

Activity 193.

Read the article. Review your answers to the quiz in Activity 192.

Mathematical historians of today are grateful to the Arabic scholars of the past for preserving, translating, and honouring the great Indian, Greek, and Islamic mathematical works of the scholars before them, and for their own significant contributions to the development of mathematics. At the end of the 8th century, with the great Library of Alexandria destroyed, Caliph al-Ma'mun set up a House of Wisdom in Baghdad, Iraq, which became the next prominent centre of learning and research, as well as the repository of important academic texts. Many scholars were employed by the caliph to translate the mathematical works of the past and develop further the ideas they contained. As the Islamic empire grew over the following seven centuries, the culture of intellectual pursuit also spread. Many scholars of 12th-century Europe, and later, visited the Islamic libraries of Spain to read the texts of the Arabic academics and to learn of the advances that had occurred in the East during the dark ages of the West. A significant amount of mathematical material was transmitted to Europe via these means.

One of the first Greek texts to be translated at the House of Wisdom was Euclid's famous treatise, "The Elements". This work made a tremendous impact on the Arab scholars of the period, and many of them, when conducting their own research, formulated theorems, and proved results precisely in the style of Euclid. Members of the House of Wisdom also translated the works of Archimedes of Syracuse, Diophantus of Alexandria, Menelaus of Alexandria, and others, and so they were certainly familiar with all the great Greek advances in the topics of geometry, number theory, mechanics, and analysis. They also translated the works of Indian scholars, Aryabhata and Bhaskara, for instance, and were familiar with the theory of trigonometry, methods in astronomy, and further topics in geometry and number theory. Any Arab scholar who visited the House of Wisdom had, essentially, the entire bulk of human mathematical knowledge available to him in his own language.

The Arab mathematician Muhammad ibn Musa al-Khwarizmi (ca. 800) wrote a number of original texts that were enormously influential. His first piece simply described the decimal place-value system he had learned from Indian sources. Three hundred years later, when translated into Latin, this work became the primary source for Europeans who wanted to learn the new system for writing and manipulating numbers. But more important was al-Khwarizmi's piece "Calculation by Restoration and Reduction", from which the topic of algebra arose. Al-Khwarizmi was fortunate to have all sources of mathematical knowledge available to him. He began to see that the then-disparate notions of "number" and "geometric magnitude" could be unified as one whole by developing the concept of algebraic objects. This represented a significant departure from Greek thinking, in which

mathematics is synonymous with geometry. Al-Khwarizmi's insight provided a means to study both arithmetic and geometry under a single framework, and his methods of algebra paved the way for significant developments in mathematics of much broader scope than ever previously envisioned.

The mathematician al-Mahani (ca. 820) developed refined approaches for reducing geometric problems to algebraic ones. He showed, in particular, that the famous problem of duplicating the cube is essentially an algebraic issue. Other scholars brought rigour to the subject by proving that certain popular, but complicated, algebraic methods were valid. These scholars were comfortable manipulating polynomials and developed rules for working with exponents. They solved linear and quadratic equations, as well as various systems of equations. Surprisingly, no one of the time thought to ease matters by using symbols to represent quantities: all equations and all manipulations were described fully in words each and every time they were employed.

With quadratic equations well understood, the scholar Omar Khayyam (ca. 1048–1131) attempted to develop methods of solving degree-three equations. Although he was unable to develop general algebraic methods for this task, he did find ingenious geometric techniques for solving certain types of cubics with the aid of conic sections. He was aware that such equations could have more than one solution.

In number theory, Thabit ibn Qurra (ca. 836–901) found a beautiful method for generating amicable numbers. This technique was later utilized by al-Farisi (ca. 1260–1320) to yield the pair 17,296 and 18,416, which today is usually attributed to Leonhard Euler (1707–83). In his writing, Omar Khayyam referred to earlier Arab texts, now lost, that discuss the equivalent of Pascal's triangle and its connections to the binomial theorem. The mathematician al-Haytham (ca. 965–1040) attempted to classify all even perfect numbers.

Taking advantage of the ease of the Indian system of decimal place-value representation, Arabic scholars also made great advances in numeric computations. The great 14th-century scholar Jamshid al-Kashi developed effective methods for extracting the n -th root of a number and evaluated π to a significant number of decimal places. Scholars at the time also developed effective methods for computing trigonometric tables and techniques for making highly accurate computations for the purposes of astronomy.

On a theoretical note, scholars also advanced the general understanding of trigonometry and explored problems in spherical geometry. They also investigated the philosophical underpinnings of geometry, focusing, in particular, on the role the famous parallel postulate plays in the theory. Omar Khayyam, for instance, attempted to prove the parallel postulate — failing, of course — but did accidentally prove results about figures in non-Euclidean geometries along the way. The mathematician Ibrahim ibn Sinan (908–946) also introduced a method of “integration” for calculating volumes and areas following an approach more general than that developed by Archimedes of Syracuse (ca. 287–212 B.C.E.). He also applied his approach to the study of conic sections and to optics.

(by James Tanton, from Encyclopedia of Mathematics)