Emmy Noether

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Doodle

Abstract

Emmy Noether was an early 1900s mathematician from Bavaria, Germany. Born before women were allowed to attend university, Noether managed to earn a PhD in Mathematics. Defying gender norms of the time she dedicating her life to redefining algebra. Through-out her life Emmy was constantly working through problems, from proving conservation in nature to helping create the subject of Abstract Algebra with her ring theorems.

1 Her Beginnings

Born on March 23, 1882 to Ida Amalia Kaufmann and Max Noether. She was the eldest of the four Noether children and the only girl. Her father was a mathematics professor at Erlangen focusing on algebraic geometrist. Her mother was from a wealthy merchant family. Her mother taught her everything a young woman in the late 19th century would need to know such as cooking and cleaning and as a teen she loved parties and dancing. **Nobel** Her brother Fritz became a well known applied mathematician. Growing up she was never rebellious in anyway, no one expected her to grow up and be the first at anything remarkable.

2 Her Education

Girls' schools at the end of the 1800s were primarily finishing schools, teaching girls languages, basic arithmetic, childcare, and other such subjects. Emmy then studied for three years to become a teacher. After completing a five day exam at the age of eighteen she was certified to teach girls French and English.

However she didn't stop there. During the late 1800s and early 1900s women were not allowed to attend university and receive a degree. Not that this stopped Emmy from obtaining a bachelors and a PhD in mathematics. But she didn't start out studying mathematics. She audited classes by asking the professors' permission. Since most of these professors worked with her father none had any problems with her sitting in on lectures. She started out by taking languages classes with the intention of teaching at a school for girls. She took a few math courses at this time and that changed everything.

In July of 1903 Emmy passed the entrance exam that granted her access into Bavarian universities. From there Emmy made the choice to leave home for the first time in order to attend university at Göttingen. However she did not stay long in Göttingen due to an illness. In October of 1904 she registered as a student at the University of Erlangen, since they finally changed their policy to admit women students. At Erlangen she studied primarily with her father and his friend, Max Gordan. Her exam results were so exceptional that the university granted her the equivalent of a bachelor's degree. University of Erlangen awarded her a PhD with highest honors. She earned her PhD after working under her father's friend, Max Gordan. Her doctoral thesis listed systems of covariant forms. **bio**

3 Emmy's Peers and Personal Life

As a woman in the early 1900s it was highly unusual for Emmy to have a PhD which didn't stop many famous mathematicians of the time from coming to her. From Einstein to Hilbert, Emmy was known to her peers as a brilliant and fresh mind. In 1915 Hilbert stumbled upon a problem of with invariant theory. He brought this problem to Emmy while she was at Göttingen, which she successfully proved laying the ground work for the Theory of Relativity. Albert Einstein took the time to read through her discoveries in order to stay up to day on algebra.

Emmy's name may have been well known among the mathematicians and scientists of the world, but her personal life did not extend much past her work. She never married or had a family of her own. Not much is known about her personal life. The letters she wrote to her peers were strictly discussing mathematics or conferences. There is no evidence that suggests that she had any desire for a family. She was an eccentric person, some comparing her to Albert Einstein.**Nobel** Once she found math, it enchanted her and kept her focus from the normal feminine conventions of her time. She was loud, energetic, caring, and messy. Her life revolved strictly around mathematics, she didn't need anything else to keep her happy.

4 Noether's Theorem and other theorems

Unfortunately it is difficult to find her original theorems because she rarely published her own books, instead her work was often published in as a part of books by her students and peers.

While Emmy is famous for her contributions to Abstract Algebra, her beginning theorems helped progress the physical sciences. In fact Noether's Theorem

is a physics theorem about conservation. In 1915 Emmy's theorem let 'physicists get conserved quantities from symmetries of the laws of nature. Time translation symmetry gives conservation of energy; space translation symmetry gives conservation of momentum; rotation symmetry gives conservation of angular momentum, and so on.'**Theorem** She also proved another theorem that set a base for elementary particle physics. These theorems is often first taught to students during Quantum Physics. Without these theorems Einstein couldn't move forward on his Theorem of Relativity.

Noetherian rings were named in honors of Emmy as she laid the ground work for these rings with her work in Abstract Algebra. "Let R be a commutative ring and M an R-module. We say that M is noetherian if every submodule of M is finitely generated." **Rings**Emmy was the one to find a way to bring the rings of polynomials and the rings of numbers. Her discoveries about rings were not widely known until Modern Algebra was published in 1930 by Van der Waerden. **modern**

A ring in abstract algebra is a ring in which the objects satisfy axioms and can be changed with two operations. The ring of integers is similar to the set of integers we use in other courses. A Noetherian ring is 'a in which every (ascending) chain of ideals is finite'. **AMT**

5 Professor Noether

Since women were not allowed to study at most universities, it was also extremely difficult for a woman to find a career in higher education at the time. For eight years after receiving her PhD she worked at the University of Erlangen without a formal position and without pay. As her father's health faded she slowly started taking on more of his responsibilities. During her time as a professor, Emmy over saw 16 PhD students, 12 of which were at the University of Göttingen.**students**

It was difficult for her to teach as a full time professor after her father passed away. She tried to find other positions and to have the university actually hire her. However Hilbert kept advocating for her to be hired by a university. He was very aware the only reason Emmy was not being hired was strictly based upon gender. Hilbert even went so far as to let Emmy lecture under his name in order to let students hear her speak.

Emmy was not good in the classroom. Often times her lectures were scattered and didn't care too much about a nice format. The students who understood her teaching style would benefit from her lectures. During her time teaching in America she lectured in broken English, sometime reverting completely to German when she got caught up in an idea. It was also a challenge for her to write about what she discovered, often times her brain moving much to find to stop and write out a formal explanation of why something worked the way it did.

While teaching in Germany, Emmy built up a collection of students who were dedicated to her teachings. As Hitler came into power the Jewish professors were slowly being pushed out of universities, with students claiming they didn't want to learn 'Jewish math'. However Emmy was the exception. Even after she was banned from teaching at universities her students would join her for secret math classes. It wouldn't be too strange to imagine a group of students

dedicated to learning going out of their way to go to secret classes, but some of these students were a part of the movement. However these students chose to ignore that Emmy was everything the movement was against.

6 Emmy in America

Unfortunately once again Emmy's gender made it difficult for her to find a job in America. As a Jewish woman, Germany was no longer safe for her but she couldn't leave Germany until she received a fellowship. While most of her peers ended up at Princeton University, the only job she was offered was a teaching position at Bryn Mawr College.

She only taught one course at Bryn Mawr even though she was on staff for almost two years. She passed away on April 14 at Bryn Mawr hospital a few days after a surgery. Following her death the New York Times placed a small obituary as they do for any Bryn Mawr professor after their death.

A few weeks after her death Albert Einstein sent a letter to the editor of the New York Times. In his letter he went on praising Emmy for her work in mathematics. "Fraeulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began."**Einstein**

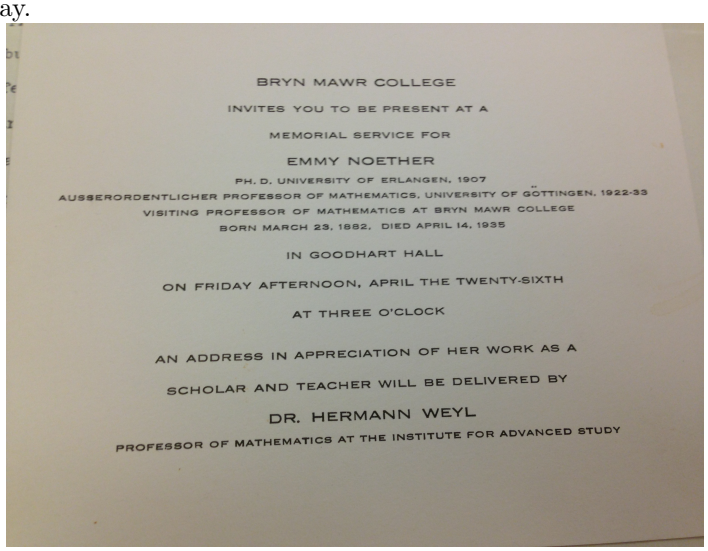
Unfortunately, Emmy was cremated after her death and her ashes went into a drawer in 1935. No one seemed to realize she never was buried properly. Instead while Bryn Mawr was moving books into a new building in 1964 her ashes were found again. She was finally buried in September of 1964. She is buried in the Thomas Cloisters at Bryn Mawr College, her ashes are buried under the walk way on the South East walk way.

pic1

Emmy's headstone is a very simple cut stone with just her initials, her birth year and the year she died.


pic2

Emmy is buried in the Thomas Cloisters at Bryn Mawr, in the left picture her head stone is at the end of the walkway before the door. In the right picture her ashes are in the corner a few feet from where the tower meets the covered walkway.



pic2

An invitation to Emmy Noether's memorial service where Dr. Hermann Weyl gave his address on April 26, 1935.

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