COMPARATIVE STUDY OF TWO CULTURES FOR FEMALE MATHEMATICIANS

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Abstract:

Muslim society and culture and European society and culture are considered to be the great rivals. This communication compares the two in the perspective of educational freedom to women. Throughout the history it has been a common but sad understating that women are not capable of acquiring knowledge in general and particularly that of mathematics. Many areas except a few have been traditionally male-dominated. This was the consequence of a number of socio-cultural factors that limited the career development of women. They were limited only to household. In some very liberal families they were allowed to learn music, painting and dance. They had no prospects in the field of science and technology. With the rise of Islam and the instruction given by Quran and the Prophet (SAW) women were equally ordered to acquire knowledge. So the Muslim society and culture evolved in a different way as compared to the other concurrent society and cultures. Islam ruled out traditional arguments based on cultural, social, and economic bindings to women. To achieve regular education in many cases was just a night mare in other cultures and societies. But in the Muslim society and culture it was a sacred duty to provide and gain knowledge to every member of the society irrespective of gender, color or race. It is in contrast to the views of the secularism worn environment of today. This study compares Muslim culture and society with other cultures and societies particularly in the era ranging from 7^{th} to 19^{th} century.

Key Words: European culture, Muslim society , mathematics, women.

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1. INTRODUCTION

Learning Mathematics as a field of science or philosophy was practically forbidden for women till 19th century. However, from the antiquity women had been attempting to learn mathematics secretly or if possible openly too. However, till the end of nineteenth century and the beginning of twentieth century only a few women were able to acquire proper training and knowledge of Mathematics. Women had to face compulsion, binding and physical and mental torture and tyranny if they attempted to learn Mathematics or any other subject except those which were allowed to them by the society. To begin with, this study briefly mentions some of the famous stories about the struggle and achievements of some prominent women mathematicians. It is remarked here that women are still a minority in the areas of science in general and Mathematics in particular.

This study compares the behavior of Muslim society towards the education of females with that of the behavior of other societies towards their female folk. In fact, the difference of the two behaviors fixes the role of women in the history of education, research and development.

After the introductory review in section 1, section 2 explores the background in which Muslim women were supported to achieve education side by side with their male counter parts. Section 3 deals with the contribution of famous women mathematicians and the efforts they made to achieve their goals. Section 4 concludes the whole discussion and in the end we have the references.

2. FEMALE MATHEMATICIANS IN MUSLIM SOCIETY

From the early years of Islam, women had crucial role in their society. They contributed substantially to the prominence of Islamic civilization. The role of Muslim women was by no means confined to house and home. They were active in many fields. However, we find little information on Muslim women's contributions. It is to quote first the Verses from **Al-Quran 96:1**,

اقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ

Read: In the name of thy Lord Who createth

خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ

Createth man from a clot

اقْرَأْ وَرَبُّكَ الْأَكْرَمُ
Read: And thy Lord is the Most Bounteous

الَّذِي عَلَّمَ بِالْقَلَمِ
Who teacheth by the pen

عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ
Teacheth man that which he knew not

These are the very first instructions of Quran given to humanity. Though, these instructions are general, for the whole humankind, these are the binding for all Muslims to follow irrespective of being a male or female. In the light of the instructions by Quran and the teachings of the prophet Muhammad (Peace be Upon Him) females also labored to acquire knowledge. And there is a long list of woman scholars in the earliest Muslim societies who not only gained knowledge themselves but contributed much in distributing knowledge to others irrespective of considering that their students are male or female. There is an ingrained value in every Muslim, man and woman alike, to pursue knowledge and to learn about God's truth by studying the surrounding world. Prophet Mohammad (SAWS), advised his followers to seek knowledge wherever it can be found. In keeping with this value, Muslim women are continuing to make headway in the field of science and their graduation ratios often exceed those of western women in pursuing scientific degrees according to figures recently released by UNESCO (http://www.missionislam.com/science/mwscience.htm). Here the discussion will be restricted to women mathematicians only. The quest for knowledge has always applied to women in Islam. God has made no difference between genders in this area. The Prophet (SAW) once said: "**Seeking knowledge is a mandate for every Muslim (male and female)**." (Sahih Bukhari) (http://www.missionislam.com/science/mwscience.htm).

Women played an important role in the foundations of many Islamic educational institutions, for example Fatima al-Fihri's founding of the University of Al Karaouine in 859 CE. This continued through to the Ayyubid dynasty in the 12th and 13th centuries, when 160 mosques and madrasahs were established in Damascus, 26 of which were funded by women through the Waqf (charitable trust or trust law) system. Half of all the royal patrons for these institutions were also women (Abu ‘l-Faraj, 1359).

According to the scholar Ibn Asakir in the 12th century, there were opportunities for female education. He wrote that girls and women could study, earn *ijazahs* (academic degrees), and qualify as scholars (*ulema*) and teachers (Al-Khatib, 1931). This was especially the case for learned and scholarly families, who wanted to ensure the highest possible education for both their sons and daughters. Ibn Asakir had himself studied under 80 different female teachers (Al-Khatib, 1931). Female education in the Islamic world was inspired by Prophet Muhammad's (saws) wives: Khadijah, a successful businesswoman, and Aisha, a renowned scholar of the *hadith* and military leader. Prophet Muhammad (Saws) is said to have praised the women of Medina for their desire for religious knowledge: "**How splendid were the women of the *ansar*; shame did not prevent them from becoming learned in the faith**" (http://en.wikipedia.org/wiki/Islamic_feminism).

2.1 Al-Mahamali

In the field of Mathematics, names of scholars featured in Islamic history such as Amat-al Wahid Sutatia Al-Mahamali from Bhagdad in the 10th century. Systematic investigation, with the methodology of history of science, will certainly yield more information on other women scholars in Islamic history who practiced mathematics, (http://www.muslimheritage.com/article/womens-contribution-classical-islamic-civilisation-science-medicine-and-politics/gallery/629.).

Sutatia was taught and guided by several scholars including her father. She was known for her good reputation as regards her morality and modesty. She was praised by historians such as Ibn-al Jawazi, Ibnal Khatib Baghdadi and Ibn Kathir. She died in the year 377H/ 987CE.

Sutayta did not specialize in just one subject but excelled in many fields such as Arabic Literature, Hadith and Jurisprudence as well as in Mathematics. It is said that she was an expert in Hisab (Arithmetic) and Faraidh (Succesoral Calculations), both being practical branches of Mathematics which were developed in her time. She discovered solutions to the equations which have been cited by other mathematician, which are related to algebra. Although these equations were few, they demonstrated that her skills in Mathematics went beyond a simple aptitude to perform calculations (Salim, 2010).

2.2 Labana of Cordaba

Labana of Cordaba (Spain, ca, 10th century) was one the few Muslim female mathematicians known by name. She was said to be well-versed in the exact science, and could solve the most complex geometrical and algebraic problems known in her time, http://www.loonwatch.com/2014/03/15-important-muslim-women-in-history/).

Her vast acquaintance with general literature obtained her the most important employment of private secretary to the Umayyad caliph of Islamic Spain, al Hakeem II. According to the famous Andalusi scholar Ibn Bashkuwāl: "She excelled in writing, grammar, and poetry. Her knowledge of mathematics was also immense and she was proficient in other sciences as well. There were none in the Umayyad palace as noble as her." (Ibn Bashkuwal, 2008).

2.3 Alia Sabur

Alia Sabur is on record as the world's youngest professor in the history of academia. In February, just a few days after her 19th birthday, Alia was appointed full professor at Konkuk University in South Korea. Colin Maclaurin, a physics student of Sir Isaac Newton, held the previous record some 300 years ago (http://www.aliasabur.com/bio).

She began reading at the age of eight months, entered college at 10 and graduated with a bachelor of science in applied mathematics from Stony Brook University at 14 – the youngest female in American history to earn a university degree. She then went on to complete a master's degree and doctorate in material sciences and engineering at Drexel University, while being on record as the youngest person to have received fellowships from NASA, the National Science Foundation and the U.S. Department of Defense (http://www.muslimheritage.com/article/womens-contribution-classical-islamiccivilisationscience-medicine-and-politics/gallery/629.).

Before leaving for Konkuk, Alia accepted a temporary position at Southern University at New Orleans, a school that had been devastated by Hurricane Katrina. The university is still operating out of trailers. Alia teaches four courses, lives on campus, and maintains her research at Konkuk online. Her students, most of whom are older than she is, appreciate her passion for teaching. What is in some ways puzzling is the comment on her post that says:

"Her achievements shatter the Western stereotype of Muslim women as inherently dim-witted and oppressed. Of course, the opportunities afforded by American society have played a vital role. One doubts that a young Muslim woman (or man) could proceed along a similar path in most Muslim countries. Yet, news reports from Saudi Arabia to Pakistan are trumpeting Alia Sabur's unique accomplishments."

Alia Sabur (L'13) has achieved something which makes her very prominent among all the current professors at Georgetown Law at that time . Sabur earned a place in the Guinness Book of World Records in February 2008, when she was appointed a full-time faculty member at Konkuk University, Seoul (http://www.aliasabur.com/bio).

As a graduate student in Material Sciences and Engineering at Drexel University, Sabur undertook several research projects, the main one being a method of delivering medicine directly into human cells using nanotubes (http://women/aatpmathwomen.htm).

This is notable that no history of compulsion, binding and physical and mental torture and tyranny is narrated in case of the above mentioned women mathematicians.

3. FEMALE MATHEMATICIANS FROM EROUPEAN CULTURE

Now some examples from European societies are provided. It is mentionable that with each of the women mathematicians history of compulsion, binding and physical and mental torture, tyranny and exploitation is associated.

3.1 Hypatia of Alexandria

Hypatia of Alexandria was a Greek philosopher, astronomer and mathematician; she was the salaried head of the Neoplatic school in Alexandra in the year 400. Her students were pagan and Christian young men from around the empire (http://en.wikipedia.org/wiki/Hypatia).

The life of Hypatia was the one enriched with a passion for knowledge. Hypatia was the daughter of Theon, who was considered one of the most educated men in Alexandria, Egypt. Theon raised her in the world of education. Most historians now recognize her not only as a mathematician and scientist, but also as a philosopher. Historians believe that Theon tried to raise her as a perfect human being (http://women/aatpmathwomen.htm). Theon and Hypatia formed a strong bound as he gave Hypatia his own knowledge and shared his passion in the search for answers to the unknown. As Hypatia grew older, she began to develop an enthusiasm

for mathematics and the science (astronomy and astrology). Mostly people thought that Hypatia surpassed her father's knowledge at a young age. However, she always worked under her father's discipline (Five Historic Female, 2011). In her education Theon introduced Hypatia to different religions of the world and taught her how to influence people with the power of words. He taught her the fundamentals of teachings so that Hypatia become a profound orator. People from other cities came to study and learn from her. Hypatia's studies included astronomy, astrology and mathematics (http://en.wikipedia.org/wiki/Hypatia). Hypatia was known more for the work she did in mathematics than in astronomy, primarily for her work on the ideas of conic sections introduced by Apollonius. She cited the work on conics of Apollonius, which divided cones in to different parts by a plane. This concept developed the ideas of hyperbolas, parabolas and ellipses with the help of Hypatia's work on this important book, the concepts become easier to understand, thus making the work survive through many centuries. Hypatia was the first woman to have such a profound impact on the survival of early thoughts in mathematics. Hypatia, the female philosopher of Alexandria and the woman who would become a target of the Christian anger that was inflamed during the feud. Daughter of Theon, and a teacher trained in the philosophical schools of Plato and Plotinus, she was admired by most for her dignity and virtue (http://www.aatpmathwomen.htm). Of the anger she provoked among Christians, Hypatia ultimately fell "victim to the political jealousy which at the time prevailed." Orestes was known to seek her counsel, and a rumor spread among the Christian community of Alexandria blaming her for Orestes' unwillingness to reconcile with Cyril. A mob of Christians gathered, led by a reader (i.e., a minor cleric) named Peter (http://en.wikipedia.org/wiki/Hypatia). They kidnapped Hypatia on her way home and took her to the "Church called Caesarean. They then completely stripped her, and then murdered her with tiles." It was said that, while she was still alive, Hypatia's flesh was torn off using oyster shells (tiles; the Greek word is *ostrakois*, which literally means "oystershells" but the word was also used for brick tiles on the roofs of houses and for pottery sherds). Hypatia's life ended tragically, however her lifelong work remained intact, Descarates, Newton and Leibniz extended her work. Hypatia made extra ordinary accomplishments as a woman, in her life time (http://en.wikipedia.org/wiki/Hypatia).

3.2 Sophie Germain

In 1789, Sophie was thirteen years old when the Bastille fell, turning Paris into a bedlam. The streets were filled with discontented Parisians demonstrating their revolutionary sentiments, foraging for food, and reveling in the general anarchy. It was no place for a young girl with Sophie's sensibilities. When Paris exploded with revolution, young Sophie Germain retreated to her father's study and began reading. After learning about the death of Archimedes, she began a lifelong study of Mathematics and Geometry, even teaching herself Latin and Greek so that she could read classical works (Osen, 1974). Her family firmly and stubbornly opposed her decision, but her determination was only strengthened by the vehemence of their opposition. The study of mathematics became a passion for her, one that no amount of familial pressure could smother. Alone and untutored, she went through every book her father's library afforded on the subject (Osen, 1974). Unable to study at the École Polytechnique because she was a female, Germain obtained lecture notes and submitted papers to Joseph Lagrange, a faculty member, under a false name, since at that time the women are not allowed to learn with such freedom (http://wikipedia.org/wiki/List_of_female_mathematicians.). When he learned she was a woman, he became a mentor and Germain soon began corresponding with other prominent mathematicians at the time. Her work was hampered by her lack of formal training and access to resources that male mathematicians had at the time (Samuel, 1904). But she became the first woman to win a prize from the French Academy of Sciences, for work on the theory of elasticity, and her proof of Fermat's Last Theorem, though unsuccessful, was used as a foundation for further work on the subject well into the twentieth century (Five Historic Female, 2011).

3.3 Sofia Vasilyevna:

Because Russian women could not attend university, Sofia Vasilyevna contracted a marriage with a young paleontologist, Vladimir Kovalevsky, and they moved to Germany. There she could not attend university lectures, but she was tutored privately and eventually received a doctorate after writing thesis on partial differential equations, Abelian integrals and Saturn's rings. Following her husband's death, Kovalevskaya was appointed lecturer in Mathematics at the University of Stockholm and later became the first woman in that region of Europe to receive a full professorship (Five Historic Female, 2011).

She continued to make great strides in Mathematics, winning the Prix Bordin from the French Academy of Sciences in 1888 for an essay on the rotation of a solid body as well as a prize from the Swedish Academy of Sciences the next year (http://wikipedia.org/wiki/List_of_female_mathematicians).

3.4 Augusta Byron:

Augusta Ada Byron (later Countess of Lovelace) never knew her father, the poet Lord Byron, who left England due to a scandal shortly after her birth. Her overprotective mother, wanting daughter to grown up as unemotional and unlike her father as possible, encouraged her study of Science and Mathematics. As an adult, Lovelace began to correspond with the inventor and mathematician Charles Babbage, who asked her to translate an Italian mathematician's memoir analyzing his Analytical Engine (a machine that would perform simple mathematical calculations and be programmed with punch cards and is considered one of the first computers). Lovelace went beyond completing a simple translation, however, and wrote her own set of notes about the machine and even included a method for calculating a sequence of Bernoulli numbers this is now acknowledged as the world's first computer program (http://www.aatpmathwomen.htm).

3.6 Emmy Noether:

(German: 23 March 1882 – 14 April 1935), sometimes referred to as Emily or Emmy, was an influential German mathematician known for her groundbreaking contributions to abstract algebra and theoretical physics. Described by Pavel Alexandrov, Albert Einstein, Jea Dieudonné, Hermann Weyl, Norbert Wiener and others as the most important woman in the history of Mathematics, she created a revolution in the theories of rings, fields, and algebras. In physics, Noether's theorem explains the fundamental connection between symmetry and conservation laws (Tent, 2008).

She was born to a Jewish family in the Bavarian town of Erlangen; her father was mathematician Max Noether. Emmy originally planned to teach French and English after passing the required examinations, but instead studied Mathematics at the University of_Erlangen, where her father lectured. After completing her dissertation in 1907 under the supervision of Paul Gordan, she worked at the Mathematical Institute of Erlangen without pay for seven years (at the time women

were largely excluded from academic positions). In 1915, she was invited by David Hilbert and Felix Klein to join the mathematics department at the University of Göttingen, a world-renowned center of mathematical research. The philosophical faculty objected, however, and she spent four years lecturing under Hilbert's name. Her habilitation was approved in 1919, allowing her to obtain the rank of Privatdozent (http://www.agnesscott.edu/lriddle/women/alpha.htm).

Noether remained a leading member of the Göttingen mathematics department until 1933; her students were sometimes called the "Noether boys". In 1924, Dutch mathematician B. L. van der Waerden joined her circle and soon became the leading expositor of Noether's ideas: her work was the foundation for the second volume of his influential 1931 textbook, Moderne Algebra. By the time of her plenary address at the 1932 International Congress of Mathematicians in Zürich, her algebraic acumen was recognized around the world. Noether's mathematical work has been divided into three "epochs". In the first (1908–19), she made significant contributions to the theories of algebraic invariants and number fields. Her work on differential invariants in the calculus of variations, *Noether's theorem*, has been called "one of the most important mathematical theorems ever proved in guiding the development of modern physics"(Tent, 2008). In the second epoch (1920–26), she began work that "changed the face of [abstract] algebra". In her classic paper *Idealtheorie in Ringbereichen* (*Theory of Ideals in Ring Domains*, 1921) Noether developed the theory of ideals in commutative rings into a powerful tool with wide-ranging applications. She made elegant use of the ascending chain condition, and objects satisfying it are named Noetherian in her honor. In the third epoch (1927–35), she published major works on noncommulative algebras and hypercomplex numbers and united the representation theory of groups with the theory of modules and ideals. In addition to her own publications, Noether was generous with her ideas and is credited with several lines of research published by other mathematicians, even in fields far removed from her main work, such as algebraic topology. In 1935, Albert Einstein wrote a letter to the *New York Times*, lauding the recently deceased Emmy Noether as “the most significant creative mathematical genius thus far produced since the higher education of women began.” Noether had overcome many hurdles before she could collaborate with the famed physicist (Tent, 2008).

She grew up in Germany and had her mathematics education delayed because of rules against women matriculating at universities. After she received her PhD, for a dissertation on a branch of abstract algebra, she was unable to obtain a university position for many years, eventually

receiving the title of "unofficial associate professor" at the University of Göttingen, only to lose that in 1933 because she was Jewish. So she moved to America and became a lecturer and researcher at Bryn Mawr College and the Institute for Advanced Study in Princeton, New Jersey. There she developed many of the mathematical foundations for Einstein's general theory of relativity and made significant advances in the field of algebra. In 1935 she underwent surgery for an ovarian cyst and, despite signs of a recovery, died four days later at the age of 53 (Five Historic Female 2011).

4 CONCLUSION:

Succeeding as a woman in Mathematics required extreme determination and willpower many years ago. Overcoming often inconceivable obstacles, women have made many noteworthy mathematical advances over time that too frequently go unnoticed. Due to laws and cultural behaviors that discouraged women from pursuing higher education and careers in certain high-level areas, men dominated mathematics into the twentieth century. But still, throughout time, a large number of women have managed to overcome both legal and cultural obstacles to make their marks in the history of Mathematics.

In this study we have shown the difference between the two cultures, and that how the Muslim world is different from the European world. Although the females of both the civilization have made strong and untiring efforts to get their goals and recognition but the support for Muslims women is much more as compare to the European society. The females are supposed to be suffered a lot in the old days but the Muslim culture has provided the better environment for their daughters to achieve their goals. And in the end to add the good news that the Fields Medal of 2014 has won by Maryam Mirzakhani. The first ever female to win this precious prize which in Mathematics is considered to be equivalent to Nobel prize .

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