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Written by Maureen Younger

VOICES

Emmy Noether: the mathematician who made her work add up against the odds

In her series on great women thinkers, *Maureen Younger* looks at Emmy Noether, one of the 20th century's greatest mathematical brains.

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If there was a pantheon in honour of history's greats down the ages there would be several centuries where great women were few and far between. Those few who did appear would often come from the upper echelons of society; their elevated social position granting them more freedom than the rest of their sex had been allotted.

Even in the West the freedoms and opportunities my generation take for granted and see as a birthright would have been unthinkable for my mother's generation. Coming from working class stock, my mother had exactly two options in life: marriage and work. Living in 1950s Dundee this usually meant working as a weaver in a jute mill.

Nevertheless some women did manage to break through the limitations that society tried to set them by dint of natural genius and sheer determination.

Take Emmy Noether. In a letter to the *New York Times*, Albert Einstein wrote: "In the judgement of the most competent living



mathematicians, Fräulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began." Yet most people haven't heard of her unless they happen to have a soft spot for

abstract algebra and theoretical physics.

Noether's career is a prime example of the hurdles women have had to face as she was continually refused the same opportunities that were granted to men with far less ability. Born in Germany in 1882, Noether had originally trained as a teacher of English and French, a well-respected path for a middle class German woman. However, instead of going on to teach she decided to study mathematics at university.

This wasn't as easy as it seems as, at the time, women were not officially permitted to study at German universities. Noether had to obtain permission from the relevant professor to sit in as a guest student. She did so and went on to sit the university entrance exam anyway.

She passed the exam but of course – you guessed it – being a woman she was still only allowed to sit in on lectures rather than be treated as a properly matriculated student. Fortunately for Noether, the rules changed and female students were allowed to matriculate the same as men and in 1904 she finally became a bona fide student at Erlangen University.

After completing her dissertation in 1907 the next logical step for Noether would have been to continue to study towards her habilitation (the highest academic qualification). But – yes, you guessed it again – women weren't allowed to do that, so instead Emily worked at the Mathematical Institute of Erlangen for seven years in an unpaid position.

In 1915 David Hilbert, regarded at the time as the greatest living mathematician, and Felix Klein (another well-respected mathematician) invited Noether to join the renowned mathematics department at Gottingen University. You'd think being recommended by two of the world's finest mathematicians would be enough but the appointment was blocked on account of her – yes, excellent guessing yet again! – gender.

For the next four years Noether lectured under Hilbert's name. Hilbert had invited Noether because he needed help on his work into the theory of relativity. It was a good job he did. As mathematician Van der Waerden writes: "*She came and at once solved two important problems.*" In a letter to Hilbert by Einstein the latter praises Emily's mathematical mind in this field and, let's face it, Einstein knew a thing or two about relativity.

Hilbert and Klein continued to fight for Noether to be officially recognised as a member of the Faculty. But it was only after the First World War, with men in short supply, that women in Germany were finally allowed to become professors.

In 1919, although Noether still did not hold a professorial chair, she was finally permitted to teach as a Privatdozent, meaning she could at last lecture under her own name. As such, she continued to work like this until 1923 when, with hyperinflation hitting Germany and her savings exhausted, she finally received a meagre payment for her teaching.

Noether remained at Gottingen mathematics department until 1933 when, because she was a Jew, she was dismissed from her post by the Nazis. The mathematician Weyl noted: "In the last summer we spent together in Gottingen ... When you were not allowed to use the institute's lecture halls you gathered your students in your own home. Even those in their brown shirts were welcome; never for a second did you doubt their integrity." Wisely deciding to leave Nazi Germany, Noether accepted a teaching post at Bryn Mawr College and left for America in 1933 and a year later she was invited to lecture at the Institute for Advanced Study in Princeton.

She died suddenly in April 1935 following an operation on her ovaries.

Now Noether is recognised as one of the greatest algebraists of the 20th century. Clearly a mathematical genius, lauded by some of the greatest mathematical minds of the 20th century, she still encountered obstacle after obstacle purely by dint of her gender. However, had she been less determined and tenacious or lacked the independent means to be able to work unpaid for so many years, Noether would have been even more of a footnote in history than she is today.

Given the obstacles women such as Noether had to face a mere 100 years ago, when pondering why down the centuries there have been so few "great women" maybe what we should be wondering is not why there are so few, but how there were any at all. We may still have some way to go to reach the finishing line when it comes to equality, but it wasn't that long ago that the obstacles women faced meant it was a mere hardy few who even got to the starting line, let alone were able to race down the track.

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