

Women in Ancient Mathematics

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1 Introduction

The history of mathematics is an intertwining story of contributions, both big and small, made by thousands of individuals; from the beginnings of number systems in ancient civilisations to the highly abstract work produced by modern scientists, mathematics is a prime example of how society can come together to form complex mechanisms for the benefit of all. Everyone knows at least some of the major figures who have helped to create mathematics as we know it today: Pythagoras, who supposedly (but not actually) found the relationship between the sides of a right-angled triangle; Euclid, author of the geometry textbook of choice for almost 2000 years; or perhaps Alan Turing, famous for his work in developing some of the first computers.

I implore you now to think of any other mathematicians that you might know. Perhaps give yourself a minute and write down those that come to mind. Now ask yourself: are these mathematicians representative of the different cultures and groups that exist within society? What proportion of them are of Asian or African descent (or indeed anywhere not in Europe?) And what proportion of them are female? You will find that the history of mathematics tends to favour certain individuals. When I tried this myself, I found that I knew very few female mathematicians from the past - Sophie Germain and Ada Lovelace were those that I recalled - and from those who are living, all but Eugenia Cheng elude me. Even then, I only know Eugenia thanks to her formula for the perfect pizza, not for any of her serious contributions to mathematics!

In this essay, I explore the different factors that affect how the history of mathematics has been written, and reasons why women in particular might be excluded from such narrative. Then, I attempt to remedy this by including details of some women in ancient mathematics who have been largely ignored by the general public.

2 Pre-Hypatian era

Hypatia was an Egyptian philosopher and mathematician who is widely regarded as the first woman to pursue such a career, born between 350_{AD} and 370_{AD} in the city of Alexandria. Before her, there is little evidence of women contributing to mathematics. Pandrosion was another 4th century mathematician working before Hypatia, but there is debate over whether Pandrosion was a woman or not. Pappus had compiled a selection of mathematical works at the time called *Collection*, which referred to Pandrosion using a feminine form of address. However, while translating Pappus' work, the 19th century historian Friedrich Hultsch decided this must have been a mistake and used the masculine form instead. Recently, a 1988 translation by Alexander Jones has convinced many scholars to take the view that Pandrosion actually was a woman.

Either way, the lack of written evidence of women in mathematics before the 4th century raises the question of whether this accurately represents the mathematical scene at the time. Was mathematics really dominated by men in the ancient era, or has the history just been changed to make it seem this way?

Much of the oppression of women in mathematics is due to the widespread introduction of patriarchal societies. However, it is worth pointing out that compelling evidence dates patriarchy as having started only 10,000 years ago, whereas humans have been developing primitive knowledge of arithmetic and geometry for more than 40,000 years. Therefore, it is likely that men and women played an equal role in the first 30,000 years of mathematical thinking. After this point, the divide between men and women widened, with men taking the higher roles in almost every aspect of society, including politics, religion, and family structures.

The power of mathematics soon came under priestly control, with patterns in numbers being used to make predictions about the world around them: for example, by plotting the path of Sirius, priests were able to predict the annual flooding of the Nile. Such use of numbers introduced a sense of elitism around mathematics, and it would have been very hard for women to enter this "secret club". However, it is not true that women were not able to enter such rings. In Babylonia and Egypt, two of the powerhouses of ancient mathematics, certain laws gave women rights that made it possible for them to become major public figures, and this included priests and other roles that customarily used numbers.

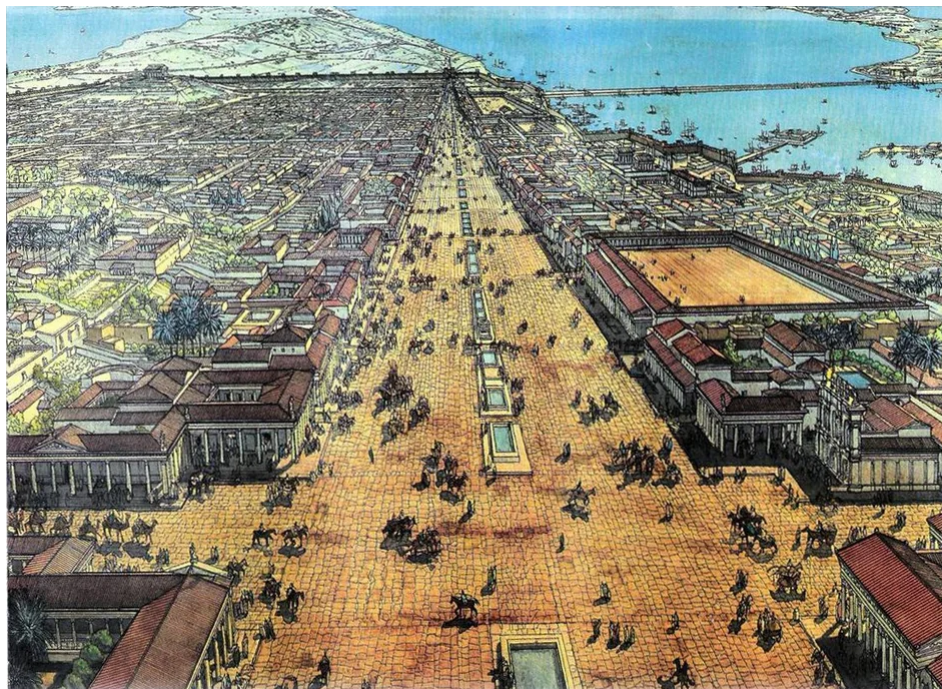


Figure 1: An artist's impression of Alexandria in 400AD, around the time Hypatia and Pandrosion were alive. Alexandria was one of the key places of mathematical research in the ancient world.

In fact, Pythagoras made his own school of thought in Italy that often accepted female mathematicians into their ranks, causing some to refer to him as the "feminist philosopher". He argued that knowledge should be taught to anyone willing to listen. One source indicates that 28 women participated in the school: among these his wife, Theano, and at least two of their daughters, who helped to spread the Pythagorean ideas. It is known that Theano wrote at least one treatise on mathematics, related to the Golden Mean. One major feature of the Pythagorean school of thought is that almost all of their work was attributed to Pythagoras himself, despite being a collective effort. It will likely never be possible to determine the effect women had in this group. One should also not be too optimistic after hearing about Pythagoras' welcoming attitude to women; his associates remained stubborn and elitist, and in other groups women were probably rejected altogether.

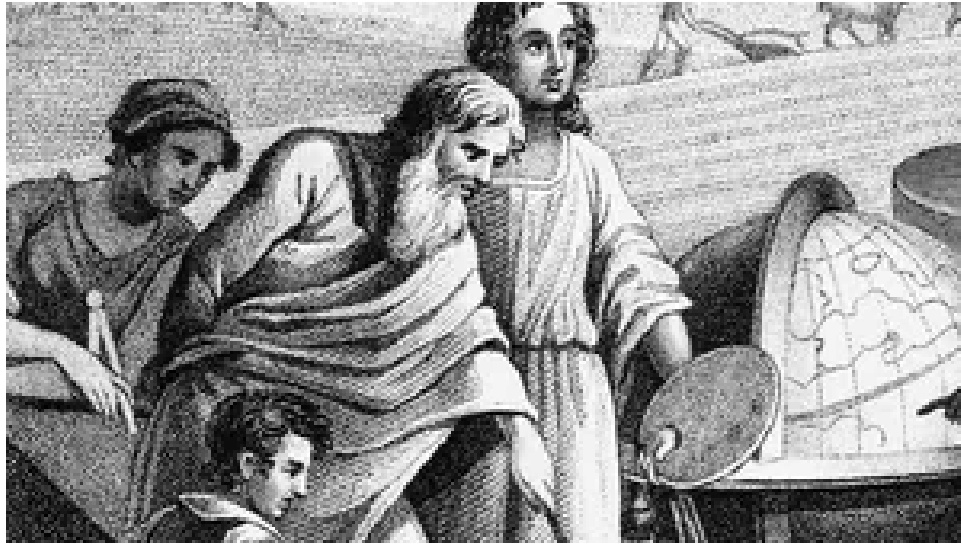


Figure 2: Pythagoras demonstrating his famous theorem in the sand using a stick.

Outside of Europe, the story was very much the same. China in particular, one of the biggest contributors to early mathematics, had a strict attitude towards women which forced them to stay indoors while men dealt with business outside. A set of policies restricted women from owning property, taking examinations, and holding office, making it even harder for women to become mathematicians than in Europe; in fact the first known Chinese female mathematician was Wang Zhenyi, born in 1768. The restrictive rights of women before this time makes it almost impossible for there to have been any earlier female mathematicians in China. Taking the risk to generalise too much (for example in parts of ancient Vietnam women had stronger rights than men) the situation was similar around the rest the world, including the Americas, Africa and Australia. Certainly no matriarchal societies were large enough for any significant female mathematicians.

3 Semi-legendary mathematicians

There are several female mathematicians before Hypatia, all from Greece, who we know from sources that were often written several centuries later. Of course, having such 'after-the-fact' sources means that any information we think we know about them is speculation at best. The oldest mentioned is Aethra from the 10th century BC, who although was not a mathematician in the modern sense, was the first woman known to have any complex knowledge of mathematics. She taught several people accounting with the use of an abacus, which was especially hard since there was no concept of zero at the time.

Next is Polygnotos, alive five centuries later, who knew many geometric theorems and also introduced the idea of acrophonic symbolism in mathematics (representing a number by the first letter of the corresponding word; for example, Greek for five was penta, and the number was written as P). She also proved that "each registered angle going in a semicircle is right" - a famous theorem taught in high school today.

Following these two female mathematicians are those of Pythagoras' school, who studied a wide range of mathematical topics. Also, Melissa worked on the construction of regular polygons that can be inscribed in a circle; Diotima was the only woman who participated in Plato's *Symposium*, a work that depicted a contest between the major philosophers of the time; Lastheneia joined Plato's Academy dressed a man since women weren't allowed, and one definition of the sphere is attributed to her; and Areti wrote forty books, two of which included mathematics. There are many more, and much more could be said about the ones mentioned, but the point is that there were countless ancient female mathematicians who all contributed in a major way.

It is probably true that men were the powerhouse behind mathematical development in ancient times, but I will leave it to you to decide whether women have been under-represented in this regard.

4 Hypatia

Although we have seen examples of earlier female mathematicians, Hypatia is the first for whom we have fairly detailed records of her life. Hypatia was the daughter of Theon of Alexandria, another mathematician who was the head of a prestigious school called the "Mouseion", and this undoubtedly gave her an advantage in following this career. In addition, Theon wanted his daughter to be different to what society deemed women should become. Her mother is never mentioned in any surviving sources. Similarly, her exact year of birth is not known; some date her as being born around 350 (since one chronicler calls her old when she died in 415), and some put the year closer to 370 (the historian Damascius claimed she flourished during the reign of Arcadius, and combined with descriptions of her physical beauty, many scholars have determined she must have been around 30 years old in the midpoint of Arcadius' reign).

Hypatia became an instructor of mathematics, philosophy and astronomy in Alexandria. She held lectures on a variety of topics and by 400_{AD} had become the head of the Platonist school. She also wrote three commentaries: one on the *Conics* of Apollonius of Perga, one on the *Arithmetica* of Diophantus, and one on the *Astronomical Canon*. These works apparently improved the clarity of teaching and made it easier for her students to understand, as well as advancing knowledge on hyperbolas and parabolas. Unfortunately, they were stored in the library of Alexandria and destroyed by Christians in 391_{AD}. It is still clear, however, that Hypatia was seen as one of the great mathematicians by the Alexandrian people.



Figure 3: Hypatia teaching her students at Alexandria.

Hypatia lived during a time of religious turmoil and this is evidenced by the burning of Hypatia's works by the Christians. Many scholars sought new places to continue their studies, but Hypatia decided to stay. In 415_{AD}, at the publication of an edict by the prefect Orestes, the Jews saw a Christian inciting the crowd to rebel and in response publicly tortured him. Archbishop Cyril threatened to harm the Jews if they didn't leave the Christians alone, but this only served to anger them even more. They planned to make a nightly attack on the Christians: by shouting that a nearby church was on fire, they lured the Christians out in the streets and brutally attacked them. The next day, the Christians overpowered the Jews and expelled them from the city. Hypatia was

a controversial figure who kept others from accepting Christianity, so a group of people took her from her chariot while returning home, lynched her, and incinerated her remains.

After Hypatia's death, most of the scholars of Alexandria, including her students, left for other parts of the world. Hypatia had a huge impact in both mathematics and astronomy, cut short by the tragedy of religious war.

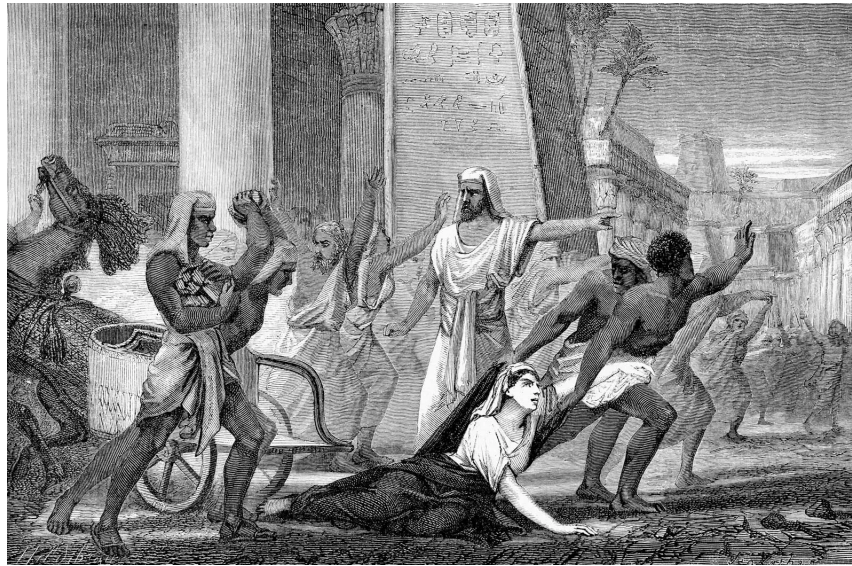


Figure 4: Hypatia being murdered at the hands of Cyril, the archbishop who drove out the Jews from Alexandria.

5 Conclusion

From the evidence we have of ancient mathematics, it seems that women were not oppressed in history, but rather in mathematics in general. Where women did become mathematicians, it was embraced by the people who documented them, and often seen as a major achievement. It is in more recent times that women have been ignored by historians, perhaps; one example is that of Pandrosion, mentioned before, who was deemed a man by modern scholars. In some cases women have had to conceal their true identity to make progress in mathematics. One example of this is Sophie Germain. She often wrote to renowned mathematicians such as Lagrange and Gauss under the pseudonym of Monsieur LeBlanc to more easily gain their approval. When Gauss discovered this, he was impressed and praised her for her strength despite the expectations of women.

In the future, it is important that we give women equal opportunity to thrive in mathematics. It is clear that in the past they have had a large impact on scientific development, and given the chance they will certainly continue to provide fresh insights and ideas.