

Hearing voices

Ellis McCarver and Michelle Francl want to turn up the volume of the voices of marginalized chemists.

The two of us hear voices in the walls. Neither of us have seen a drenched woman with long hair in a ruined lab coat come wailing out of the solvent cabinet — though such a haunting could explain much about the failing rotavaps — but we do hear the voices of the women who walked these halls in the last century. We listen because they have things we need to hear in this century if our field is to flourish.

In the cloisters adjoining the old library at Bryn Mawr College where we work, there is a stone tablet carved with the initials 'EN' set into the walkway (pictured). It is unlikely many people know that beneath the stone lie the ashes of the eminent German mathematician Emmy Noether, whose work on symmetry and conservation is foundational to much of modern physics. In 1933 Noether fled Germany as the Nazis came to power, coming to Bryn Mawr. Neither nearby Princeton University nor the Institute for Advanced Study, which had welcomed other refugee scholars such as Albert Einstein and Hermann Weyl, were apparently willing to grant a position to a woman¹. For several years Noether's desk sat unmarked in an alcove near a classroom where one of us (MF) taught quantum mechanics. Each time I went to class I let my hand brush over the desk, hoping to soak up some small piece of Noether's mathematical genius as well as her interactive teaching style. She flipped her classroom long before it was a trend. I missed the desk when it was moved during a renovation, but I still hear Noether's faint whisper in my ear encouraging me to bring an interesting new problem to class for my students to solve.

Some of the voices have been muffled. Despite walking past a building bearing her name every day for nearly four years, it took one of us (EM) until their senior year to learn that Enid Cook — the first Black student to graduate from Bryn Mawr — studied the same subject they did: chemistry². In the late 1920s Cook fought hard for admission to the college, opposed by the formidable (and formidably racist) former president of Bryn Mawr, M. Carey Thomas³. Though eventually allowed to matriculate, the college refused to let Cook live on campus, forcing her to live in town and walk to campus each day. Cook nevertheless persisted, graduating in 1931 with degrees in chemistry and biology. She went on to the University of Chicago



The stone that covers the ashes of Emmy Noether at Bryn Mawr College, Pennsylvania, USA.

to earn her doctorate in virology. In 1946 Cook became head of the Public Health Laboratory in Panama City and eventually a founding member of the faculty at the University of Panama's School of Medicine. She published broadly in virology and epidemiology⁴, occasionally with her husband, Arcadio de Rodaniche⁵, but we know little about the life of this determined woman beyond her publication record⁶. EM wonders whether Cook was angry at the people who held her back. They wish, too, that they could soak up Cook's determination and dedication.

Enid Cook's missing biography is more the norm than the exception, particularly for members of minoritized groups, including women of any ethnicity. In a recent interview, mathematician Ranthony

Edmonds, who developed a course at The Ohio State University on the mathematics and mathematicians hidden in plain sight around the region, laments these missing narratives. She points out, 'We often see the end results but we don't often see the journey'⁷. In the 1990s the American Chemical Society, recognizing that there is value — particularly for young chemists — in hearing about chemists' journeys and hoping to inspire the generations that follow, commissioned a series of autobiographies of 22 distinguished organic chemists⁸. Still, as reviewers at the time noted, the range of voices was limited⁹. No women of any ethnicity or Black organic chemists, such as Gloria Long Anderson, Madeleine Joullié or Fillmore Freeman¹⁰, were included. We know that the stories we tell about how

Box 1 | A brief and idiosyncratic bibliography of sources of interesting people and narratives in science

Patricia Fara. *A Lab of One's Own* (Oxford University Press, 2018).

Jeanette Brown. *African American Women Chemists* (Oxford University Press, 2011).

Jeanette Brown. *African American Women Chemists in the Modern Era* (Oxford University Press, 2018).

Margaret Rossiter. *Women Scientists in America: Forging a New World Since 1972* (Johns Hopkins University Press, 2012).

Marco Fontani, Mariagrazia Costa & Mary Virginia Orna. *The Lost Elements: The Periodic Table's Shadow Side* (Oxford University Press, 2015).

Patrick Coffey. *Cathedrals of Science: The Personalities and Rivalries That Made Modern Chemistry* (Oxford University Press, 2008).

Rachel Ignatofsky. *Women in Science: 50 Fearless Pioneers Who Changed the World* (Ten Speed Press, 2016).

Kathleen Lonsdale. The structure of the

benzene ring in $C_6(CH_3)_6$. *Proc. Roy. Soc. A* **123**, 494–515 (1929).

Kit Chapman. *Superheavy: Making and Breaking the Periodic Table* (Bloomsbury Sigma, 2019).

Roma Agrawal. *Built: The Hidden Stories Behind our Structures* (Bloomsbury Publishing, 2018)

Hasok Chang. *Inventing Temperature: Measurement and Scientific Progress* (Oxford University Press, 2008).

James Kessler. *Distinguished African American Scientists of the 20th Century* (Greenwood Publishing Group, 1996).

Ruth Hege Howes & Caroline L. Herzenberg. *Their Day in the Sun: Women of the Manhattan Project* (Temple University Press, 2003).

Anna Reser and Leila McNeill. *Forces of Nature: The Women Who Changed Science* (Frances Lincoln, 2021).

Nature Chemistry 'In Your Element' Series; <https://go.nature.com/3xahDBm>

science and scientists worked in the past subtly shapes who does science today. Whose stories are we telling now?

It is not autobiographies but textbooks that give beginning students the bulk of their images of chemists, yet the diversity of voices remains dismayingly limited at the college level. A recent study by Mona Becker and chemist Melanie Nilsson has shown that general chemistry textbooks feature men far more than women¹¹. The authors acknowledge that the binary frame they used fails to register the broader landscape of gender, and so provides only a partial picture of gender representation in these texts. Becker and Nilsson report that men were represented in illustrations much more prominently than women (by more than a factor of two). A man's name appears in a text roughly once every four pages. A woman's? On average once every 250 pages.

Though it might be tempting to suggest this imbalance arises because the key early chemists were men, Becker and Nilsson point out that the texts they examined had no consensus list of key figures. Only eight scientists appear in every text: Svante Arrhenius, Robert Boyle, John Dalton, Dmitri Mendeleev, Linus Pauling, Ernest Rutherford, Robert Millikan and Joseph Thompson. In one text, James Cusumano (a proponent of sustainable development)¹² gets a mention whereas Stefanie Horowitz (who proved the existence of isotopes) does not. Gender representation in the

text EM used for general chemistry is not substantially more diverse than it was in the era MF took the course, despite changing demographics in the field over the intervening four decades. There were three women scientists listed in the index of the 1977 edition of that text, forty years later there were four. And yes, one of them was Marie Curie.

The imbalance in gender representation in textbooks is paralleled by an extraordinary lack of racial and ethnic diversity. In the most recent text that I (MF) pulled off my shelves, I had to go almost 300 pages before any person of colour appeared — two women in traditional garb carrying water. Even all the disembodied hands appear to belong to white people. At a time when 45% of US bachelor's degrees in chemistry are earned by students of colour and 50% are earned by women, the book feels particularly out of step and MF will no longer assign texts that don't represent the students in her classroom.

How can we amplify these muffled voices for our students? One obvious step is to demand textbooks that reflect the diversity of the population. But one needn't wait for texts to catch up or for particular celebrations to arise, be they Black History Month or International Day of LGBTQIA+ People in STEM. Try consistently doing small things, microresistance to counter microaggression. MF routinely includes short biographical sketches of chemists on

assignments, with an emphasis on the stories of minoritized groups and chemists working in a wide variety of fields and situations. Many departmental colloquia series regularly feature a short safety briefing; a history minute could be added to the rotation.

There are many resources one can draw from, a brief bibliography is included in Box 1. Historian and medicinal chemist Jeanette Brown's two volumes on Black women chemists in the US are on MF's shelf and are a rich source about the lives of these scientists^{13,14}. Physicist Jess Wade has contributed hundreds of biographies of scientists from marginalized groups to Wikipedia. Browse Andy Brunning's collection of chemistry cards that highlight women working in the field¹⁵. Follow Ranthony Edmonds' lead and keep an ear out for the stories of local chemists. Seek out diverse stories of chemists from your own campus and community. This Thesis essay had its origins in a presentation the authors did on the first Black chemists at Bryn Mawr. Do not be tempted to tack up a poster of Marie Curie and leave it at that.

"If I have seen further it is by standing on the shoulders of Giants" wrote Isaac Newton to Robert Hooke in 1675 (ironically paraphrasing a predecessor, the 12th century philosopher Bernard de Chartres)¹⁶. We take it as a given that we build on the scientific achievements of those who preceded us, but we also look to their lives hoping to learn how they reached those heights, and perhaps imagining we can do the same. How often did we hear in the early days of the pandemic of Newton, developing the calculus at his country estate while plague ravaged London, with its tacit challenge — what are you doing with your time at home? But perhaps it was Kathleen Lonsdale solving the crystal structure of hexachlorobenzene at her kitchen table shortly after the birth of her first child (acutely aware of what it took to juggle caregiving and research) whose story we really needed to hear as we struggled with the pandemic's challenges¹⁷. We are stronger from hearing all the stories.

If we don't value the past contributions that marginalized groups have made — if we ignore the faint voices in our walls — our students might reasonably think that we will not value their contributions in the present or going forward. We desire to be part of a diverse community, not because we want the field to be better positioned to solve the hardest and most pressing issues facing us — though it surely cannot hurt to have more brilliant scientists working on such problems — but because it is a matter of justice and human dignity. Students at Bryn Mawr went on strike last fall over the

institution's habitual failure to see and hear people of colour on campus. We need to create conditions where modern-day Enid Cooks can thrive because of the people and structures around them, rather than in spite of them. We need to listen to the voices in the walls, then turn up the volume so students and colleagues can hear them more clearly. Their lives matter. 

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Competing interests

The authors declare no competing interests.