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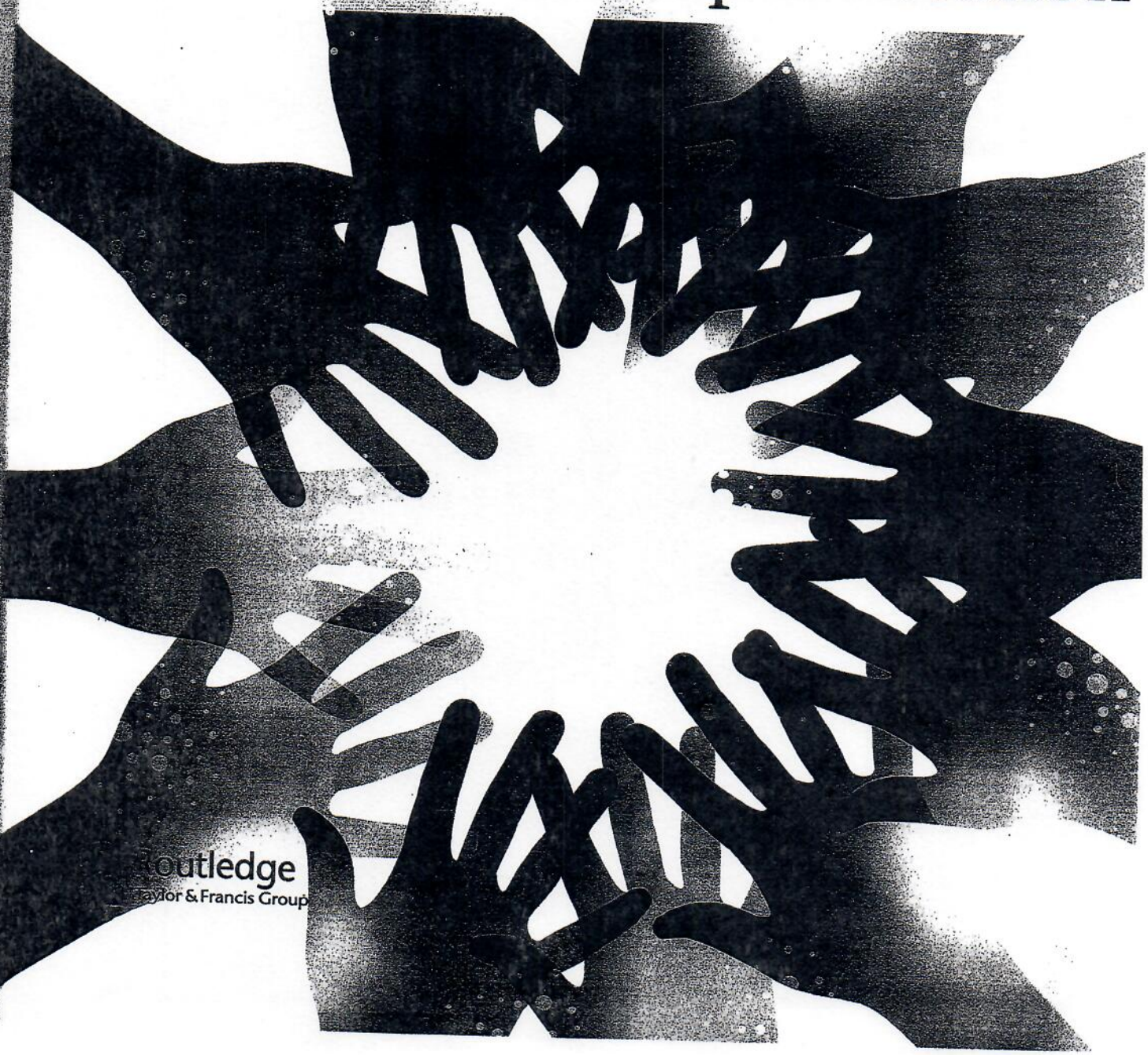

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Exploring Universality: Does the World Really Use the Same Numbers?

by Rebecca Klemm and Rachel Wallace
NumbersAlive!

Arguably one of the most under-appreciated, yet ubiquitous and frequently utilized aspects of modern, globalized society, our number system exemplifies how we are inextricably interconnected. Indeed, without a universal number system, there would be no global collaboration and no global solutions.

Within a global citizenship education framework, we might consider what aspects of our lives and societies can be considered truly universal. It is interesting to consider whether numbers are universal and, if so, how that universality came to be. A short answer is that numbers are universal, *or almost so,* as are other structures of daily life, such as the annual calendar and units of measure. Another intriguing question is why language is not universal. While an in-depth investigation of this issue cannot be done in a short article, we can discuss what the universality of numbers says about our developing nature as global citizens.

Over time, humans have become more globalized as a result of trade, migration, travel, and, recently, the internet. More fundamentally, however, the current global world developed because humans are complex, curious, community-based creatures, capable of adaptation and invention. We adjust the environment to meet our needs. While such adaptation, of course, benefits us in our own lifetimes, as complex thinkers no longer

concerned about daily survival, we can now also consider long-term global consequences.

The development of a universal number system is a wonderful example of how individual cultures evolved—and how their members became global citizens while still maintaining their own historic identities. Early humans communicated via drawings, movement, and story-telling. Language and number systems evolved from these communication strategies. A certain spoken word became associated with a certain picture, both being used to represent a specific thing, such as a horse. To distinguish characteristics, if important, the pictures needed to become more complex: two horses, large and small horses, male and female horses, etc. Picture communication was beautiful but time-consuming and so we humans developed writing systems to more efficiently communicate our messages. Numbering and counting systems also developed, but these systems, unlike languages, were eventually standardized to become almost universal.

The Evolution to the Current Base 10 Place Value System

Trade within the increasingly connected world necessitated a system that allowed measuring and counting across language barriers. The current base 10 place value system evolved to meet this need. It is used almost universally, or at least by every country that trades in the international markets. This system evolved as global cultures met and mingled, and their various number systems were necessarily adapted to allow for more precise communication.

Early number systems were visual and emphasized quantity by observation. These systems started by drawing a numeral glyph, or symbol, as one vertical segment, horizontal segment, knot, or symbol. Symbols for 2 and 3 were drawn as repeats of a mark for 1. The "one, two, many" theory suggests that some cultures developed words for "one" and "two" before anything else, and any amounts greater than two were simply referred to as "many." For a family or small tribe, differentiation among only small quantities was sufficient (some aboriginal tribes in the Amazon may still use a numbering system like one-two-many). As human communities grew and lifestyles became more complex, a continual series of dots and dashes was hard to read quickly and consistently. The glyphs therefore evolved to accommodate human needs and physical limitations.

One well-known ancient system still in use today is Roman numerals. Roman numerals are visual, "picture," glyphs that describe quantities and dates. In this system, 1 is a vertical line (I) and 2 is two vertical lines (II). Rather than merely continuing with vertical lines *ad infinitum*, however, special glyphs were developed to represent 5 (V), 10 (X), 50 (L), 100 (C), 500 (D), etc. Subtraction was later introduced as another strategy to shorten the writing: 4 was written as IV (representing 5 minus 1), 9 was written as IX (10 minus 1), and 499 was written as ID (500 minus 1). The currently used Roman numeral glyphs are not necessarily the same as when the system began. It was adapted over time to simplify

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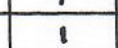
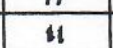
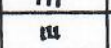
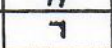
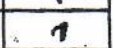
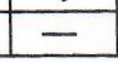
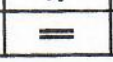
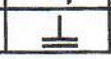
Modern Glyphs	1	2	3	4	5	6	7	8	9	10
Roman	I	II	III	IV	V	VI	VII	VIII	IX	X
Incan Quipu*										see below
Babylonian										
Egyptian										
Chinese										see below

Figure 1. Roman, Incan Quipu, Babylonian, Egyptian, and Chinese early number systems.

* There are two possible variations for 1. The other is: 

Many number systems have been lost to history but others, like the Chinese, remain, with some evolutionary changes. The Incan Quipu system was a primitive place value system; when 10 was reached, the knot counting started over with an empty space between the 1s, 10s, 100s, etc. The Chinese system was also a primitive place value system; these glyphs represent ivory or bamboo rods that were placed in a checker board-like "counting board." The right-most column represented the ones, the next column to the left represented the tens, etc. The Babylonian system was a base 60 primitive place value system, which is the historical basis of our 60 min/hr, 60 sec/min, and 360 degrees in a circle.

the way it was written and accommodate an ever-growing and more complex "global community." Such adaptations, and the meeting and comingling of various systems, eventually led to our current universal number system.

Different elements of the current base 10 place value system originated in different societies. While these global cultures developed independently and in isolation from each other, some important similarities can nonetheless be noted. All early numbering systems were based on counting, as numerical communication involved building temples, houses, and roads; measuring distances; and dividing crops for work payment. Most systems began with a 1 and continued along a "number line," easily adapted to a measuring tool. Few cultures had an official zero, no matter what the "base" of the system. Eventually, it became clear that a simplistic picture-based counting system was inadequate for situations involving larger sums and numbers. Commerce and development required a way to easily distinguish 60 from 360 in a base 60 system, for example, or 10 from 100 in a base 10 system. The earliest solutions involved symbols, such as commas (Babylon) or blank counting rods (China), to represent a primitive form of place value. While Mayans were interested in elapsed time, and so their numbering system included a zero (0) as a starting point, assigning 0 the critical role in a place-value system did not come until much later.

Where Did "Arabic Numerals" Come From?

When did the world switch from these ancient systems to the contemporary numerals used today? The introduction of the printing press in the mid-1500s led to a "standard" set of numeral glyphs. Some countries or tribes do still write the numerals 0-9 slightly differently, as if writing with different dialects. Like an American speaking to a British citizen, these differences (such as a long-angled 1 or a cross on the "body" of a 7) rarely impede understanding.

Our current numerals are often called "Arabic" or "Hindu-Arabic" numerals, but their history is actually rather complicated and multi-cultural. Most historians believe the current numbers, and the origin of a place-value zero (0), come from India (most often attributed to the Brahmi system).[1] Much of Europe was confused by the concept of nothing, and left it out of their formal counting systems. It was not necessary to define zero until trade required the ability to denote quantities "ordered but not yet delivered" or of poor quality. Statements of debt and IOUs could only be written in text until the introduction of zero and negative numbers provided a numerical notation. As prominent world traders, Arabs spread the concept of Hindu/Brahmi numerals around the world, often referred to as Hindu-Arabic numerals.

Why was the system from India adopted widely, rather than Roman numerals or another ancient number system? Accountants and other record-keepers desired a system that was less time-consuming to write and a place value system "fit the bill." Earlier systems may have been nice for visual communication, but were time-consuming to learn and write and difficult to use for arithmetic.

As various countries, tribes, and other groups of humans joined the evolving global economy, they adopted the Hindu-Arabic numeral system. This now universal system simultaneously allows for global communication and retains a lot of evolving human history, evident in its various components. If a country, tribe, or group decides to remain independent, as many in the

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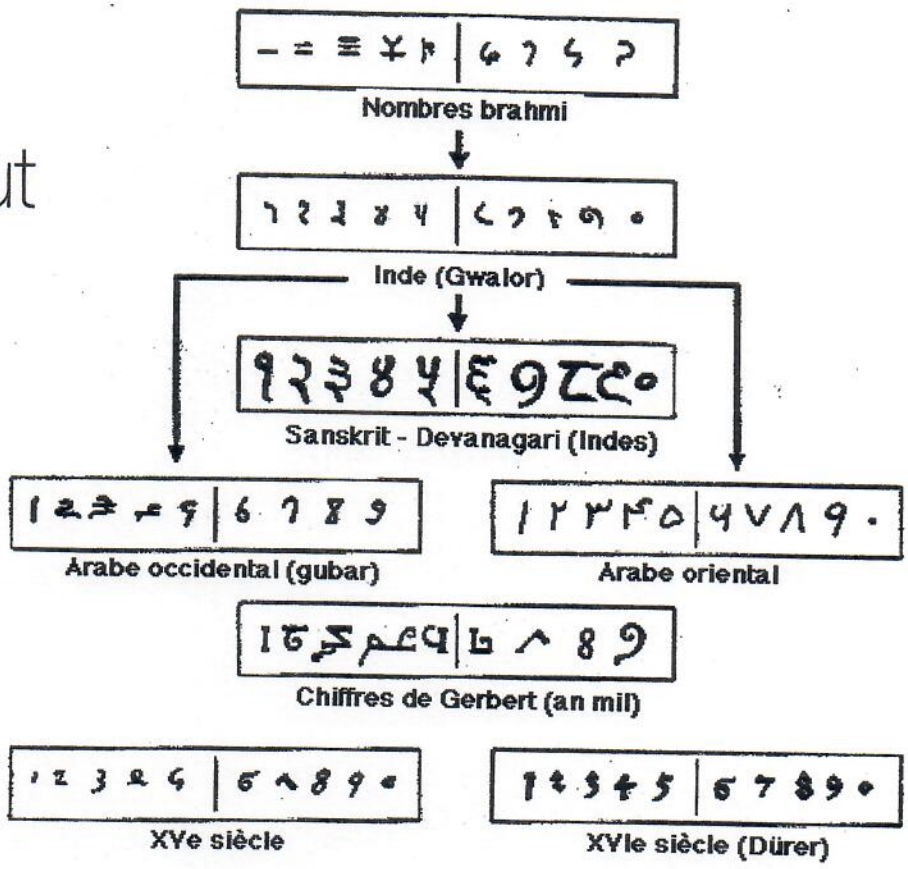

Figure 2. Evolution of Brahmi numeral system to modern glyphs

Amazon have, they do not need to adopt this system. However, participation in global trade demands adoption of the system to facilitate and provide consistency in trade. Although we do not have a universal language (yet) to describe all products traded, specific quantities and measurements are identified using the now-standard Hindu-Arabic numerals.

How Do We Display and Explain the Universality of Numbers?

As Dr. Rebecca Klemm travels the world speaking about the meaning of numbers, she is often asked if all countries really use the same numbers. When she realized that many educators and parents did not realize or understand the universality of numbers, she was inspired to create a learning tool to illustrate how one system of numbers is used worldwide and thus serves as a powerful example of an organically developed global agreement.

She developed a poster for educators that showed the universality of the numeral glyphs 0-9, and how they are written in the major languages of the world. This resource illustrates visually that we all use the same numerals/number system, and also highlights that we write them slightly differently in each individual language, or language family.

The poster includes languages from each continent (other than Antarctica), those that

contributed most to world trade and those that were spoken and/or written by the greatest portions of the global population. Identifying which languages to include was difficult, as there are literally thousands of languages spoken and/or written around the world, with about one-third of them spoken by 1,000 people or fewer.

In the center section of the poster, 28 currently spoken languages are listed, providing a visual demonstration of the variability of written languages in describing one concept. The languages are grouped into:

- The six official languages of the United Nations (English, French, Spanish, Mandarin Chinese, Russian, and Arabic)
- Other languages spoken/written across all continents
- Visual and kinesthetic languages (American Sign Language, maritime signal flags, and die-cut braille all "viewers" can engage with)
- Computer language (i.e., binary or base two)
- Two "constructed" languages: Esperanto and Klingon.[2]

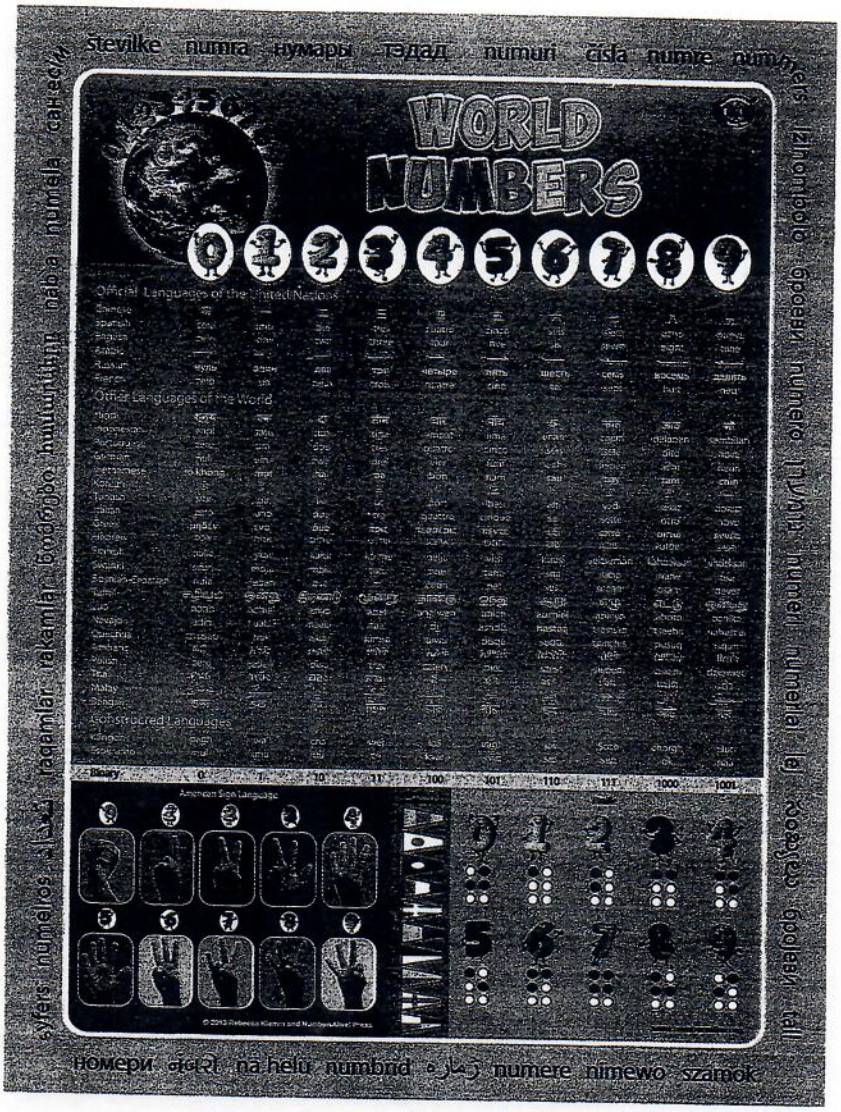

Figure 3. World Numbers Poster © Rebecca Klemm and NumbersAlive! Press 2013

When multiple languages use the same glyphs for the numbers, one language is included as a representation of the language family (e.g., Mandarin, Cantonese, and Japanese are represented by Chinese). Along the border of the poster, the word "numbers" is translated into 36 other languages.[3]

Why Should We Discuss and Teach the Universality of Numbers?

The universal nature of the world's "standardized" number system is an important aspect of modern, globalized society for many reasons. It is a valuable and prominent example of an important system that was created through international cooperation, whether intentional or not. The system we use today was developed

over time, as societies developed and began to interact with each other. The story of humankind's journey from isolated communities into a global society is important to learn and teach in order to encourage future generations to understand the importance of and continue to pursue international trade and other relationships. The history of our modern number system also demonstrates that no non-protected societies exist in isolation. Given the ease and popularity of travel and communication today, in addition to the continued importance of international trade, it makes even more sense to tap into the different experiences and insights of various cultures and peoples as we continue to improve global society.

In addition, understanding the history of our universal number system can contribute to discussions about how ideas are shared and transmitted. This article examined trade as a catalyst for globalization of the "Arabic" numeral system, but trade was not the only way ideas were spread. Historically, conquest and colonization also played a role, as have religious missionaries. Even today, as we develop new and easier ways to communicate and travel, we are really developing new and easier ways to spread ideas, practices, and perspectives that are already leading to new projects that would have been inconceivable without such collaboration.

In conclusion, the universality of our number system offers proof that we are all inextricably connected. It is important to recognize this so that we and future generations can take advantage of the possibilities that international collaboration opens up.

Questions for Further Discussion:

1. What else can you think of that was influenced by multiple cultures/societies? Alternately, what *hasn't* been influenced by multiple cultures/societies?
2. How would the world be different if we didn't have one universal number system? How would it be different if we all adopted Esperanto?
3. Why did the attempt to create a universal language fail while a universal number system appeared to develop organically?
4. What projects require collaboration to be usable/best form, either at a personal or global level?

Notes:

[1] Read about some new findings regarding the history of the zero symbol https://www.theguardian.com/science/2017/sep/14/much-ado-about-nothing-ancient-indian-text-contains-earliest-zero-symbol

[2] Esperanto was developed by Polish-Jewish ophthalmologist L. L. Zamenhof and first published in *Unua Libro*, on 26 July 1887. It is the most widely spoken constructed language in the world. Klingon was fully developed for the science fiction franchise *Star Trek*, as an alien-sounding language and was fully described in the 1985 book, *The Klingon Dictionary*, by Marc Okrand.

[3] Slovenian, Albanian, Belarussian, Tajik, Latvian, Czech, Danish, Dutch & Flemish, Zulu, Macedonian, Filipino, Yiddish, Latin, Lithuanian, Hmong, Telugu, Serbian, Norwegian, Hungarian, Haitian Creole, Romanian, Kurdish, Estonian, Hawaiian, Gujarati, Ukrainian, Afrikaans, Galician, Persian/Farsi/Dari, Uzbek, Turkmen, Georgian, Armenian, Kikuyu, Samoan, Kazakh.