only classified as partially true, since all the above steps took several years (centuries) to be achieved. However, one "evidence" stands out in favour of India. [10].

In Gwalior, India, there is a fort, commonly known as Gwalior Fort.
Built atop Gopachal Parvat, the largest of the five clusters of rock-cut Jain monuments from the 15th century, the Gwalior Fort is replete of impressive architectural feats. Next to the fort is the small Chaturbuja temple. Inside the temple is a statue with four arms but no face. It did once have a face, but it has since been vandalised. There are two inscriptions in this temple. One is engraved over the main door. The other is inscribed into an indentation, roughly square in shape, on the left wall of the sanctum sanctorum as you enter it, to Lord Vishnu's right.

The second, shoddy inscription, on the other hand, is one of the most important records in the history of mathematics. If there is any record in all of India that is fully deserving of generating and maintaining its own cannon of India facts, this is it. There should be entire museums complete with multimedia displays and gift shops dedicated to this inscription.

So what does this piece of inscription say? Does it reveal the name of a mysterious king? Give a concrete date for a historical episode that experts had argued over for decades? Does it tell the future, then, in some Nostradamic way?

No. It is merely an inscription informing one of a donation that has been made to this temple.

The numbers in them. Especially the two measures in hastas and the number of flower garlands. Inscribed in 876 CE, this inscription is the oldest text anywhere in India in which the zero is used in exactly the way we use it today. (The inscription itself refers to year 933 in the Saka calendar or 876 CE, in case you are wondering).

What the Gwalior tablet shows is that our current place-value system with a base of 10 had become part of popular culture in at least one region of India since 876 CE. That is all we have to support the claim that "India invented zero".

Now, let us take a look at the timeline of zero.

3.1 Aryabhatta (476 - 550 CE)

In the first millennium, Hindu astronomical texts were presented in a prose-verse format called as "siddhanta" (treatise), to describe various cosmological events and parameters. The origins of siddhanta are themselves too fuzzy to be documented with certainty. Sidhanta texts were closely related to the "katapayadi" system of coding. The katapayadi system of numerical notation is an ancient Indian alphasyllabic numeral system to depict letters to numerals for easy remembrance of numbers as phonetic words or verses. The katapayadi system was a system of phonemic number notation in which numbers are represented by a consonant-vowel monosyllable. It was a practice to give a katapayadi symbol to a "silent" note (or empty note), a precursor to the concept of zero.

This tradition gave rise to various forms of siddhanta including the one attributed to Aryabhatta. Aryabhatiya or Aryabhatiyam , a Sanskrit astronomical treatise, is the magnum opus and only known surviving work of the 5th century Indian mathematician Aryabhatta. Aryabhata, in his treatise Aryabhatiya, is known to have used a notation similar to katapayadi to represent astronomical numbers.

Direct details of Aryabhatta's work are known only from the Aryabhatiya. Aryabhatta himself may not have given it a name. The name "Aryabhatiya" is due to later commentators. The Aryabhatiya (c. 500), states *sthanat sthana dasagunam syat* (from place to place each is ten times the preceding), implying that the decimal-valued number system was known before Aryabhatta.

3.2 Brahmagupta (598 CE - 668 CE)

Almost 50 years after Aryabhatta came Brahmagupta.

Brahmagupta was the first to give rules to compute with zero. This made zero legitimately acceptable as a number. This paved the way for all other discoveries and innovations involving zero (e.g the concept of negative numbers).

Brahmagupta's Brahmasphutasiddhanta is the first book that provides rules for arithmetic manipulations that apply to zero ("shunya" in Sanskrit) and to negative numbers. The Brahmasphutasiddhanta is the earliest known text to treat zero as a number in its own right, rather than as simply a placeholder digit in representing another number as was done by the Babylonians or as a symbol for a lack of quantity as was done by Ptolemy and the Romans.

This, by itself, was no small contribution. The genius of Brahmagupta lies in having seen an otherwise unseen and unknown concept – a quantity which denotes nothing.

Notice that the inscription of zero, found at Gwalior, and mentioned above, dates from 876 CE (much after Brahmagupta).

3.3 Giuseppe Peano (1858 - 1932)

Almost a thousand years after Brahmagupta came the first formal recognition of zero as a "natural number" or number.

Peano axioms, also known as the Dedekind - Peano axioms or the Peano postulates, are axioms for the natural numbers presented by Peano. In 1889, Peano published a simplified version of Dedekind - Peano axioms, as a collection of axioms in his book: The principles of arithmetic presented by a new method (Latin: Arithmetices principia, nova methodo exposita). The first axiom states that the constant 0 is a natural number. This implies that zero was known from even before Peano (so he could include it in his definition of numbers).

Peano axioms , form the unifying basis of all arthmetic involving numbers, including negative numbers (a challenge to our imagination). They also conform to the criteria mentioned in the beginning of this section i.e. Sec. 3. These axioms in turn, are used in various branches of higher mathematics – trigonometry, geometry, algebra, statistics etc.

And thus was born, the real "zero" as we know and use today.

4 Closing remarks

The subject of zero has a long history of several centuries. This article has borrowed material from several sources. The reader is requested to send all remarks, criticisms and suggestions to the author at drpartha@gmail.com.

A whole lot of similar articles and tutorial material is available for download from [7] This article is released under a liberal license [8] and is published on the web at [9].

5 Anticlimax

Although all this may sound very biased in favour of India. A queer habit in India is that no-one (or almost no-one) uses the Indian name (shunya, bhujyam, sunna ....) in spoken language. It is always "zero". This is proof of the belief that English is also an Indian laguage ! This is also similar to the decimal number system we use. In India, these numerals are called arabic numerals. In most Arab countries, these are Hindu numerals, or simply Hindu-Arabic numerals. In fact, Fibonacci (of the Fibonacci sequence) borrowed heavily from Indian and Arabic sources. In his book Liber Abaci, he described the Hindu-Arabic numeral system represented by the numbers 0 through 9. He called this the "Modus Indorum," or the method of the Indians.

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