HOW MANY WOMEN MATHEMATICIANS CAN YOU NAME?

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Until my last semester as an undergraduate student in 1964, my answer to the question of the title would have been "One: Emmy Noether, the German algebraist." That semester a woman mathematician, Yvonne Choquet-Bruhat, was a visiting professor at my undergraduate institution so my list increased to two! If you restrict your answer to those women who were active by the middle of the twentieth century, you are unlikely to be able to name more than seven: Hypatia (*c.* 370-415); Gabrielle-Émilie Le Tonnelier de Breteuil, Marquise du Châtelet (1706-1749); Maria Gaetana Agnesi (1718-1799); Sophie Germain (1776-1831); Mary Somerville, (1780-1872); Sofia Kovalevskaia (1850-1891), and Emmy Noether (1882-1935).

By the time I got my Ph.D. in 1972, my list of women mathematicians active by mid-century had increased by one, Dorothy Maharam Stone, whom I met when she was visiting my master's institution. However, there were a number of women on the mathematics faculty of my doctoral institution so I could name a number of women who had become mathematicians in the 1950s and 1960s, including my dissertation advisor. In the late 1970s I became interested in the history of women in mathematics and I have been working in that field ever since, collaborating with Jeanne LaDuke of DePaul University. What we learned is that women have been mathematicians for longer, and in greater numbers, than most people, even most mathematicians, realize. Much of the second half of this talk summarizes and updates a paper Jeanne LaDuke and I wrote in 1987;[1] it also relies on another of our papers.[2]

So, let me start by quickly introducing those of you who know nothing about women in mathematics to Hypatia, du Châtelet, Agnesi, Germain, and Somerville. These five are often considered the only women in mathematics before the middle of the nineteenth century. I will talk later about Kovalevskaia and Noether, who worked between the middle of the nineteenth and twentieth centuries.

Hypatia, a Neoplatonist of Alexandria who died early in the fifth century, is said to have written commentaries on various earlier Greek works. Her work has not been preserved but much has been written about her life and violent death at the hands of a Christian mob, including a mid-nineteenth century novel by Charles Kingsley. Within the last few years a full-length biography of Hypatia and an article dealing with her mathematics have been published, so it is now easier to distinguish fact from fiction.

While we have to skip to the eighteenth century to get to the next women on the list, there were women involved in mathematics even before Hypatia. For example, early in the fourth century

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[1] Judy Green and Jeanne LaDuke. "Women in the American mathematical community: The pre-1940 Ph.D.'s." *Mathematical Intelligencer* 9 no 1 (1987): 11–23.

[2] Judy Green and Jeanne LaDuke. "Contributors to American mathematics: An overview and selection." In G. Kass-Simon and Patricia Farnes (eds.), *Women of Science: Righting the Record*, 117-146. Bloomington: Indiana University Press, 1990.

there was a woman teacher of geometry named Pandrosian. Over the centuries we find somewhat unusual evidence that women were interested in mathematics. For example, there is a twelfth century Indian text on astronomy containing arithmetic and algebra problems in verse, a number of which are worded as questions posed to a female. Then, in the eighteenth century, we find that a popular English magazine entitled the *Ladies' Diary* consisted mainly of mathematical problems and puzzles. While these examples do not constitute much of a presence of women in mathematics, it does tell us that the satisfaction one gets from solving mathematical problems was not limited to men.

If we now go back to our list we find two eighteenth century women, Gabrielle-Émilie Le Tonnelier de Breteuil, the Marquise du Châtelet, and Maria Gaetana Agnesi. The Marquise du Châtelet, who was the author of philosophical and literary works, made the first translation into French of one of Isaac Newton's books, *The Mathematical Principals of Natural Philosophy*. Agnesi was the author of an early treatise on algebra and the calculus that was published in 1748 and translated into several languages. She was appointed an honorary professor at the University of Bologna in 1750 and devoted herself to religious work after the death of her father in 1752.

We now come to the first woman recognized as having published original mathematics. Sophie Germain, who worked both in mathematical physics and in number theory, was awarded a major prize by the French Academy of Sciences in 1816. She is often mentioned as having used the pseudonym M. Le Blanc while corresponding about number theory with the most important mathematician of the period, Karl Friedrich Gauss. In fact, most of her early research results were not published but were contained in letters to Gauss and other mathematicians. Despite that, there is a theorem that bears her name. It is a particular case of Fermat's last theorem: if p and $2p + 1$ are both primes, then there are no integers x, y, and z relatively prime to p, for which $x^p + y^p = z^p$.

Moving further into the nineteenth century we find Mary Fairfax Greig Somerville who is best known among mathematicians as a translator into English of a French treatise on celestial mechanics. Her major work was as a physical scientist, both as an expositor and an experimentalist. One of the first two colleges for women at Oxford (the one in England) was named in her honor.

Starting in the second half of the nineteenth century, more women were trained in mathematics beyond arithmetic and some of them became mathematicians. Among the earliest were two women who left Russia in the 1860s in pursuit of higher education. Elizaveta Fedorovna Litvinova became the first woman to be awarded a Ph.D. in mathematics based on a regular course of study when the University in Bern granted her a degree in 1878. Sofya Kovalevsky is the sixth well-known woman mathematician and the first one who has been written and talked about extensively. Some of you may have heard her name since it is attached to a theorem, the Cauchy-Kovalevsky Theorem, that provides conditions for a given system of partial differential equations to have a unique solution. While I will spend some more time talking about Kovalevsky than I did about the previous five women, I also want to recommend some books about her, both a wonderful biography[3] and an autobiographical novel.[4]

[3] Ann Hibner Koblitz. *A Convergence of Lives. Sofia Kovalevskaia: Scientist, Writer, Revolutionary*, 2d ed. New Brunswick: Rutgers University Press, 1993.

Kovalevsky or Kovalevskaia, was born in 1850 in Moscow and studied mathematics, including the calculus, with tutors. In 1868, in order to be able to leave Russia in pursuit of a higher education, she entered into a fictitious marriage with Vladimir Kovalevskii who was about to go to Heidelberg to study paleontology. After three semesters of study at the University of Heidelberg, Kovalevskaia moved to Berlin to continue her studies with Karl Weierstrass. However, in Berlin she was not allowed to study at the university, although she was able to study privately with Weierstrass. She was the first women to apply for a degree in mathematics in Germany and, in 1874, was granted her degree *summa cum laude* from the university at Göttingen *in absentia*.

That same year Kovalevskaia and her husband returned to Russia where they each sought, but neither found, an academic position. They decided to live together and, in 1878, they had a daughter. The following year, Kovalevskaia again left Russia and returned to her study of mathematics. In 1884 she became Professor of Mathematics at the University of Stockholm. Four years later she was awarded a prize by the French Academy of Sciences but only three years after that, in 1891, she died of pneumonia at the age of forty-one.

This puts us in the late nineteenth century when English speaking women had already had access to training in mathematics beyond arithmetic for about half a century and some were beginning to receive real training as mathematicians. While it was still unusual for women to receive higher education of any sort, it was not a secret that when they did, they studied mathematics. In fact, in 1894 George Bernard Shaw wrote about it in his play, *Mrs. Warren's Profession*. In the first act, the following dialogue takes place between a middle-aged gentleman, Mr. Praed, and Mrs. Warren's twenty-two-year-old daughter, Vivie. Vivie has just taken the mathematical tripos, the honors examination in mathematics at Cambridge, and has achieved the same score as the third wrangler, that is the male candidate with the third highest score. Mr. Praed is quite impressed with Vivie's accomplishment but Vivie tells him that she "wouldnt do it again for the same money," explaining that

> Mrs. Latham, my tutor at Newnham, told my mother that I could distinguish myself in the mathematical tripos if I went in for it in earnest. The papers were full just then of Philippa Summers beating the senior wrangler… and nothing would please my mother but that I should do the same thing. I said flatly it was not worth my while to face the grind since I was not going in for teaching; but I offered to try for fourth wrangler or thereabouts for £50. She closed with me at that, after a little grumbling; and I was better than my bargain. But I wouldnt do it again for that. £200 would have been nearer the mark.

One can surmise that Shaw chose to have Vivie Warren study mathematics at Newnham and made reference to Philippa Summers, who is supposed to have beaten the senior or top-scoring wrangler in a previous year, because of a real incident. In 1890 a student at Newnham, Philippa Fawcett, who regularly spent six hours a day studying for the mathematical tripos, did indeed score above the senior wrangler. In fact, she scored thirteen percent higher than the man who received the title of senior wrangler. Her accomplishment was discussed in the English

[4] Sofya Kovalevskaya. *A Russian Childhood.* New York: Springer-Verlag, 1978.

newspapers and even the *New York Times* ran an article describing her success and the significance it had for the higher education of women.[5]

Although Fawcett's achievement was unprecedented, women from Newnham and Girton, the first two women's colleges at Cambridge, had been formally competing in the tripos since 1881. Previous to that a woman had to obtain special permission to sit for the tripos and had to find an examiner to grade her paper, and even then, her score was officially ignored. The change came because of an incident in 1880 when Charlotte Angas Scott of Girton scored between the seventh and eighth wranglers. Since women were not mentioned at the awards ceremony, the undergraduates who were present shouted her name and cheered her as the true eighth wrangler. In subsequent years the rankings of the women were given separately but relative to the men's rankings and the successful women were awarded a special certificate, though not a degree. Women did not receive degrees from Cambridge until 1948!

Neither the fictitious Vivie Warren nor the real Philippa Fawcett pursued an academic career in mathematics; Vivie, in the play, becomes an actuary and Philippa Fawcett, after about ten years as a Lecturer at Newnham, went to South Africa and helped develop a system of farm schools in the Transvaal. She returned to England in 1905 and spent the remainder of her career working for the London County Council first as Assistant to the Director of Education and later as Assistant Education Officer for Higher Education. On the other hand, by the time Philippa Fawcett had distinguished herself in the tripos, Charlotte Scott had come to the United States to Bryn Mawr College in Pennsylvania.

Charlotte Angas Scott was born in 1858 and was educated by private tutors until she enrolled at Girton College, Cambridge, in 1876. Girton had opened seven years earlier as England's first college for women and was located three miles from the Cambridge University. Even the supporters of higher education for women were against their receiving degrees. One such supporter was quoted as saying: "If given the BA, they must next have the MA… [and e]ven the BA would enable them to take 5 books at a time out of the University Library…"[6] Despite the fact that Cambridge was not to grant degrees to women for another seventy-two years, even in 1876 most of the Cambridge professors allowed women to listen to their lectures. Thus the women of Girton had opportunities to obtain a real education and Scott took advantage of this education. Although she received no official recognition for her achievements at Cambridge, in 1882 the University of London opened all degrees, prizes, and honors to women and Scott received a B.Sc. by examination that year. She served as Lecturer at Girton and continued her mathematical studies at Cambridge, where her main interest was algebraic geometry. In 1885 she received a D.Sc. from the University of London, again based on examinations. She was hired by Bryn Mawr, then a newly founded women's college, to head its mathematics department, and remained there for forty years, retiring in 1925, six years before her death.

Scott's influence on American mathematics was publicly acknowledged in many ways. In 1906 she was ranked by her peers as fourteenth among the top ninety-three mathematicians of the

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[5] "Miss Fawcett's Honor: The sort of girl this lady Senior Wrangler is." *New York Times*, 24 June 1890, 6.

[6] Stephen Sikos. *Philippa Fawcett and the Mathematical Tripos.* Cambridge: Newnham College, 1990, 12.

period. That same year Scott served as vice-president of the American Mathematical Society, being the first woman to hold that office and the only one to do so until seventy years later when Mary Gray, one of the founders of the Association for Women in Mathematics (AWM), was elected.

Another Girton educated Englishwoman, Grace Chisholm Young, also has an important place in the history of women in mathematics. Grace Chisholm was born in 1868, the year before Girton was founded. Like Scott, she did not receive any formal education until she entered Girton in 1889. At the end of her first year she heard Philippa Fawcett of Newnham College announced as "Above the Senior Wrangler." When Chisholm sat for the mathematical tripos two years later, she placed between the twenty-third and twenty-fourth Wranglers. She accepted a challenge to become the first woman to sit for the Oxford Honour exams and received First Class Honours with the highest score on the exam.

Chisholm returned to Girton the following year and then went to Göttingen to be one of three women to be the first women officially admitted to study at the university there. She wrote a dissertation and, in 1895, became the first of the three pioneering women students to receive her Ph.D. As such, she was the first woman to receive a doctorate as a regularly enrolled student in a university administered by the Prussian government. Although Sofia Kovalevskaia had received a Ph.D. *in absentia* from Göttingen in 1874, she had never taken classes or been enrolled at any German university.

Chisholm returned to England with a doctorate but without a job and started a mathematical collaboration with William Henry Young, one of her Girton tutors. A year later they were married. The following year their first child was born and they moved to Göttingen where they both spent their time doing mathematical research. Although the Youngs were doing very well mathematically at Göttingen, neither of them was earning money, so Will Young eventually had to resume his tutoring duties at Cambridge. He did this part-time while Grace Young and their children remained on the continent. Based on his published work to that time, Will Young received a D.Sc. from Cambridge in 1903 but was still only able to get part-time jobs. Meanwhile, in Göttingen, Grace Young was studying medicine, raising four children, and doing mathematics. In 1908 the family, now with six children, moved to Switzerland. Will Young didn't get his first regular appointment until five years later, in 1913, and then it was in Calcutta. Grace Young and the children continued to live in Switzerland and finally, in 1919, Will Young got a job closer to his family, in Wales.

Early in their career, the Youngs produced many mathematical works together, but almost all of the papers were published under Will Young's name alone. The first of the works appearing under both their names was a 1905 geometry book intended for elementary school children. In 1914, Grace Chisholm Young started publishing under her own name again, this time on the foundations of the differential calculus.

At the outbreak of World War II Grace Young was visiting in England and Will Young was stranded alone in Switzerland, where he died in 1942 without having seen his family again. Grace Young died two years later in England. The Young's mathematical heritage includes their work as well as a daughter, a son, and a granddaughter who became mathematicians.

As mentioned earlier, Chisholm was one of the three first women to be officially admitted to study at Göttingen. The other two women were Americans, Margaret Maltby, who came to study physics, and Mary Frances Winston, who also came to study mathematics and who received her Ph.D. two years after Chisholm. It is not a coincidence that none of these three women were German and that they had come to Göttingen to study mathematics and physics. At about this time, early in the 1890s, there had been discussion in Germany concerning admission of women to the universities. While the Prussian Minister of Culture was not unsympathetic to the idea, the overseer of the University at Göttingen was firmly against it. In spite of that, it was decided that foreign women should be admitted to study mathematics. Felix Klein, the mathematician responsible for bringing Chisholm and Winston to Göttingen, explained later that "Mathematics had here rendered a pioneering service to the other disciplines. With it matters are, indeed, most straightforward. In mathematics, deception as to whether real understanding is present or not, is least possible."[7]

In the summer of 1893 Klein came to the United States with mathematical models to be displayed at the Columbian Exposition in Chicago and to speak at the International Mathematical Congress held in conjunction with the Exposition. In Chicago Klein met Mary Winston, a graduate student at the University of Chicago whose undergraduate degree was from the University of Wisconsin. After teaching for two years in Milwaukee she studied with Charlotte Scott at Bryn Mawr before coming to the University of Chicago in its inaugural year, 1892. Klein agreed to sponsor her admission to the university but could not provide her with financial support.

Although Winston applied for a European fellowship from the Association for Collegiate Alumnae, she did not receive it and was able to go to Germany only because of the generosity of a woman mathematician, Christine Ladd-Franklin, who personally provided her with a $500 stipend. Mary Winston arrived in Göttingen in the fall of 1893 and waited for Klein to clear the way for her admission to the university. A few weeks after her arrival, Winston wrote her family that the people in Göttingen were very skeptical as to her chances for admission; they were wrong.

Two years after coming to Germany, Winston published a short paper in a German mathematical journal. The authors of a 1934 book about mathematics in nineteenth century America[8] note that this particular journal contains fifteen articles published by Americans between 1893 and 1897. They then list the authors of fourteen of these articles, omitting only the name Mary Winston. Winston's paper was based on a talk she had given in the mathematics seminar at Göttingen within months of her arrival in Germany. That talk was the first such given by a woman and she wrote her family that the presentation "went off reasonably well.… I do not think that anyone will draw the conclusion from it that women cannot learn Mathematics."

Upon her return to the United States in 1896, Mary Winston took a job teaching high school in Missouri. The following year she received her Ph.D. from Göttingen and became Professor of

[7] Göttingen. Niedersächsische Staats- und Universitätsbibliothek. Handschriftenabteilung. Nachlass Klein.

[8] David Eugene Smith and Jekuthiel Ginsburg. *A History of Mathematics in America before 1900.* Chicago: Mathematical Association of America, 1934.

Mathematics at Kansas State Agricultural College, now Kansas State University. Three years later she resigned and married Henry Byron Newson, a mathematician at the University of Kansas. Henry Byron and Mary Winston Newson had three children born in 1901, 1903, and 1909. Mary Winston was widowed in 1910 when her youngest child was just three months old. She moved in with her parents, who were then living in Lawrence. She returned to teaching, but not to mathematical research, a few years later at Washburn College in Topeka, Kansas. Her son reported that she took that job because Topeka was within commuting distance of Lawrence and her parents could care for the children during the week. Newson remained at Washburn until 1921; she spent the rest of her career at Eureka College in Illinois, retiring in 1942.

While Mary Winston Newson was the first American woman to receive a degree from a foreign university, by the time her degree was awarded in 1897 eight American women had been awarded Ph.D.'s in mathematics in the United States. The first American woman to *earn* a Ph.D. in mathematics was Christine Ladd, who is the Christine Ladd-Franklin who provided the $500 that allowed Mary Winston to go to Germany. Ladd graduated from Vassar College in 1869 and during the next ten years she taught school and began publishing mathematics, including several articles that appeared in an American journal and at least twenty mathematical questions or solutions to questions in a British periodical, *The Educational Times*. She also attended classes at Harvard and, in 1878, she applied to Johns Hopkins University to study mathematics at the graduate level. Since Hopkins was not open to women, her admission was far from routine. The head of the mathematics department, J. J. Sylvester, had read some of her published work and wrote on her behalf both for admission and for the granting of a fellowship. Ladd was admitted, but under the condition that she was to attend only Sylvester's lectures. Although she was not required to pay tuition, she was not given a fellowship. After her first year of attendance, 1878-79, she was voted the $500 stipend of a fellowship for the following year. Despite this, her name was not included on the actual list of fellows but appeared in a footnote. Thus, like Philippa Fawcett and Charlotte Scott, Christine Ladd received the recognition she deserved but not the title.

During her four-year stay at Johns Hopkins, Ladd did not confine her studies to those she could pursue with Sylvester, but also attended classes given by other members of the mathematics faculty. She also continued her contributions to mathematical journals. By 1882 she had written a dissertation under the direction of the logician Charles S. Peirce. However, she did not receive the Ph.D. she had earned simply because Hopkins was unwilling to grant degrees to women. The following year she married a member of the Johns Hopkins mathematics faculty, Fabian Franklin; they had two children, a son who died in infancy and a daughter who was born in 1884. Starting about 1887 Ladd-Franklin began a second research career in the physiological optics of color vision. She later served as a lecturer in logic and psychology at Hopkins and then at Columbia. Actually Ladd had originally wanted to study physics but switched to mathematics, what she called "the next best subject," because physics laboratories were not open to women.

In 1926, Johns Hopkins offered Ladd-Franklin, then seventy-eight years old, an honorary doctorate in recognition of her work in color vision. Ladd-Franklin was able to convince Hopkins to award her the Ph.D. in mathematics that she had earned forty-four years earlier. The

New York Times reported that the ovation she was accorded was "one of the outstanding features of the day."[9]

In 1886 Winifred Edgerton became the first American woman to be *awarded* a Ph.D. in mathematics when Columbia University granted her the degree. In order for Edgerton, an 1883 graduate of Wellesley, to study at Columbia, which, like Hopkins admitted only men, the trustees had to approve her request to study mathematics and astronomy. While the request was eventually granted, it took several meetings of the trustees. In 1982 one of her sons reported "that a condition of her admission was to dust the astronomical [instruments] and so comport herself as not to disturb the men students. ... When working alone in the observatory she would arrange dolls around the room to keep her company. If she heard someone coming she hid them in a window box."

By the spring of 1886 Edgerton had written a dissertation and the trustees voted to award her the degree of Doctor of Philosophy *cum laude*. Her degree was both the first Ph.D. in mathematics awarded to an American woman and the first degree of any kind that Columbia awarded to a woman.

For two years after the receipt of her doctorate, Edgerton taught at a school for girls in New York. In 1887 she married Frederick James Hamilton Merrill, a geologist who did not approve of her involvement in the movement to increase the availability of education for women. They soon had four children. Although she participated in the founding of Barnard College, her husband objected to her attendance at meetings that were held in a man's office and she resigned her position on Barnard's original Board of Trustees. In 1890 she moved to Albany, New York, where her husband worked for the State of New York. In 1904 the family returned to New York City and two years later she founded a school for girls in Greenwich, Connecticut, where she taught for 20 years. She was honored in 1933 when Columbia hung her portrait in what was then the woman's graduate clubroom in Philosophy Hall; its inscription reads: "She opened the door."

Although they were the first two American women to be awarded Ph.D.'s in mathematics, neither Ladd nor Edgerton emerged from an intellectual vacuum. Ladd had studied with the astronomer Maria Mitchell at Vassar, and Edgerton was a product of an entirely female mathematics department of Wellesley College. Wellesley's mathematics faculty stayed entirely female for many years and most of the faculty had doctorates from among the best known schools in the country: Harvard, Johns Hopkins, the University of Chicago, the University of Pennsylvania, and Yale.

With that many women Ph.D.'s on the mathematics faculty at Wellesley, it is clear that Ladd and Edgerton did not lack for successors, although it did take another seven years, until 1893, for the second Ph.D. in mathematics to be awarded to a woman in this country. However, by the end of the nineteenth century Edgerton and Winston had been joined by eight women who had received Ph.D.'s in mathematics: three from Cornell, three from Yale, and two from Bryn Mawr College, both under the direction of Charlotte Scott. Even counting Christine Ladd-Franklin, the number eleven sounds quite small by modern standards. However, one must bear in mind that the Ph.D.

[9] "To restore ideal at Johns Hopkins." *New York Times*, 23 February 1926, 12.

was a far less common degree then than it is now and only about 150 American men had received Ph.D.'s in mathematics by the turn of the century.

After the turn of the century, the number of American women entering the field of mathematics began to increase and by the mid 1930s were sufficiently established to motivate a study of the history of American women in mathematics by Helen Owens, a 1910 Cornell Ph.D. in mathematics. This was not the case for African-Americans, with the first Ph.D. in mathematics having been granted by Cornell to Elbert Cox in 1925. It was not until twenty-four years later that the first African-American woman, Evelyn Boyd Granville (Ph.D. Yale 1949), earned a Ph.D. in mathematics. In 1993 Granville described Vivienne Malone-Mayes and Etta Falconer as her "two best students at Fisk," where Granville taught from 1950 to 1952. After graduating from Fisk in 1952 and 1953, Malone-Mayes and Falconer both received master's degrees in 1954, Malone-Mayes from Fisk and Falconer from the University of Wisconsin. Neither immediately received a doctorate, Malone-Mayes' was awarded twelve years after her master's and Falconer's fifteen years. During these intervening years a number of Black women received Ph.D.'s in mathematics, although by 1980 the number was still less than twenty-five. You can find information about other African-American women in mathematics at the website "Black Women in Mathematics."[10]

On the other hand, by 1940 there was one oriental woman, Shu Ting Liu (later Hsia) (Ph.D. Michigan 1930), and 224 white women who had been awarded Ph.D.'s in mathematics by American schools. About half of these women had attended women's colleges, including one who graduated from Oxford College for Women and three who graduated from Western College for Women, both now part of Miami University. The women who were students at Oxford and Western are fairly typical of the 225 women who received Ph.D.'s in mathematics in the US by 1939.

Rosa Lea Jackson graduated from Western in 1904. From that time until 1931, three years after she received her Ph.D., she taught in various colleges and studied at the University of Chicago. Immediately after receiving her bachelor's degree she taught at Athens College (now Athens State College) in Alabama, serving as head of the mathematics department and then as dean. After one year at Chicago she taught history and was dean at Central College in Lexington, Missouri. She then taught, first high school in Tennessee, then at Randolph-Macon, and then again at Athens College. In 1921 she returned to Chicago and received her master's the following year. She spent four years on the faculty of Northwestern before returning to Chicago for another year of study, 1926-27. The following year she was an instructor at Stanford and upon receiving her Ph.D. in 1928 moved to New York City where she taught first at Hunter College and then in the women's division of Brooklyn College. Jackson spent most of her career, 1931 to 1959, at what is now the University of Montevallo in Alabama.

Clara Eliza Smith (Ph.D. Yale 1904), who spent most of her career at Wellesley, most likely taught Helen Tappan (Western 1909) since she was on the faculty at Western 1907-08. Tappan's connection with the schools in Oxford began when she was a child. Her father, Reverend David Stanton Tappan, was president of Miami University 1899-1902 and it is for him that the dormitory Tappan Hall is named. Helen Tappan taught at Western for two years after earning her

[10] www.math.buffalo.edu/mad/mad0.html.

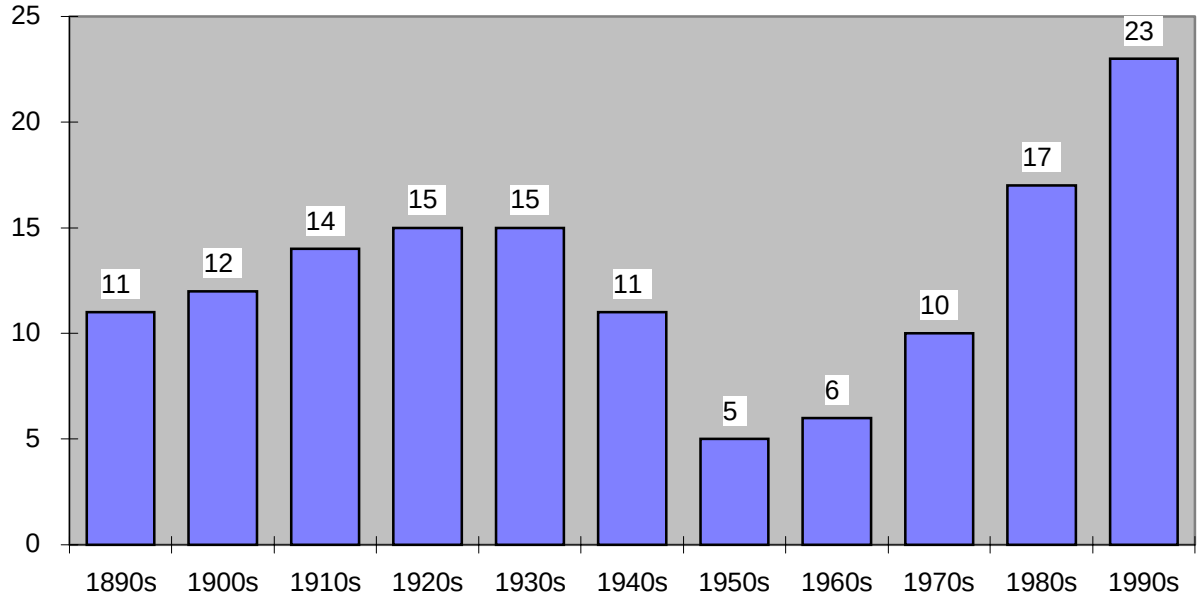
bachelor's degree and then went to Cornell where she earned a master's in 1912 and a Ph.D. in 1914. After a number of years at Iowa State, she returned to teach at Western in 1925. Tappan served as Dean of Women at Western from 1927 to 1941 and as academic dean from 1941 to 1944. In 1953 she was named as one of Western's ten outstanding living alumnae.

Tappan probably taught Anna Stafford (Western 1926) during Tappan's first year back and Stafford's last year as an undergraduate. Stafford and Tappan both appeared in plays at Western, Stafford having been "The Chief Villain" in a play by A. A. Milne of *Winnie the Pooh* fame. After graduating Stafford taught at private schools before enrolling at the University of Chicago where she received her master's degree in 1931 and her Ph.D. in 1933. She spent two years at the Institute for Advanced Study in Princeton and two years at the University of Nebraska before going to the University of Utah in 1937. She married Douglas Henriques, an administrative law judge, five years after coming to Utah and remained on the faculty another fourteen years before moving to New Mexico where she taught at what is now the College of Santa Fe until her retirement in 1971.

Mildred Ellen Taylor graduated from Oxford College in 1921, where she would have taken classes with Gertrude Iona McCain (Ph.D. Indiana 1918) who was a professor at Oxford from 1915 to 1921. Taylor, who was raised on a farm in central Illinois, received her masters degree from the University of Illinois in 1922 and her Ph.D. in 1931. She taught high school the year following her masters and then became an instructor at Knox College. She spent only one year, 1929-30, working full time on her doctorate. Following that year she went to Mary Baldwin College in Staunton, Virginia, where she stayed until her retirement in 1968.

During the period from 1886 to 1939 the percentage of women earning Ph.D.'s steadily increased. However, starting in the mid-1930s the percentages began to drop and by the mid-1940s they had dropped below ten percent, lower than at any in the first four decades of the century. Although the drop ended in the post-Sputnik boom, it took until the 1980s to reach the level of the 1930s and it took until 1991 to surpass twenty percent.

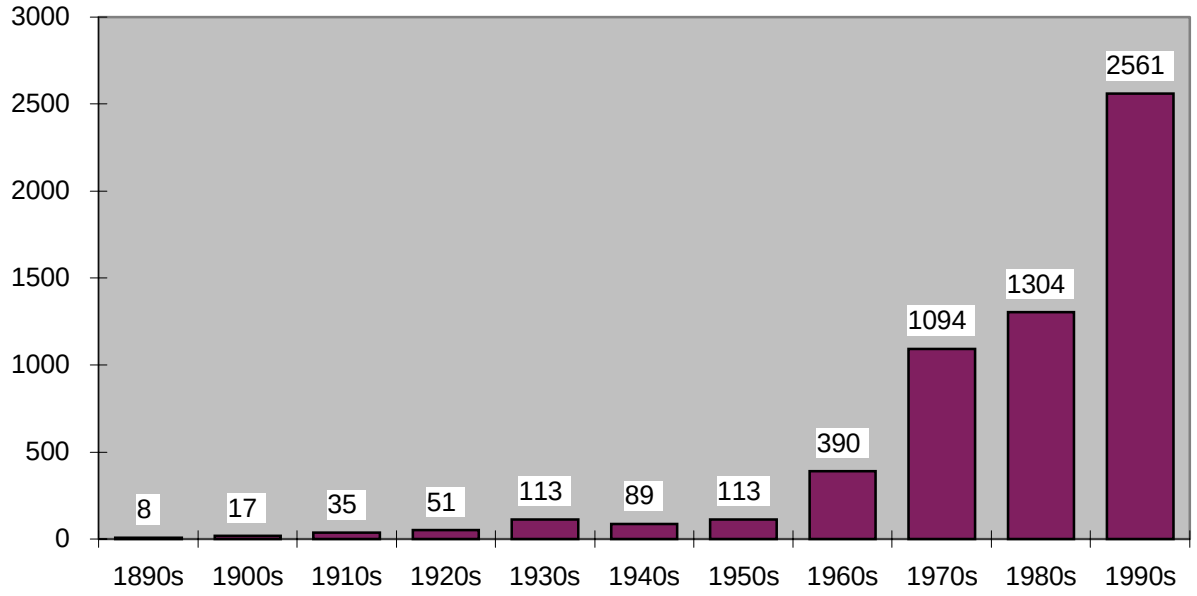
APPROXIMATE PERCENTAGE OF PH.D.'S EARNED BY WOMEN



While the percentages of women were dropping during the late 1930s through around 1960, the numbers dropped only from the mid-1930s through the mid-1940s. Furthermore, the increase from the 1960s to the 1970s in the percentage of women getting Ph.D.'s does not show the dramatic growth in the 1970s in the numbers of women getting Ph.D.'s. This growth continued into the 1980s, but at a slower rate. Since the 1990s, the numbers have been consistently above 200 Ph.D.'s being granted annually to women by schools in the United States. In 1999 the number exceeded 300 for the first time when 318 women received Ph.D.'s in mathematics in the United States; these women made up twenty-eight percent of all the Ph.D.'s granted in this country. If this growth continues, the visibility of women in mathematics should increase to the point where it will soon seem absurd to ask how many women mathematicians you can name.

It is only in recent years that women mathematicians have begun to receive the type of recognition that Emmy Noether received early in this century. Noether is the one woman mathematician who is universally recognized as one of the outstanding mathematicians of the twentieth century. While her father Max was a well-known algebraic geometer at Erlangen and her brother Fritz was a mathematics professor at Breslau, Emmy Noether is by far the best known of the three for her work in the development of abstract algebra. She is well known not only to mathematicians, but also to physicists, although mathematicians and physicists tend to be familiar with different aspects of her work. Despite having taught at Göttingen for many years, first without compensation and then for a small salary, she never held a professorship in Germany. In 1933 she was dismissed from her lectureship by the Nazi government and came to the United States to a guest professorship at Bryn Mawr, just two years before her death.

NUMBERS OF PH.D.'S EARNED BY WOMEN AT US SCHOOLS



One could easily talk for hours about Noether and her accomplishments but, as my time is up, I suggest you look at some of the references on the list I distributed; I especially recommend the biography *Emmy Noether. 1882–1935* by Auguste Dick[11].

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