

**They Journey of Nothing**

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## The Journey of Nothing

*“In the digital world, all knowledge is divided into two parts. The binary strings of 0s and 1s that make up the genetic code of data allow information to be fruitful and multiply, and allow people to create, manipulate, and share data in ways that appear to be revolutionary. It is often said that digital information is transforming the way we learn, the way we communicate, even the way we think.” (Smith, 1999)*

It is rather fascinating to think that the author of this quote would place the weight of all the information and knowledge contained in the digital world on the shoulders of just two numbers. The inclusion of zero in this duo is particularly intriguing as it is a term that per its definition actually represents nothingness. How then did something that represents nothing, come to represent in part an entire digital world? It is of course well known that the binary code consisting of zeroes coupled with ones forms the basis of operation for everything from calculators to computers today. Using a base 2 system, combinations of 0's and 1's can generate all the other digits instead of trying to make use of the usual writing convention that relies on a base ten system.

Is there something that differentiates zero from the other numbers though? Well, a basic understanding of numbers involves the ability to identify them as mathematical objects that at a fundamental level are used to count or measure things with (Clawson, 1994). This works perfectly well for a number such as two where identifying a pair of objects can be well-demonstrated using tangible examples. However, zero as a number does not fit this classical definition very well when trying to apply the same logic. How does one count something that does not exist? How can zero's existence or non-existence be demonstrated in any tangible way? The concept of zero thus requires abstract reasoning and an ability to detach understanding thereof from any empirical experience (Nieder, 2016).

Unfortunately, there exists a profound link between human understanding and the physical manipulation of the world as Haas (2013) testifies to in the statement that, “the materially-based conduct of human activities has profound applications for the development of human culture and the shape of human consciousness.” The mental challenge of understanding the concept of zero is thus no mean feat and is part of the reason why zero’s development as a number was such an arduous one.

How then did a concept representing nothingness come to be? To answer this question some history has to be revisited to uncover the meandering journey of zero’s symbols and meanings among the numerous civilizations that at times independently developed their own understanding and assigned unique meanings to the concept of zero. Along the way a greater understanding will be gained of why it is that this number listed first of all the natural numbers was in fact the last to be invented.

### **The Sumerian Journey**

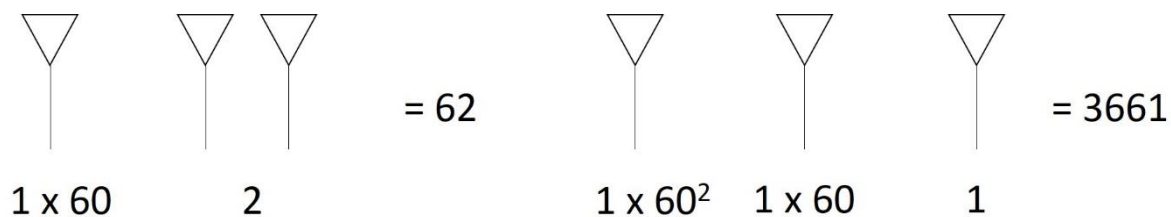
The journey starts with the ancient Sumerians roughly 5000 years ago. Located in the region known as Mesopotamia, this civilization played an instrumental role in the development of reading and writing. The Sumerian writing style involved the pressing of circles and semi-circular shapes into wet clay tablets using the tip of a hollow reed and once written on, these tablets would then be baked for future preservation. The writing style would eventually evolve into wedge-shaped (cuneiform) marks being used with numbers developed as words to refer to the collections of objects (Schmandt-Besserat, 2009). This counting system consisted of 1s and 10s, better known as the base ten system familiar to most and was used to keep track of livestock, agricultural products and trades. Unlike the current popularized base-ten system for counting though the Sumerians also developed a system in which they counted by 60s. Although this might seem peculiar, parallels to their practice

might be drawn to our own tendency to count 60 seconds as a minute and 60 minutes as an hour.

The Sumerian system of writing was eventually adopted by the Babylonians who then went on to develop a very sophisticated method of expressing also large numbers with cuneiform symbols as can be seen in the figure below with the spaces that the symbols occupy being used to give an indication of the value of that number in what is known as a positional value system (Kaplan, 2000).

### Figure 1

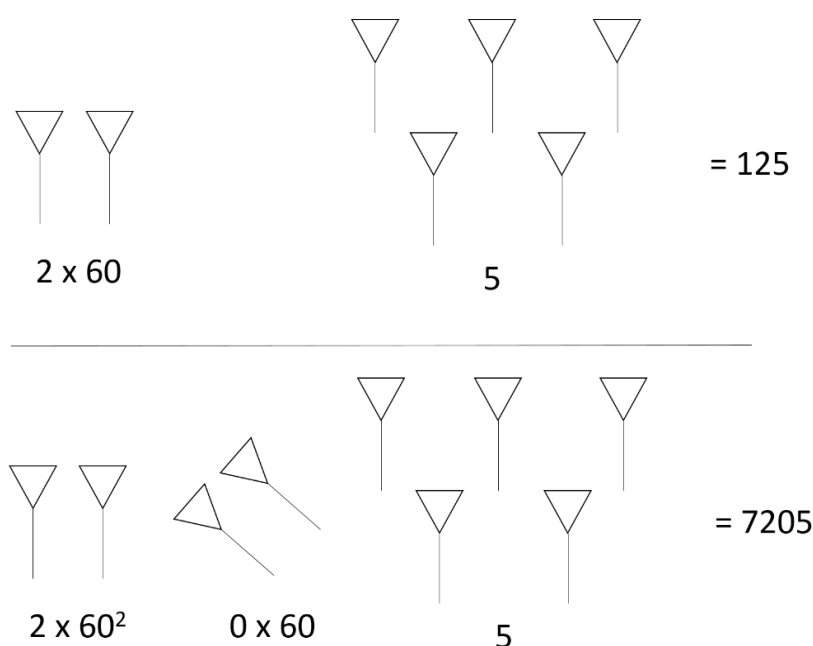
*Sumerian cuneiforms with the inclusion of spaces to indicate to the reader the true value being represented*



Of course, this system was very confusing and the absence or presence of periods between symbols to indicate magnitude were often left to the interpretation of the reader. For that reason, a separate cuneiform symbol was developed to indicate this space or period that should be present between other symbols. Just look at the difference created in the numbers given in Figure 2 when a space is recognized by the use of these new symbols versus when it is left to the reader to decide whether there is a significant space meant to relay information or not.

**Figure 2**

*Sumerian cuneiforms expressing the numbers 125 and 7205*



The sideways symbol inserted between numbers would be recognised as representing an empty column separating symbols. There could no longer be any confusion as to whether there was a space left open on purpose or not. Hook-like symbols were also used to a similar effect and with this, the Sumerian cuneiform writing style developed into a system in which the zero was used as a placeholder in order to give context to the reader of their symbols.

### **The Role of Ancient Greece**

The next step in the journey of discovery into the origin of zero takes us to ancient Greece. One would easily be forgiven for thinking that we probably have the ancient Greeks to thank for the gift of the zero to modern society. They were after all the civilization that gave us the Pythagorean theorem and geometry but an assumption of their almost definite contribution to the concept of the zero would be a mistake. In fact, the Greeks did not make use of a positional system for counting and expressing values although the confusing manner in which they did report large numbers, which was similar to the Roman system, certainly indicated a need for such a concept (Reid, 2017).

However, there is some evidence that zero was used by Greek astronomers as a placeholder in writing and counting numbers but no Greek text exists on the study of the concept itself. Seeing how Greek mathematicians were so revered throughout history, this was considered an oddity by historians. One reason for why the Greeks might not have chosen to explore the concept of zero is that the Greeks were so focused on the study of geometry and outwardly rejected algebraic work that they simply didn't need the concept of the zero (Kaplan, 2000). The example of the difficulty in counting and expressing numbers without zero representing a positional value though contradicts this idea somewhat.

Logan (1979) on the other hand suggests a different reason for the Greek's rejection of zero and argues that it might have had less to do with the mathematical focus of the Greeks and more with the underpinning philosophy engrained in their society at the time. It is well known that the Greeks cultivated a culture of thinking that relied on logical arguments in all areas of inquiry and empirical evidence was valued above all else to explain phenomena. It may thus be that the Greeks found the concept of zero contradictory to their beliefs and as such, were limited in their imagination to comprehend its place in their society. This essentially made it impossible for them to be able to even conceive the idea of the zero.

### **An unexpected development in the Americas**

Next, we take a journey to the Americas for a discovery of zero that took place independently from the rest of the world. Where the Greeks failed to develop their own understanding of zero, the Mayans could perhaps be regarded as having done the opposite. They had not just one but numerous symbols to represent zero (Blume, 2011). What the Mayans were interested in was the counting of time and to that end, they developed several different calendars to mark the passage of time and forecast important dates. The Long Count calendar recorded dates in terms of a zero day and so revered was the number zero that it had

markedly elaborate symboling in comparison to other numbers in use for their calendar. Ornate faces, figures, flowers and shells were all typically found on their manuscripts and monuments (Kaplan, 2000).

Their reverence and highlighting of zero clearly alludes to a deeper devotion to the number than simply being able to use it for its positional value abilities. This argument is reaffirmed when investigating another Mayan calendar, the Haab (Blume, 2011). In this calendar, the first day of each month was numbered 0 instead of the usual 1 most often seen. This day was regarded as the day that the god of the previous month would hand over his duties to a new god (Kaplan, 2000). The Mayans great fear of time ending even saw them assign the name Zero to one of their gods, the god of Death. They had thus developed the concept of the zero not only as part of a counting system but had intricately entwined it into their religion. It could be said that the Mayans had established the idea of counting with zero as part of the very foundation of their culture and religion.

### **It is to India that we owe our Thanks**

The next focal point in the journey through history sees the development of zero as the number we now know it as and not just as a symbol to function as a placeholder in calculations. India gave us our true understanding of the zero with its application in arithmetic (Reid, 2017). It was an unnamed Hindu scholar that was responsible for putting down the first dot he called *sunya* that would later become our zero. The symbol would eventually travel to the western world through Arab merchants that spread the message of the zero to places as far as Russia and China (Reid, 2017). Initially, just used as a mechanical device to indicate an empty space, the mathematician Brahmagupta would end up laying down rules for basic arithmetic involving the number zero around the 7<sup>th</sup> century AD (Boyer, 1944). This is an

important distinction, because for centuries zero was used as just a placeholder, a way to indicate the magnitude of a value when entered in an array of numerals.

Interestingly, it is the contrast of the Indian culture with that of the Greeks that many believe led to the discovery of the concept of zero in India. The concepts of negativity and non-being are regarded as positive attributes in Hinduism and Buddhism and the existence of nothing is considered a positive thing as opposed to the Greeks that simply couldn't come to terms with the existence of nothingness (Kaplan, 2000). They were thus able to extend their reasoning beyond the traditional logical approaches that the Greeks relied on and thus there was no logical obstacle to overcome in order to develop and extend their idea of the zero.

It would then be the mathematician, Fibonacci, after his return to Italy from North Africa that would be responsible eventually for promoting the use of zero throughout the western world (Wallin, 2002). After having being exposed to the Indian number system along with its Arabic symbols, he became acutely aware of its potential to transform the status quo of mathematics at the time into a field that would be more democratized.

However, it was also thanks to the Indian discovery of the zero that we owe its modern name. The Arab word, *sifra* was used as a direct translation from the word *sunya*. This word would eventually reach Italy and France where it would become *cifra* and eventually *cipher*, an old word for zero that is still in use today. The Latin translation of *sifra* is *zephirum*, which is the word that would eventually transform into the word *zero*. Other Latin names for emptiness such as *nulla* and *nihil* would lead to the development of the words often used alongside zero such as naught and null (Kaplan, 2000).



## Conclusion

The journey of zero throughout history to come into its full existence covered all corners of the world. What was intrinsically linked to these different parts of the story was the need that drove the development of the number and concept. In the case of the Greeks, the number wasn't needed and the concept didn't fit their understanding of the world, so no attempt was made to incorporate zero into their society. The Indian story tells a different tale, one of where the need to seek nothingness was a positive trait so entwined in their culture that they were more open to the idea of exploring the concept of zero, which ultimately led to the development of the concept as we know it today.

Vygotsky proposed that human development in terms of psychological growth and historical/ cultural change occurs through the creation and use of psychological tools such as writing and numerical analysis (Haas, 2013). Therefore, humans' ability to have made the mental leap of abstracting the idea of zero as a number created a tool, which we would eventually use to develop the binary code. Without that mental leap, we would not have the tool that powers our algorithmic digital world today that also ultimately has influenced the way we teach, learn and think.

“In the history of culture the discovery of zero will always stand out as one of the greatest single achievements of the human race.” (Dantzig, 2005)

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