The Great Mathematician Emmy Noether
(1882–1935)

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Introduction

Emmy Noether was a German mathematician in Göttingen University in the early 1900s.

Pronunciation

$$'nø:te$$

Not as in "another". Pronounce it like neuter, but with a long "u" sound. [3]

Contributions

1. Abstract mathematics
2. Noncommunicable algebra
3. Theoretical physics

Described as "fat, rough, and loud, but so kind, humorous and sociable that all know new her loved her" [1].

Early Life

- Born in Erlangen, Germany on March 23rd, 1882, to a Jewish family.
- Not a child genius of prodigy.
- Two slightly younger brothers and one much younger brother.

Figure: Noether, Emmy; Noether, Alfred; Noether, Fritz; Noether, Robert – Annotation: vor 1918 – Source: Konrad Jacobs, Erlangen [3].

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University Education

- Since woman were unable to attend, Noether had to audit classes at the university of Erlangen.
- She graduated from a *Realgymnasium* in Nuremberg [3].

Graduate Program

- Noether returned to the University of Erlangen after the prohibition was lifted.
- In 1907, she wrote her dissertation "Über die Bildung des Formensystems der ternären biquadratischen Form" (On Complete Systems of Invariants for Ternary Biquadratic Forms, 1907) [1].
- For her dissertation, over 300 different forms of invariance were listed as her supervisor suggested to her. At the same time, David Hilbert's work was making this expensive process largely irrelevant.

Teaching at the University of Erlangen

- From 1908 to 1915, she taught at the University of Erlangen without pay. Noether was introduced to some of David Hilbert's work, and began working on abstract algebra.
- Noether was eventually invited to teach at the prestigious University of Göttingen by David Hilbert.

- Despite the university administration's wishes, she taught there from 1915, where she was allowed to enter *habilitation* (tenure) in 1919.
- At Göttingen, she produced most of her work on abstract algebra, as well as proving Noether's Theorem, an important symmetry result in theoretical physics.

Fate

- Emmy Noether never married or had children.
- After the Nazi Party's "Law for the Restoration of the Professional Civil Service", she was exiled out of the university.
- She left for America in 1933 and died two years later in 1935 in surgery [1].

Excerpt from Einstein's Obituary of Emmy Noether

"Fräulein Noether was the most significant creative mathematical genius thus far produced since the higher education of women began." [2]

Mathematical Contributions

Noether's Theorem

For every physical conservation, there is a differentiable symmetry.
For example, the Lagrangian formulation of classical mechanics provides
the corresponding symmetry for the conversation of energy [1].

Over the course of her life, she worked on many developing mathematical
fields [1].

1. Algebraic invariance
2. Abstract algebra – primarily theory of rings.
3. Non-commutative algebra and arithmetic.

Potentially her greatest contribution

Noether was also known for her consistently invaluable advice.
Often, she would inspire students with well-placed ideas and
improvements, rarely taking credit for her own work [3].

Interesting Facts

Striving against the academic norms, Noether pursued a fervent passion in mathematics, often with a complete disregard for society's restrictions:

- Sending postcards continuing trains of thought on mathematics to associate Ernst Fischer.
- Becoming so passionate about mathematics as to forget:
  1. table-manners
  2. food
  3. frazzled hair
  4. and others.
- Attending classes at a college you cannot attend.
- Teaching at a university for no salary.
- Allowing on many occasions other people to publish her ideas.
- Leaving half of her small salary to her nephew.

Personal Favorite

Fast-paced lectures often confusing to outsiders. So confusing, one student said of another observer, "The enemy has been defeated; he has cleared out." [1].

Conclusion

Emmy Noether struggled immensely to leave an impact on the world of mathematics.

Her own work, either directly or indirectly, has reached many diverse fields.

It is likely her unexpected death robbed the world of many further great achievements.

She will be remembered not only for her mathematics, but for

- persistence
- courage
- constant advice
- and finally as an inspiration to the rest of us.

Questions?

📄 A. DICK, *Emmy Noether 1882–1935*, Springer, 1981.

📄 A. EINSTEIN, *Professor einstein writes in appreciation of a fellow-mathematician*, New York Times, 5 (1935).

📄 EMMY NOETHER, *Emmy noether — Wikipedia, the free encyclopedia*, 2018.
[Online; accessed 25-May-2018].