Journal of Humanistic Mathematics

Volume 15 | Issue 2 July 2025

Let's Teach More Accurate and Inclusive History! The Case of Islamic Contributions to Mathematics and Science

Nuh Aydin
Kenyon College

Recommended Citation
Nuh Aydin, "Let's Teach More Accurate and Inclusive History! The Case of Islamic Contributions to Mathematics and Science," *Journal of Humanistic Mathematics*, Volume 15 Issue 2 (July 2025), pages 340-362. DOI: 10.5642/jhummath.THPK8014. Available at: https://scholarship.claremont.edu/jhm/vol15/iss2/19

Let's Teach More Accurate and Inclusive History! The Case of Islamic Contributions to Mathematics and Science

Nuh Aydin

Department of Mathematics & Statistics, Kenyon College, Gambier, Ohio, USA
aydinn@kenyon.edu

Synopsis

Schools commonly teach a history of mathematics and science that is Eurocentric. This selective version of the history of science, called Classical Narrative by some, is rooted in colonial times and mindset, and has reinforced certain negative opinions about other cultures. It ignores or downplays contributions to mathematics and sciences from non-western civilizations, and falsely attributes many scientific discoveries to European scholars. Medieval Islamic Civilization, which had strong connections to Renaissance Europe, serves as a clear example of how this narrative is distorted. Based on research on primary sources since the middle of the 20th century, we now know that some of the most fundamental notions of modern mathematics and science come from the medieval Islamic Civilization. Moreover, modern researchers also discovered that Islamic science was influential on Renaissance scholars. However, these facts are generally not known and there is a significant disconnect between the most accurate academic knowledge on the subject and what is being taught, or not taught in schools. Despite the passage of many decades, accurate knowledge based on primary source research has not become common knowledge or part of the school curricula. Based on my personal journey into the field, academic research on primary sources, and discovery of a global story, I draw attention to what needs to be done in this area, and invite the larger community to help develop strategies to contribute to efforts to decolonize the curriculum.

Keywords: history of mathematics, history of science, Eurocentrism, decolonizing the curriculum, inclusive pedagogy

1. Introduction

I am a mathematician whose primary area of research is algebraic coding theory. I recently became interested in history of mathematics, especially in the Islamic World. Though I was born and raised in a Muslim majority country, I was largely unaware of the many profound contributions of the medieval Islamic civilization[1] to mathematics and sciences. This is not an isolated situation. Most people simply do not know about these contributions. Some vaguely know a few things about the subject but it is often mixed with false information such as "Muslims invented zero" (this is a very popular but false conception). On the other hand, perhaps as an overreaction to marginalization, some tend to exaggerate Islamic contributions to mathematics and science. The main reason for this state of affairs is the fact that Islamic contributions to sciences are generally not taught in schools. This is true in the West as well as the Islamic world.

Until I read the book *Islamic Science and Making of the European Renaissance* by George Saliba [37], I was not aware of the larger picture regarding the narrative of global history of science and mathematics and the problems associated with it. I was not aware that mathematics and science produced by the medieval Islamic Civilization were highly influential on the European Renaissance. I also did not know why the legacy of Islamic science was so

[1] In the following, I will be using the term "Islamic Civilization" (and occasionally more specifically the term "medieval Islamic Civilization") in a very broad sense. In my use, these terms refer to the medieval Islamic civilization for which the time period extends approximately from late 7th century to the 16th century (inclusive). Geographically, this spans a large region — from Spain in the west to China, and India in the east. Therefore, the term encompasses much diversity in terms of languages, ethnicities, and cultures. It also contains many different political powers and organizations (such as Umayyads, Abbasids, Fatimids, al-Andalus, Seljuks, Ottomans, Safavids, The Mughal Empire and others). Medieval Islamic Civilization was ethnically and religiously highly diverse, and individuals from many different backgrounds contributed to scientific knowledge and progress; being a Muslim was not a prerequisite to participate in knowledge production. Arabic was the language of science during this time period, as it was the language of religious studies. In short, I use the term in a very broad sense and in no way imply a monolithic culture or civilization.

neglected and forgotten. My research in this field reveals that my personal story is a reflection of a much larger global story, and it demonstrates the need to change the way history of mathematics and science is taught. It needs to be more accurate and more inclusive.

My journey made me realize that many educators may unintentionally have contributed to the reinforcement of the dominant Eurocentric narrative. This is an uncomfortable realization for many. Fortunately, there is something we can do about it.

2. A Few Striking Examples

I would like to present a few specific examples that illustrate the problem this article raises. These were highly striking to me in my journey to the field.

2.1. An Underappreciated and Largely Forgotten Giant in History of Science

The first example is about a scholar who made many profound contributions to mathematics and natural sciences. We only mention a sample of his many contributions. Very few people seem to know that an Islamic scholar and polymath by the name Abu Ali al-Hasan ibn al-Hasan ibn al-Haytham[2] (965–1040) was the pioneer of the experimental method who introduced experimentation into scientific inquiry in a systemic way in the early eleventh century. Ibn al-Haytham insisted on using simple repeatable experiments to prove or disprove hypotheses about scientific questions centuries before the Renaissance scholars [40]. He is known as the "father of optics" because he was the first person who correctly understood how vision occurs in the human eye, and he discovered properties of light [43]. In doing so, he refuted two incorrect theories about vision from ancient Greeks. It was in the context of his discoveries in optics, explained in his book of optics [35], that he realized the importance of experimentation. He constructed the first camera obscura, a precursor to modern cameras. For various reasons as explained in [40], ibn al-Haytham did not get the credit of being the pioneer of the experimental method. Instead, the credit usually goes to European scholars such as F. Bacon (1561-1626), G. Galilei (1564-1642), and I. Newton (1643-1727).

[2] Known as al-Haytham or Alhazen in the West.

Ibn al-Haytham was a remarkable polymath who made contributions to other disciplines as well such as astronomy and mathematics. There is a problem known as “AlHazen problem” in the literature named after him [6] which was solved by Ibn al-Haytham himself geometrically but an algebraic solution was not given until the 20$^{\text{th}}$ century [17, 25].

There is evidence that scholars in different parts of the world, such as in India and in the Islamic World, did some Calculus centuries before Newton and Leibniz [9, 21, 27]. Even though they did not fully develop Calculus, they had certain ideas of Calculus such as infinite series expansions of some trigonometric functions [9], and integration [21, 27]. One of these scholars was Ibn al-Haytham. In the context of his work in optics, Ibn al-Haytham used what are called Riemann sums in modern mathematics to calculate the volume of a paraboloid. After explaining his method of computing this volume, Perkins says “This approach to finding a volume by cutting it into ever-thinner slices pre-dates the official discovery of calculus in the 1600s by centuries. In fact, were ibn al-Haytham the direct ancestor of those discoverers, he would be their great-grandfather twenty times over.” [27].

One other area that Ibn al-Haytham pioneered was the astronomical shukuk tradition in the Islamic Civilization. The Arabic word “shukuk” means doubts. This refers to the doubts Islamic scholars had about Greek science. They noticed various problems and contradictions in Ptolemy’s astronomy and started a program of reforming Greek astronomy. The main purpose of this research program was to eliminate contradictions in *Almagest*. Over several centuries, multiple Islamic scholars contributed to this research program and they were able to update Greek astronomy with new results and new models. Later Renaissance scholars benefited much from the outcomes of this research program. Ibn al-Haytham wrote a book titled “Doubts concerning Ptolemy” [44] and he was a pioneer of this tradition. According to Voss, *Doubts* is composed of twenty-eight essays which contain “Ibn al-Haytham’s criticism of Ptolemy’s three most prominent works, the Almagest, the Planetary Hypothesis, and the Optics” [44]. More details about the astronomical shukuk tradition in Islam can be found in [37].

Considering his total contributions to science, Ibn al-Haytham should be considered among the very best scientists in history. However, he is not widely known among the general public or even among highly educated people.

For example, in his popular book *The 100: A Ranking Of The Most Influential Persons In History* [18], Hart never mentions Ibn al-Haytham or any other Islamic scholar. He places Newton in number 2 on his list. Part of his justification for this high ranking is Newton's discoveries in optics. He writes "Newton's achievements in optics alone would probably entitle him to a place on this list", yet he says nothing about the father of optics. Invention of integral Calculus was the most important reason for Hart in ranking Newton very high on the list. "Had Newton done nothing else, the invention of integral Calculus by itself would have entitled him to a fairly high place on this list". As usual, there is no mention of any other individual or civilization in terms of their contributions to Calculus.

There are many Renaissance scholars in Hart's list. Ranked number 12, Gallileo is high in the list. The main reason for this placement is the assumption that Gallileo should be credited with the development of the scientific method. "The great Italian scientist who was probably more responsible for the development of the scientific method than any other individual" writes Hart and continues to say "It was he who first insisted upon necessity of performing experiments." Given the clear evidence about ibn al-Haytham's insistence on using experimentation in scientific inquiry, his fundamental discoveries in optics, his work in Calculus, and many other contributions to multiple disciplines centuries before European scholars, one wonders how Hart would have ranked Ibn al-Haytam if he was aware of his work and if he was consistent with his criteria of ranking. One also wonders why Hart was not aware of such a great scientist while writing on history of science. Once again, Hart is not an outlier but representative of the dominant narrative.

2.2. Copernican Connections

Nicolaus Copernicus (1473-1543) is commonly regarded as one of the pioneers of Renaissance and the scientific revolution. His book *De Revolutionibus Orbium Coelestium* (On the Revolutions of the Celestial Spheres) is considered one of the most important books in history of science [11]. According to Hart [18], "the publication of *De Revolutionibus* was the starting point of modern astronomy–and, more importantly, the starting point of modern science." Since the 1950s, researchers discovered interesting connections between Copernicus's work and the works of multiple Islamic scholars who lived centuries earlier. The first discovery about these connections was published by V. Roberts in 1957 with the intriguing title "The Solar and

Lunar Theory of Ibn ash-Shāṭir: A Pre-Copernican Copernican Model" [28]. Roberts explains the purpose of his publication as "to present the solar and lunar theory developed by the Damascene astronomer, Ibn ash-Shatir (I304-I375/6 A.D.) in his Kitab Nihayat as-Sul fi Tashih al-Usul (A Text of Final Inquiry in Amending the Elements)." The most interesting of the findings in the article, according to Roberts, is that "his lunar theory, except for trivial differences in parameters, is identical with that of Copernicus". This was a surprising discovery. As Roberts noted [28], there is no evidence for any of ibn Shatir's books having been translated into Latin and "it is possible that the two individuals hit upon the same solution independently. On the other hand, Copernicus utilized the work of other Islamic scientists, notably that of Thabit bin Qurra".

Another discovery about the connections between the works of Copernicus and earlier Islamic scholars was made by Hartner in 1970s [19]. There is a theorem known as "Tusi couple" in the literature, introduced and proven by the thirteenth century Persian scholar Nasir al-Din al-Tusi (1201-1274). Tusi invented this theorem in the context of the larger research program of fixing the problems in *Almagest* (the shukuk tradition). The main utility of this theorem is to produce linear (rectilinear) motion from two circular motions. More information about this theorem can be found in [36] or [37]. Hartner observes that Copernicus re-invented this theorem. Though it might have been an independent discovery (that happens in mathematics and science), Hartner presents compelling evidence for the case that it is more reasonable to assume a direct influence or borrowing. He writes [19, page 421]

> However, what proves clearly that we have to do with a case of borrowing, is the lettering of the diagrams found in the Tusi manuscripts and in *De revolutionibus.* In both the five letters, a, d, b, g, and h, denote the same characteristic points (see figs. 3-5). A reasonable explanation would be that Copernicus, doubtless in Italy, saw the diagram in a manuscript of Tusi's astronomical treatise, Tadhkira, and asked somebody who knew Arabic to translate the passage for him. It may have been years later that he found again the note then made and made use of it.

These discoveries prompted other scholars to take a closer look at the works of Copernicus in comparison with the works of earlier Islamic scholars in astronomy. Upon their close examination of these works, Swerdlow and Neugebauer came to this conclusion: "In a very real sense, Copernicus can be looked upon as, if not the last, surely the most noted follower of the Maragha School" [42, Volume 1, page 295]. This conclusion, reached upon a close examination of primary source materials by researchers, is usually not what people learn about Copernicus.

2.3. History of the Decimal Point and Decimal Fractions

> The decimal number system ... is so familiar to most of us that one might forget that it actually had to be invented by someone. This someone also had to find out how to add, subtract, multiply and divide such numbers. His name is Simon Stevin, an ingenious physicist and mathematician born in Bruges in the sixteenth century....

This quotation is from the foreword of the book [14] written by Gerard't Hooft, Nobel Laureate for Physics in 1999. It is striking that the very first sentences of a book about Simon Stevin contain patently false information written by a Nobel Laureate. This unfortunate situation a reflection of the larger problem this article brings to the attention of the readers. Hooft simply repeats the false information contained in the book. The authors of the book [14] make statements like

> Stevin's most radical math invention was his elegant way of representing decimal fractions and using them to carry out elementary calculations. (page 55)

and

> He is no less than the author of the first textbook about decimal fractions. (page 62)

It turns out that there is a deeper background and much longer history regarding this topic. In his 1935 paper [38], Sarton wrote about the history of decimal fractions. Sarton is a very important figure in the discipline of history of science; in fact, he is considered by many the founder of the modern discipline. He was a professor at Harvard University and a co-founder of the History of Science Society.[3]

[3]See https://en.wikipedia.org/wiki/George_Sarton for more on Sarton.

In his paper [38] about the history of decimal fractions, Sarton clearly attributes the invention to Stevin. He writes

> The Thiende was the earliest treatise deliberately devoted to the study of decimal fractions, and the Stevin's account was the earliest systemic account of them. Hence, even if decimal fractions were used previously by other men, it was STEVIN –and no other – who introduced them to the mathematical domain. That important extension of the idea of number –the creation of the decimal number – was undoubtedly a fruit of his genius, and its occurrence can thus be very exactly dated as 1585.

There is a vague implication in these statements to the possibility that other people may have worked with decimal fractions before Stevin, yet Sarton thinks that Stevin deserves the credit, in very clear terms, of being the inventor of decimal fractions. In the very next paragraph, he says he will survey the history of the subject to prove his claim. He notes that examples of decimal numeration go as far back as the fourth millennium before Christ and he gives examples of civilizations that used a decimal number system. He states that the decimal number system and what is now commonly called "Arabic numerals" "were transmitted to us[4] by Arabic writers". He then explains how it was received in Europe and states that by the end of the fifteenth century, the decimal number system was well established in Western Europe.

In the next section of his paper Sarton discusses the history of decimal fractions. Early in this section (second paragraph, page 167) Sarton writes

> The fact that even the best mathematicians of the Middle Ages did not think of decimal fractions in spite of their familiarity with one and the same time with decimal numbers and with sexagesimal fractions simply proves that they had not yet grasped the decimal idea in its fullness, and no wonder considering how slow they were in apprehending it at all.

Later in this section, Sarton states that

[4] By "us" Sarton probably means Europeans, specifically Western Europeans.

> the earliest suggestion of decimal fractions I know of is found in the *Mishnat ha-middot*, a Hebrew treatise the dating of which is uncertain.

and gives a number of examples of scholars in China, Islamic World, and Europe who have done work related to decimal fractions including Persian mathematician Abu-l Hasan Ali ibn Ahmad al-Nasawi (eleventh century), John of Seville (twelfth century), Jordanus Nemorarius (thirteenth century), Chinese mathematician Yang Hui (thirteenth century), John of Meurs of Lisieux (fourteenth century), German scholar Johann von Gemunden (fifteenth century), Persian mathematician Ghiyath al-Din Jamshid ibn Mas'ud (fifteenth century), Austrian scholar Georg Peurbach (fifttenth century), German scholar Regiomontanus (fifteenth century), Ottoman scholar Taqi al-Din Muhammad ibn Ma'ruf (sixteenth century), Italian mathematicians Borghi and Pellizzati (fifteenth century), German Christoff Rudoll (sixteenth century), among others.

In his discussion of these scholars, Sarton makes some interesting comments such as

> It would seem that the great Chinese mathematician YANG HUI (fl. c. 1261-75) made use of decimal fractions to replace complex numbers by simple ones, but I know the relevant text only through MIKAMI'S interpretation of it, and in any case that Chinese contribution did not influence the development of the decimal idea in the West.

This comment seems to suggest that a mathematical invention in a culture is relevant only if it influences the development of that topic in the West. After this Eurocentric remark, Sarton moves to the Islamic world and writes on the next page

> One of the earliest examples of a true decimal fraction was given by GHIYATH AL-DIN JAMSHiD IBN MAS'UD (d. 1436-7)... JAMSHID separated the fractional from the integral part by writing the word sahah on the top of the latter.

Despite these facts, Sarton thinks that none of these scholars who came before Stevin actually invented decimal factions. He states

> If they had been capable of a little more abstract thinking they might have discovered the decimal fractions, but they were not.

He also disagrees with D. E. Smith's remark "If one man were to be named as the best entitled to be called the inventor of decimal fractions, RUDOLFF might properly be the man," and writes

> I cannot agree with this: RUDOLFF'S invention was purely intuitive; something more is needed to complete a scientific, and above all a mathematical, invention. It is not enough to stumble on something; the inventor cannot be recognized as such until he has justified his invention and proved his full understanding of it and of at least some of its implications.

The two authors debate which European scholar should get the credit. It does not seem to occur to them that it could be a non-European scholar who preceded the Europeans by centuries that really deserves the credit.

In this section Sarton mentions that the Italian mathematician Giovanni Antonia Magini (1555-1617) explained how to convert decimal fractions into sexagesimals and the fact that Magini referred Elijah Mizrahi (1455-1525 or I526) as the inventor of that method. Sarton also mentions Viete's book *Universales inspectiones* and writes

> wherein decimal fractions are quite clearly written: the fractional part printed in smaller type than the integral one and separated from the latter by a vertical stroke. What is perhaps even more important in the Canon mathematicts, VIETE, renounced sexagesimal fractions in favor of decimal ones.

Apparently, none of this was enough for Sarton to consider decimal fractions being invented before Stevin. Next he starts another section titled "STEVIN'S achievement of 1585" (page 174) which starts with

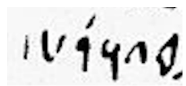
> My account of decimal fractions before STEVIN is more than sufficient I believe to prove two things: first that the idea was "in the air" in the sixteenth century; second, that in spite of the fact that many mathematicians had hovered around it none, excepting perhaps VIETE, had grasped it clearly and completely. There are many examples of decimal fractions before 1585 yet no formal and complete definition of them, not to speak of a formal introduction of them into the general system of numbers. This was done by STEVIN and, but for his notation which need not have been as

> clumsy as it was, his achievement was as near perfection as it could be in his time. This alone would establish the singularity of his genius...

It seems that Sarton's view and treatment of the subject may have influenced Devreese and Berghe in [14]. For example, they also suggest that "the idea of decimal fractions was already in the air" before Stevin but nobody before him actually invented it. Moreover, they seem to be unaware of some very important and totally relevant research findings on the subject that happened after Sarton's article.

In 1940s the manuscript *Miftāḥ al-Ḥisab* (by al-Kāshī) came to the attention of researchers. According to [16], the commonly accepted view that Stevin was the inventor of decimal fractions was shown to be false via Luckey's work on *Miftāḥ* [24]. A translation of *Miftāḥ* was published in 1956 [31]. Even though a full translation of *Miftāḥ* to English was not done until recently (in a series of three volumes [3, 4, 5]), except for two relatively small sections, one on root extraction [13], the other on muqarnas [15], its content has been well known by the specialists in the field. For example, a number of references to its content is made in [7, 8] and several topics from *Miftāḥ* are explained there, including justifications of some procedures that are not found in *Miftāḥ* itself (such as the root extraction algorithm). In particular, *Miftāḥ* contains a systemic treatment of decimal fractions which is treatise 2 in volume 1 [3]. Moreover, al-Kāshī specifically named them as "al-kusur al-ashariyya" which literally means decimal fractions. The content of *Miftāḥ* clearly demonstrates that al-Kāshī had a mastery of decimal fractions. He devoted significant part of *Miftāḥ* to decimal fractions, as well as conversion between decimal and sexagesimal fractions. To researchers familiar with *Miftāḥ*, it is clear that al-Kāshī fully understood decimal fractions. For example, Katz states "It is in the work of Giyath al-Din Jamshid al-Kashi in the early fifteenth century that we first see both a total command of the idea of decimal fractions and a convenient notation for them." ([20, page 270]

Though al-Kāshī fully understood decimal fractions and explained them in much detail in *Miftāḥ*, he is not their inventor. Another manuscript, written almost five centuries before *Miftāḥ*, came to the attention of researchers in 1960s. Written in 341 AH (around 952/3 CE) by Abu al-Hasan Ahmad ibn Ibrahim al-Uqlidisi, *Kitab al-Fusul fi al-Ḥisab al-Hindi*[5] (The Book of Chapters on Indian Arithmetic) introduced decimal fractions in the middle of the tenth century [33]. An English translation of the entire book was published in 1978 [34]. In the section "Al-Uqlidisi on Decimal Fractions", Saidan writes "The most remarkable idea in his work is that of decimal fractions. Al-Uqlidisi uses decimal fractions as such, appreciates the importance of a decimal sign, and suggests a good one."[33]. The notation Al-Uqlidisi uses to denote the decimal point is a small vertical dash, as seen in the figure



which shows the number 179.685 with a vertical dash above 9 that represents the decimal point. Putting Al-Uqlidisi's work in historical context, Saidan observes that Al-Uqlidisi's notation was better than the three different ways al-Kashi used (who did not have a specific symbol for the decimal point) and better than Stevin's notation, who more than six centuries after al-Uqlidisi, denoted the number 184.54290 as

184⓪5①4②2③9④0

Berggren concurs: "However, his [Stevin's] awkward notation was nowhere near as good as al-Uqlidisi's" [7, page 39], [8, page 47].

Given all this information from primary source materials on the history of decimal fractions, it is surprising that neither al-Kāshī nor al-Uqlidisi is mentioned in the discussion of the earlier history of the subject in [14]. The authors seem to talk about the earlier history of the subject [14, pages 59–62], yet they leave out the most relevant figures in their discussion. There are striking similarities between their approach and that of Sarton in [38] even though a lot of new information was discovered by researchers after Sarton's article and decades before the book [14] was published. Anyone reading either [14] or [38] without the knowledge of more accurate information and the larger context may get the impression that they have done a thorough

[5] Editors' Note: Readers might find another article published in this issue of Journal of Humanistic Mathematics of interest: "A Practical Rule of Divisibility By 7 in Uqlīdisī's *Kitāb al-Fuṣūl fī al-Ḥisāb al-Hindī*", another article published in this issue of Journal of Humanistic Mathematics.

analysis of all available sources and came to the fair conclusion that Stevin was the true inventor of decimal fractions.

3. More Examples of Misattributions in Mathematics and Other Disciplines

The field of mathematics is full of examples of misattributions. Here I would like to give a few other examples of such attributions, some well known, others not so much.

"Pascal's Triangle". This well-known object to compute the binomial coefficients, among its other utilities, is almost universally attributed to Blaise Pascal (1623–1662). As stated in [39] however, "scholars in India, China, Iran, and the wider Islamic World, North Africa, southern Europe, and the Hebrew tradition had [already] been studying binomial coefficients, discovering their properties, and putting them to use." One of those scholars was al-Karaji. According to Berggren [7, page 58], [8, page 66] "However, it might with more justice be called al-Karajī's triangle, for it was al-Karajī (953–1029) who, around the year AD 1000, drew the attention of mathematicians in the Islamic world to the remarkable properties of the triangular array of numbers." Shahriari refers to this triangle as "the Karaji–Jia triangle" and notes that it is sometimes called "Khayyam's, Yang Hui's, or Tartaglia's triangle."

"Fibonacci Numbers". This is a well known sequence (f_n) of numbers defined recursively by $f_0 = 0, f_1 = 1$, and $f_n = f_{n-1} + f_{n-2}$ for all $n \geq 2$. This sequence is almost universally called the Fibonacci sequence, after Italian mathematician Leonardo of Pisa (1170–1240) better known as Fibonacci, but Shahriari [39] chooses to call it the Pingala–Fibonacci sequence because of the fact that "generations of commentators in India starting with Acarya Pingala—circa third to second century BCE—studied this sequence of integers." Berggren notes that Fibonacci made considerable use of works of earlier Islamic scholars such as Abu Kamil (850–930). It is therefore quite possible that Fibonacci may have learned about these numbers through medieval Islamic scholars.

"Wilson's Theorem". This is a theorem in number theory which states "a positive integer n is prime if and only if $(n-1)! \equiv -1 \mod n$."

Equivalently, this theorem states that n is a prime number if and only if $(n-1)!+1$ is divisible by n. Although it is attributed to the English mathematician John Wilson (1741–1793), it was first stated by ibn al-Haytham some of whose contributions to mathematics and science are described above. Wilson was neither the first one to state this theorem nor to prove it.

"Ceva's Theorem". This is a theorem in geometry about triangles. According to Berggren [8], even though it was thought to be first stated by the Italian mathematician G. Ceva (1647–1734), it was actually first stated and proven in *The Book of Completion* by Ibn Hud (d. 1085), a medieval Islamic mathematician and ruler in Muslim Spain.

"Ruffini-Horner Method". This is a method to solve algebraic equations. It is commonly attributed to the British mathematician William George Horner (1786–1837), or jointly to Horner and the Italian mathematician Paolo Ruffini (1765–1822). However, the method had been known to many mathematicians in various cultures long before the eighteenth century.[6] One of those mathematicians was al-Kāshī. In analyzing the root extraction algorithm of al-Kāshī, Dakhel observes that the technique used by al-Kāshī is what is normally called the Ruffini-Horner method, and makes the following remark: "Recalling that al-Kāshī used the algorithm a long time before either Ruffini or Horner lived, we say that the latter two are not the <u>first</u> to invent the method and use it. It was certainly known and used by oriental mathematicians, among whom al-Kāshī only one, at least four centuries before Ruffini and Horner" [12]. On the other hand, Rashed showed that the Ruffini-Horner method had been developed centuries earlier, by mathematicians of Al-Karaji's school; this was evident from a treatise written by Al-Samaw'al in 1172 [30, page 91]

"Hamiltonian Cycles". A Hamiltonian path in a graph is a path that visits each vertex exactly once. A Hamiltonian cycle is defined analogously. Hamiltonian cycles are named after the Irish mathematician Sir William Rowan Hamilton(1805-1865) who invented a puzzle in 1856 and the goal of the puzzle was to find such paths. According to [39],

[6] See `https://en.wikipedia.org/wiki/Horner's_method` for more details.

the study of Hamiltonian cycles and graph theory has a much older history, some of which is intertwined with the game of chess.

"Newton-Raphson Method". This is an iterative method, alternatively called Newton's Method, and commonly taught in Calculus classes to approximate the root of an equation (or zero of a function). According to [45], the French mathematician Viete (1540–1603) had a method which was almost identical to the Newton-Raphson method, and Newton was familiar with Viete's work. Ypma writes

> The precise origins of Viete's method are not clear, although its essence can be found in the work of the 12^{th} century Arabic mathematician Sharaf al-Din al-Tusi. It is possible that the Arabic algebraic tradition of al-Khayyam, al-Tusi, and al-Kashi survived and was known to 16^{th} century algebraists, of whom Viete was the most important.

Considering numerous misattributions in the field of combinatorics alone, Shahriari [39] observes

> When you look at the totality of the common names of mathematical objects in combinatorics —Pascal's triangle, Vandermonde's identity, Catalan numbers, Stirling numbers, Bell numbers, or Fibonacci numbers — a remarkable and seemingly non-random pattern emerges. All the names chosen are from the European tradition. Undoubtedly, European mathematicians contributed significantly — and, in many subareas of mathematics, decisively — to the development of mathematics. However, this constellation of names conveys to the beginning student that combinatorial ideas and investigations were limited to Europe. In the case of combinatorics, nothing could be further from the truth. Mathematicians from China, Japan, India, Iran, northern Africa, the wider Islamic world, and the Hebrew tradition, to mention a few, have very much worked on these topics.

The situation in other areas of mathematics, and more generally in other sciences, is not much different either, and this is a reflection of a larger problem. To give examples from other disciplines, consider what King writes about the field of scientific instruments in [23] "My purpose in this volume is not only to portray the richness and variety of Islamic instrumentation, but also to present some examples of European instruments previously considered to be European inventions but which we now know had Islamic precedents."

A final example is from the field of medicine. The discovery of the pulmonary circulation of blood is commonly attributed to William Harvey (1578–1657), a British physician of seventeenth century. However, a manuscript [1] that came to the attention of researchers in 1924 made it clear that it was actually discovered centuries earlier by an Islamic scholar whose name is Ibn Nafis (1213–1288). The authors of [1] write "after the rediscovery of Ibn Nafis' manuscript no.62243 titled Sharah al Tashreeh al Qanoon, or "Commentary on the anatomy of Canon of Avicenna" in 1924 AD in Europe, it became clear that Ibn Nafis had described the pulmonary circulation almost 300 years before Harvey." Even though it has been a century after the rediscovery of ibn Nafis's manuscript, accurate information did not become the common knowledge. In Hart's list, Harvey is placed in position 55. The very first sentence in Hart's description of Harvey's contributions starts with [18, page 273] "William Harvey, the great English physician who discovered the circulation of blood and the function of the heart was born in ..."

4. The Classical Narrative

All of this is a reflection of a dominant, Eurocentric narrative of history of science called "classical narrative" by Saliba [37]. It portrays a distorted picture of scientific progress through history in which ancient Greeks and Renaissance scholars are privileged as originators and revitalizers of brilliant scientific inventions and progress. In this narrative, the role of other civilizations in the historical progress of science is either ignored or marginalized. The Islamic Civilization, as an example, is portrayed as a preserver of the brilliant ancient Greek science. Although a "golden age" of Islamic science is acknowledged, the contributions of Islamic Civilization is reduced to preserving Greek science through translations during the European dark ages to make it available to Renaissance scholars later. According to this narrative, Islamic Civilization acquired science because it came into contact with other more advanced civilizations, particularly ancient Greeks. According to this oversimplified and distorted version of history, the golden age was a relatively short period (from late eighth century to the twelfth century) and it did not contribute much beyond translations.

The classical narrative fails to explain the remarkable advances in scientific progress in the early Islamic Civilization, and it overlooks its significant achievements after the twelfth century. In particular, it fails to explain these achievements in terms of the internal dynamics of this vibrant civilization.

According to Simon Schaffer (professor emeritus of History and Philosophy of Science at the University of Cambridge), the root of this narrative is the colonial mindset of western Europeans. Schaffer says:

> When western Europeans reflect on why they are superior — does not often cross their minds that they may not be superior to everybody else — for a long time they supposed their superiority laid in their religion. Around eighteenth century we begin to see a shift: Europeans are superior because of science and technology.[7]

Khalili explains (in the same documentary) that this view of Islamic Civilization made the colonial enterprise more palatable to the colonizers who did not feel comfortable subjugating people who may be as sophisticated as they are.

We see the manifestation of the idea of intellectual superiority of Europeans and Greeks to other cultures in many publications. For example, in *The Legacy of Islam*, in the chapter on Science and Medicine, Meyerhof writes "The Muslim scholars, though acute observers, were thinkers only in a restricted sense" [2, page 345]. In the same book, the very first sentence of the chapter on Astronomy and Mathematics is "We must not expect to find among the Arabs the same powerful genus, the same scientific gift of imagination, the same enthusiasm, the same originality of thought that we have among the Greeks" [2, page 376]. In the previously mentioned chapter on Science and Medicine, the author writes "none of Galen's anatomical and physiological errors could be corrected." This ignores the fact that when Ibn Nafis discovered the pulmonary circulation of blood, he actually refuted Galen's explanation. Similarly, when Ibn al-Haytham discovered how vision occurs in the human eye, he refuted incorrect theories from ancient Greeks. This book also contains the statement "When Islamic medicine and science

[7] This is from the BBC documentary "Islam and Science, Part 3", available at https://www.youtube.com/watch?v=wlsNXEi9_bI, last accessed on July 25, 2025; the quotations are between 51 and 54 minutes. Some edits were made.

came to a standstill about 1100 ..." It is one of the assumptions of the classical narrative that the golden age of Islamic science came to an end with the criticism of philosophers by al-Ghazali (1058–1111).

One of the most important contributions of the Islamic Civilization to mathematics is the creation of algebra as a new and distinct discipline. The birth of algebra can be traced back to the book [29] *Kitab al-Jabr wa-al-Muqabala* (The Book of Restoration and Balancing) by al-Khwarizmi (780–850). In fact, the term algebra is a transliteration of the Arabic word "al-jabr" one of whose meanings is restoration. In the section on Algebra in [41, page 83], Stillwell writes "...the simple algebra of al-Khwarizmi served this purpose better than those of his more sophisticated predecessors." Those "more sophisticated predecessors" refer to Greek mathematicians. Although not always explicitly stated, the view that European scholars are intellectually superior to people of other cultures has been widespread.

I refer the reader to Edward Said's well-known book *Orientalism* [32] and a large body of scholarship that was generated as a response to it to better understand the deeply embedded problems in the West regarding the Islamic world. Additionally, I recommend [37] for a more detailed analysis and critique of the classical narrative as well as an alternative narrative that explains the rise of scientific activities in the Islamic Civilization and its contributions to the development of the global history of science. Another reference that critiques the classical narrative in a way similar to [37] is [22], in which King writes:

> Some out-dated notions wide-spread amongst "the informed public" and even amongst historians of science are that:
>
> (1) The Muslims were fortunate to be the heirs to the sciences of Antiquity.
>
> (2) They cultivated these sciences for a few centuries, but never really achieved much that was original.
>
> (3) They provided, mainly in Islamic Spain, a milieu in which eager Europeans emerging out of the Dark Ages could benefit from these Ancient Greek sciences once they had learned how to translate them from Arabic to Latin.

> Islamic science, therefore, one might argue is of no consequence *per se* for the development of global science and is important only insofar as it marks a rather obscure interlude between a more sophisticated Antiquity and a Europe that later became more civilized. What happened in fact was something rather different... [page *xvi*]

5. What Needs to be Done

By now, it should be clear that the way history of mathematics and science is commonly taught is not accurate. It is heavily Eurocentric and does not properly describe the contributions of non-European civilizations, in particular the Islamic Civilization. This is a key reason why most people are not aware of the most accurate knowledge on the subject. Changing school curricula so that a more accurate and inclusive history of mathematics and science is taught is necessary. It is not a trivial task, but it is something that needs to be done. This goal can be seen as part of the larger effort of decolonizing, and decolonizing the curriculum in particular [10]. More work is still needed on

a) academic research on primary source materials,

b) creation of materials to help disseminate accurate information to the general public,

c) creation of materials that can be used in school curricula.

There is a clear gap between academic knowledge on the subject and what is taught and not taught in schools. Despite the need to create a lot more materials for b) and c), there already exist some materials freely available for those who might be interested, such as the resources my colleagues, my students, and I began to put together at Digital Storytelling and Dissemination of Research Findings on Contributions of the Medieval Islamic Civilization to Mathematics and Sciences; these are available at `https://digital.kenyon.edu/mathislamds/`. These samples show that we can make a difference to help change the narrative and teach a more accurate history of science. They also show that not only researchers and specialists in the discipline but also undergraduate students can contribute to the effort if they have the chance to study the right materials.

References

[1] Mohammad Akmal, Mohd Zulkifle, and Abdul Haseeb Ansari, "Ibn Nafis- a forgotten genius in the discovery of pulmonary blood circulation," *Heart Views* Volume **11** (2010), pages 26-30.

[2] Sir Thomas Arnold and Alfred Guillaume, *The Legacy of Islam*, Oxford University Press, 1931.

[3] Nuh Aydin and Lakhdar Hammoudi, *Al-Kashi's Miftaḥ Al-Hisab, Volume I: Arithmetic: Translation and Commentary*. Springer, 2019.

[4] Nuh Aydin, Lakhdar Hammoudi, and Ghada Bakbouk, *Al-Kashi's Miftah al-Hisab, Volume II: Geometry: Translation and Commentary*. Springer Nature, 2022.

[5] Nuh Aydin, Lakhdar Hammoudi, and Ghada Bakbouk, *Al-Kashi's Miftah al-Hisab, Volume III: Algebra: Translation and Commentary*. Springer Nature, 2022.

[6] Marcus Baker, "Alhazen's problem," *American Journal of Mathematics* 4.1 (1881) pages 327-331.

[7] John Lennart Berggren, *Episodes in the mathematics of medieval Islam*, Springer-Verlag, New York, 1986.

[8] John Lennart Berggren, *Episodes in the mathematics of medieval Islam*, 2nd ed, Springer, New York, 2016.

[9] David Bressoud, "Was calculus invented in India?," *The College Mathematics Journal*, Volume **33** (2002), pages 2-13.

[10] Elizabeth Charles, "Decolonizing the curriculum," *Insights*, Volume **32** (2019), page 24.

[11] Nicolaus Copernicus, *On the revolutions of heavenly spheres*, Prometheus Books, 2010.

[12] Abdul-Kader Dakhel, *The Extraction of the Nth Root in the Sexagesimal Notation*,Ph.D dissertation, American University of Beirut (Lebanon), 1951.Available at ProQuest Dissertations & Theses, https://go.exlibris.link/2Vf921KW

[13] Abdul-Kader Dakhel, *The extraction of the n-th root in the sexagesimal notation. A study of chapter 5, treatise 3 of Miftaḥ al-ḥisāb*. W. A. Hijab and E. S. Kennedy, eds, Beirut: American University of Beirut, 1960.

[14] Jozef T. Devreese, and Guido Vanden Berghe, *Magic is no magic: The wonderful world of Simon Stevin*, WIT Press, Southampton UK, 2008.

[15] Yvonne Dold-Samplonius,"Practical Arabic mathematics: measuring the muqarnas by al-Kashi", *Centaurus*, Volume **35** (1992), pages 193-242.

[16] Edmund Robertson and John O'Connor, "Ghiyath al-Din Jamshid Mas'ud al-Kashi," MacTutor History of Mathematics website, available at https://mathshistory.st-andrews.ac.uk/Biographies/Al-Kashi/, last accessed on July 25, 2025.

[17] Jack M. Elkin, "A deceptively easy problem," *The Mathematics Teacher*, Volume **58** (1965), pages 194-9.

[18] Michael H. Hart, *The 100: A Ranking Of The Most Influential Persons In History*, Carol Publishing Group, Revised Edition, Secausus, N.J. 1992.

[19] Willy Hartner, "Copernicus, the man, the work, and its history," *Proceedings of the American Philosophical Society*, Volume **117** (1973), pages 413-422.

[20] Victor J. Katz, *A History of Mathematics, 3rd ed.* Addison-Wesley, Boston, 2009.

[21] Victor J. Katz, "Ideas of calculus in Islam and India," *Mathematics Magazine*, Volume **68** (1995), pages 163-174.

[22] David A. King, *In synchrony with the heavens*, Studies in astronomical timekeeping and instrumentation in medieval Islamic Civilization, Volume One, The Call of the Muezzin, 2005.

[23] David A. King, *In Synchrony with the Heavens*, Volume Two, Instruments of Mass Calculation:(Studies $X - XVIII$). Vol. 55. Brill, 2005.

[24] Paul Luckey, *Die Rechnenkunst bei Gamsid b. Masud al-Kasi* Wiesbaden, 1951.

[25] Peter M. Neumann, "Reflections on reflection in a spherical mirror," *The American Mathematical Monthly*, Volume **105** (1998), pages 523-528.

[26] J. J. O'Connor; E. F. Robertson,, "Abu Ali al-Hasan ibn al-Haytham", MacTutor History of Mathematics Archive, University of St Andrews, https://mathshistory.st-andrews.ac.uk/Biographies/Al-Haytham/

[27] David Perkins, *Calculus and its origins*, MAA Notes #70, 2012.

[28] Victor Roberts, "The solar and lunar theory of Ibn ash-Shāṭir: A pre-Copernican Copernican model," *Isis*, Volume **48** (1957), pages 428-432.

[29] Roshdi Rashed, *Al-Khwārizmī: the beginnings of algebra*, Saqi Books, 2009

[30] Roshdi Rashed, *The development of Arabic mathematics: between arithmetic and algebra*, Vol. 156. Springer Science & Business Media, 2013.

[31] B. A. Rosenfeld, V. S. Segal, A. P. Youschkevitch, *Klyuch Arifmetiki* [Key to Arithmetic], Traktat ob Okruzhnosti, Moscow, 1956.

[32] Edward W. Said, *Orientalism*, Pantheon Books, (1978).

[33] Ahmad S. Saidan, "The earliest extant Arabic arithmetic", *Isis*, **57** (1966), pages 475-490.

[34] Ahmad S. Saidan, *The arithmetic of al-Uqlidisi: The story of Hindu-Arabic arithmetic as told in Kitab al-Fusul fi al-Hisab al-Hindi*, translated and annotated by A. S. Saidan, Dordrecht, Reidel Publishing, 1978.

[35] Abdelhamid Ibrahim Sabra, *The Optics of Ibn al-Haytham. Books I, II, II: On Direct Vision*, with translation, introduction, commentary, glossaries. London: The Warburg Institute 1.3 (1989).

[36] George Saliba, "Greek Astronomy and the Medieval Arabic Tradition: The medieval Islamic astronomers were not merely translators. They may also have played a key role in the Copernican revolution," *American scientist*, Volume **90** (2002), pages 360-367.

[37] George Saliba, *Islamic science and the making of the European renaissance*, MIT Press, 2007.

[38] George Sarton, "The first explanation of decimal fractions and measures (1585). Together with a history of the decimal idea and a facsimile (no. XVII) of Stevin's Disme." *Isis* Volume **23** (1935), pages 153-244.

[39] Shahriar Shahriari, *An Invitation to Combinatorics*, Cambridge University Press, 2021.

[40] Bradley Steffens, *First Scientist: Ibn Al-Haytham,* Blue Dome Press, 2021.

[41] John Stillwell, *Mathematics and its History*, 2nd edition, Springer, New York, 2002.

[42] Noel M. Swerdlow, and Otto Neugebauer, *Mathematical Astronomy in Copernicus' De Revolutionibus: In Two Parts*, Volume 1, Springer, 2012

[43] Abdelghani, Tbakhi, and Samir S. Amr, "Ibn Al-Haytham: father of modern optics," *Annals of Saudi medicine*, Volume **27** (2007), pages 464-467.

[44] Don Leo Voss, *Ibn al-Haytam's "Doubts Concerning Ptolemy": A Translation and Commentary*, The University of Chicago, 1985.

[45] Tjalling J. Ypma, "Historical development of the Newton–Raphson method," *SIAM Review*, Volume **37** (1995), pages 531-551.