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MAT 139 Demonstration: The History of the Hindu-Arabic Number System

Introduction

As we've discussed in class, we use the Hindu-Arabic number system because it proved to be the most simple and efficient. Compared to other number systems, it has fewer symbols—all possible numbers can be represented using 10 symbols—and the decimal place value system is much easier for performing computations. We call it the Hindu-Arabic number system because it originated in India, but came to Europe through the Arabs.

History

The history of mathematics not only spans thousands of years, but the globe as well. "It belongs in a tradition that began in the Ancient Near East, then developed and grew in Ancient Greece, India, and the medieval Islamic Empire. Later this tradition found a home in late-Medieval and Renaissance Europe, and eventually became mathematics" (Berlinghoff & Gouvea, 2002, p. 5) as we know it today.

Although one cannot ignore the mathematical contributions of the Mayans, Egyptians, Babylonians, Chinese, Greeks and Romans, much of the world uses the Hindu-Arabic number system and we must therefore focus on its development in India and the Islamic Empire. During the Dark Ages of Europe and the Islamic Empire's expansion, mathematical tradition was flourishing in India, influenced by Babylonian and Greek astronomy, and possibly China as well. By 600, the Indians were using a place-value system based on powers of ten, with nine symbols for the numbers 1 to 9 and a dot or small circle to signify an empty space. In 628, Brahmagupta defined zero as the result of subtracting a number from itself (O'Connor & Roberston, 2000). The new number system spread to Syria, Cambodia, and China, and by the 9th century, it was known in the Islamic Empire capital of Baghdad. According to Berlinghoff & Gouvea (2002), much of what we know about the Indian number system came to Europe through "Baghdad and the Arabic mathematical tradition" (p. 28).

As the Islamic Empire was growing in size and power, the House of Wisdom was founded and members began collecting and translating Greek, Sanskrit and Indian texts. "Not all of the great mathematicians writing in Arabic were ethnically Arab, and not all of them were Muslim," but the common language of the Islamic Empire was Arabic, and its use throughout the empire was essential to the spread of mathematical ideas. This common language allowed them to build upon each other's work, "creating a new and vital mathematical tradition that was active from the 9th to the 14th centuries" (p. 29).

A member of the House of Wisdom, Muhammad Ibn Musa Al-Khwarizmi (also written al-Khuwarizmi and al-Khowarizmi) wrote several influential books and is considered the father of algebra. First, he translated and explained the Indian decimal place value system for writing numbers and doing arithmetic. The Arabic text, written circa 820, did not survive and is only known through a Latin translation written in the 12th century (Ibn Labban, 1965, p. 3), which was a source from which Europeans gained much knowledge of the Hindu-Arabic numerals. The term "algorism" came to mean computation with Hindu-Arabic numbers because Latin texts used the phrase "dixit Algorismi," or "so says Al-Khwarzimi" (Berlinghoff & Gouvea, 2002, p. 33). Al-Khwarizmi also wrote a book of "al-jabr w'al-muqabala" (which roughly means "restoration and compensation" or "transposition and reduction"); this work includes discussion of the quadratic equation. Although it is known that Al-Khwarizmi gained knowledge about the decimal number system from India, it is possible that concepts in his algebra book came from multiple sources, including India, Hebrew mathematics and "native Mesopotamia tradition" (p. 30).

A huge conceptual leap was made in the 9th century by the Hindus. They concluded that *sunya*, the absence of quantity (empty space or zero), was actually a quantity. Al-Khwarizmi had considered

zero a placeholder and not a number. But, circa 850, Hindu mathematician Mahavira wrote that a number multiplied by zero results in zero, zero subtracted from a number left the number unchanged, and a number divided by zero also remains unchanged. Circa 1100, mathematician Bhaskara, revised the latter fact and declared that a number divided by zero was an infinite quantity (p. 72).

The oldest surviving Arabic work using Hindu numerals in algorisms is Kushyar ibn Labban's *Kitab fi usul hisab al-Hind*, (translated: *Principles of Hindu Reckoning*). Written circa 1000, it includes nine numeral symbols and a circle for zero. There were, of course, other mathematicians in the Islamic Empire who contributed to the continued use of Hindu-Arabic numerals, and the growing contact between Europe and the Islamic Empire through trade led to the dissemination of information beyond the Arab and Hindu worlds.

Leonardo of Pisa (also known as Fibonacci) traveled with his father, a trader, and learned about Arabic mathematics. His first book, *Liber Abbaci* (translated: *Book of Calculation*), was published in 1208 and revised in 1228; most importantly, this work explained the Hindu-Arabic number system to Europe. But, "despite its simplicity and efficiency, [this] method of writing numbers did not displace . . . the Roman numeration system in Europe for many centuries" (p. 66). More specifically, Yong (1996) stated that assimilation of the Hindu-Arabic numeral system and its associated computations occurred between 1200 and 1600. Europeans eventually realized that it was easier to compute with Hindu-Arabic numbers and the availability of cheap paper also helped the new symbols catch on. The invention of moveable-type printing in the 15th century standardized the ten symbols; by the early 17th century, the Roman system had been replaced by the Hindu-Arabic system in Europe for writing numbers, and algorithms for simple arithmetic using the new system had been developed.

The use of the Hindu-Arabic numerals and positional notation has become so prevalent in the modern world that it is difficult to imagine what mathematics would be like without it. Banking, accounting, and capitalism in general could hardly be possible without a system that allowed the expression of large numbers in compact form and the easy calculation of interest.

Quiz Question: How was the Hindu-Arabic number system introduced to Europe?

Test Question: Why is the Hindu-Arabic system preferred over the system of the Babylonians, the Romans, or the Chinese?

References

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