Denny Weber

8 November 2013

Arab Contribution to Mathematics

In this research paper I will explore the Arab Contribution to Mathematics. I will do this by discussing the Islamic Religion and Empire as well as the main mathematical figures as it pertains to the Arab world. I will go into some depth about the historical context as it relates to Islam and the Islamic Empire. The peculiar Arab interest with the Greek influence on mathematics will also be touched. My aim for this paper is to shed some light as to why the Arabs were influential to the world of mathematics and also discuss the contributions of the key men and women Arab mathematicians.

The year 622 A.D was when the Prophet Muhammad left Mecca and sought asylum in Medina, which is approximately 350 kilometers away from Mecca (Gheverghese 301). In or around 750 A.D., the Islamic Empire was at the peak of its influence in the world. Baghdad had a strong reputation as a huge intellectual center during the years 800-825 A.D (Gheverergheese 301). There have been many theories as to why the Arabs had such a huge influence on mathematics. One possible explanation was the two distinct caliphs, or groups of men who were universally seen as the mortal successors of the Prophet (Gheverghese 301). These powerful men were either Umayyads, the ruler of the East, who up until 750 were in control and then were overthrown and their power was inherited by the Abbasids.

The year 750 A.D. is generally regarded as the peak of the Islamic empire because under the Umayyads, unlike the more racist Abbasids, the empire was more welcoming and tolerant of

people from different cultures and ethnicities and therefore was able to get more converts from many groups (Gheverghese 302). Also in or around 750 A.D. the Islamic empire stretched all the way from the west portion of India to a portion of Spain. When the Abbasids first came into power one of the first actions was to build a new imperial capital, whose location was a natural one where east and west could meet (Boyer 28). The Abbasid caliphs took a more deliberate action to the intellectual growth of the Islamic/Arabic Empire (Boyer 29). The Abbasid caliphs discovered the House of Wisdom, an academy of science, gathered scholarly papers in Greek and Sanskrit and found scholars who could understand them. Over the upcoming years Greek and Indian math was studied in large part due to the beneficial influence of the Arab led Academy of Science (Boyer 30).

The first Greek text to be translated was Euclid's Elements. Arab mathematicians formulated theorems precisely and proved them in Euclidian time (Berlinghoff 30). During the Middle Ages, the Islamic world represented fertile ground for both mathematical development and the preservation of ancient mathematical knowledge (Boyer 53). An important event that helped shape this era in mathematical history was the establishment in 766 A.D. of the city of what is known in the 21st century as Baghdad (The capitol of what is now Iraq).

The Arabs were very interested, almost infatuated with the Greeks. "The philosophers of Islam admired Aristotle to the point of aping him, but eclectic Mohammadean mathematicians seem to have chosen appropriate elements from various sources" (Boyer 208-209). Arabic scholars had great admiration for Greek astronomy, mathematics, medicine and philosophy (Boyer 208). One, if not the most renowned Arab mathematician, was al-Khwarizimi. Al-Khwarizimi's system of performing certain mathematical functions (i.e. enumeration) were likely derived from India, his performance of Algebra and algebraic system equations may have

come from the Mesopotamia land, and perhaps his most beloved development, the "…geometric framework for his solutions was palpably derived from Greece" (Boyer 210).

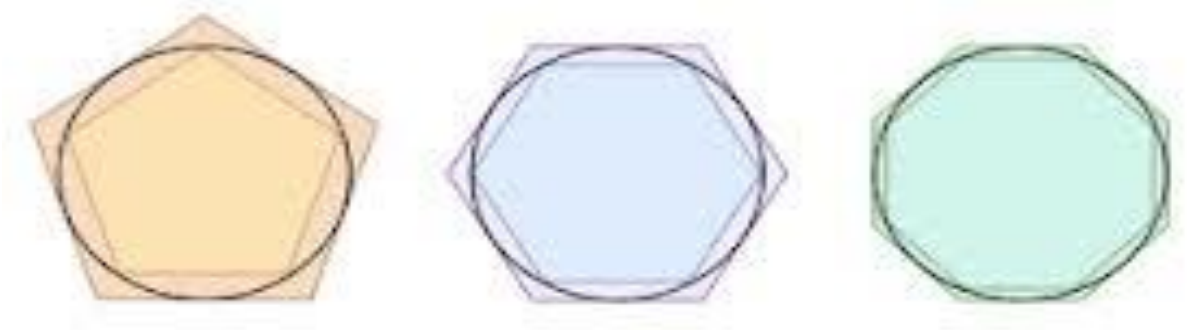
The main mathematical figure of the Arabic Empire is undoubtedly seen as Al-Khwarizimi. One of my possible choices majors when I attend a state university next year is the Bachelors of Arts in Film Studies. To parallel my interest with film and the task of writing this paper, I believe it would be a fair comparison to say that Al-Khawarizimi was to the world of Arab math what Steven Spielberg was to the world of film in the 21st century. Just as Spielberg directed critically acclaimed films (Schindler's List) as well as box-office hits (Jurassic Park), Al-Khwarizimi had key influence on Arab Caliphates. A caliphate is an Islamic state led by a religious or political leader known as a caliph. His mathematical texts were vital to Arabs because they contain vital legal language using algebra and analysis of property relations and the distribution of inheritance according to Islamic law, and rules for drawing up wills (Gheverghese 307).

Another influential Arab mathematical figure was Abul Hassan Thabit ibn Qurra Marwan al-Harranti. Thabit belonged to a religious sect that were descendants of Babylonian star-searchers whose possession of sacred books were recognized by the Quran and had a great devotion to mathematics. His contribution to mathematics included a rule for discovering pairs of 'amicable numbers' proofs on spherical trigonometry, and contributions to the mensuration of parabolas and paraboloids (Gheverghese 308).

Omar Khayyam's contribution to mathematics was in geometry and the theory of proportions. Khhayam, like his other Arab mathematician colleagues, very much liked the Greeks and this theory is a good example of "… how he and other Arabs mathematicians

absorbed and the reinterpreted Greek geometry" (Gheverghese 309). Ideas like these were transmitted by the respected Persian mathematician Nasir al-Din al-Tusi to "European mathematics that provided the impetus for a more rigorous examination of the concept of real numbers" Gheverghese 310). Another contribution by Khayyam was the concept of zero. Gheverghese states that Omar's aim was to enhance the concept of zero so that "to include positive irrational numbers" (Gheverghese 310). One example of how this is used is in decimals, because in decimal expansion an irrational number does not repeat itself or end like in an rational number. A decimal, in the decimal numeral system has ten as its base. An integer is a number that can be written as numbers without a fraction or decimal. An example is: -2, 0, or 4. But 0.75 would not be an integer. A rational number is any number that can be made by dividing one integer by another. 0.75 is an example of this. The word comes from "ratio". An irrational number is any real number that cannot be a ratio of a and b, where a and b are integers.

Another main mathematical figure is Jamshid al-Kashi. Kashi's main contribution was in large calculations. His approximation for π, correct to 16 decimals, was found by circumscribing a circle by a polygon having 3 x 2 to the 28^{th} (805 30 368) sides (Gheverghese 311). In the diagram, the yellow, light blue and green portions outside of the black circle are the circumscribed portions. The yellow, light blue, and green portions inside of the three black circles are the inscribed portions.



In this example, circumscribe means to draw (a figure) around another, touching it at points but not cutting it. Notice the more sides of the polygon, the closer the perimeter of the polygon is to the circumference of the circle. Also the more sides the polygon has, the closer the area of the polygon is to the circle's area. His most well-known book, titled Miftah al-hisab (The Calculator's key), which he finished in the year 1427, contributed to the world of mathematics an overview, or 'greatest hits' of the best of Arab arithmetic and algebra. In *Miftah* the first systematic exposition of decimal fractions is discussed. Also a solution of a cubic equation to get a value for the sine of one degree is included in Kashi's book (Gheverghese 311). The Timurid ruler and mathematician recognized Jamshid al-Kashi's achievements, calling him "the admirable Mullah known among the famous of the world, who had mastered and completed the science of the ancients, and who could solve most difficult questions" (Gheverghese 311). The Arabs had other impacts of mathematics well before this time.

The concept of zero was first introduced in Mesopotamia sometime before 1600 B.C. (Berlinghoff 79). Zero's early use was as a placeholder by the Babylonians. An Arabic contribution to mathematics was that the Arabs learned ten place value system invented by the Hindus and the Arabs spread this learned system to Europe in the next couple centuries that came. So the Hindus were the ones who developed the base-ten place value system but it was the Arabs whose influence spread this vital mathematical idea in Europe. The base-ten place value system refers to the numbering system in common use. For example, the number 531, the 1 is in the one's place, the 3 is in the tenth's place, and the 5 is in the hundredth's place. Each number is 10 times the value of the number to the right of it, which it is why it is called base ten. The numbers carry on in this sequence: 100, 10,1,0.1,0.01,0.001, etc.

The mathematical discipline of algebra was discussed in al-Khrawizmi's key work *Algebra,* a work which is unfortunately more than halfway missing of the original Arabic draft (Boyer 207). In this work al-Kharizmi introduces the six types of algebraic equations composed of the three kinds of quantities: roots, squares, and numbers (i.e., x, x squares, and real numbers) (Boyer 207). The root of a number is x is another number, which when multiplied by itself a given number of times, is equal to x. A square is a four-sided regular polygon, or shape, with all four sides equal and all inside angles being ninety degrees.

The mathematical concept of Arithmetic was influential because of Al-Khwarizmi's book De numero Indorum. Sadly, the original version of this book has been misplaced, and as of this year has still not yet been found. In De numero Indorum, "al-Khwarizmi gave so full account of the Hindu Numerals that he is probably responsible for the widespread but false impression that our system of numeration is Arabic in origin" (Boyer 206). This book was important because Al-Khawrizmi gave an extremely detailed explanation of the use of Hindu numerals that most scholars agree is probably responsible for spread of algorithms which now means "any rule, procedure, or operation, such as the Euclidean way of finding the greatest common divisor" (Boyer 206).

So in conclusion the Arab people had a huge and lasting influence on the world of mathematics because they transported key theories of the trigonometry of the sine, the base 10 place value system, approximation of pie by the circumscription of polygons, as well as the concept of zero to Europe and also because of Al-Khwarzimi's lasting contribution in algebra and arithmetic. As a student, the research and time spent writing this paper have enlightened me to the Arab contribution of mathematics and I hope whomever reads this is also intrigued and is perhaps inspired to look closer into what the Arabs did for the vast world of mathematics.