

CANADIAN CONTRIBUTIONS

Dean of the Faculty of Science at Ryerson University in Toronto discusses how Canadian science is increasing equity, diversity and inclusion

Who are the Canadian scientists we should be celebrating on the next banknote? This was a question I was asked recently, but the question had a twist. On International Women's Day, 8 March 2016, the prime minister of Canada, Justin Trudeau, announced that an iconic Canadian woman would be on the next series of bank notes.¹ The Bank of Canada launched public consultations and the Canadian public is offering suggestions, ideas and comments. While there are some internationally recognised Canadian women writers and artists, such as Lucy Maud Montgomery, Canadian female scientists are relatively unknown. On 10 April 2016, I was a guest on the national radio show, Cross Country Checkup, where I was asked to speak on the topic of Canadian women scientists as candidates for being printed on our money.²

As science returns to the centre stage in Canada,³ and diversity and science communication are proposed as national priorities by the major science-funding agency,⁴ this is a good time to celebrate the contributions of Canadian scientists in a way that will make them more regularly visible. Canada, like many other countries, celebrates its athletes and contemporary artists to an extreme degree,^{5,6} but Canadian scientists, male or female, are rarely as well-known internationally. Celebrating our scientists by including them on our money helps to bring attention to their contributions, and reminds us that science is an important part of our national fabric.

But which Canadian female scientists should we put on a banknote?

Perhaps surprisingly to Canadians there are many potential candidates. A leading contender for a permanent placement on a banknote is Dr Maud Menten (1879-1960), a physician-scientist whose name is part of an equation learned by every first-year biochemistry student. While all students learn the Michaelis-Menten equation, very few learn about either Dr Michaelis or Dr Menten. Canadian schoolchildren learn a lot about the European pioneers who laid the foundation of the Canada we know today, so they should also hear the stories of the remarkable Canadian scientists who were also pioneers and contributed to fundamental discoveries. We should especially be celebrating the achievement



Dr Maud Menten (1879-1960)

of female pioneers in science who were often not appreciated or celebrated in their lifetimes.

The origin of the Michaelis-Menten equation came from the collaboration of Dr Maud Menten with Dr Leonor Michaelis, who had a research lab in Berlin. Menten moved to Berlin following her graduation from the programme in medicine at the University of Toronto. She was one of the first women to graduate with a medical degree in Canada and, following her work with Michaelis, subsequently completed a PhD at the University of Chicago. The work of Michaelis and Menten, showing that enzyme-catalysed reactions could be predictable depending on substrate and enzyme concentrations, was an important contribution to the development of enzyme-inhibiting drugs and the Michaelis-Menten equation is still part of the standard biochemistry curriculum around the globe.⁷

Another pioneering woman in science in Canada was Dr Alice Wilson (1881-1964) who, in 1938, became the first woman elected to the Royal Society of Canada (RSC). The RSC subsequently created an award in her memory, noting: 'Dr Wilson was a world-renowned palaeontologist and one of Canada's foremost geologists. Her career with the Geological Survey of Canada lasted from 1909 to 1946, while she advanced from museum assistant to geologist. In addition to her research contributions, she brought geology to the public, especially to children, in many ways.'

Harriet Brooks (1876-1933), who graduated from McGill University in 1901, was perhaps Canada's first nuclear physicist and possibly the only person to have ever worked with three Nobel prize winners, Ernest Rutherford, Marie Curie, and JJ Thomson.⁸ Her research and ideas were key to the development of Rutherford and Frederick Soddy's hypothesis that radioactivity results from the disintegration of atoms. Both Rutherford and Soddy were ultimately awarded Nobel prizes for their discoveries. In contrast, Harriet Brooks was asked to resign from her position as a physics tutor at Barnard College in New York City when she became engaged to a physicist from Columbia, reflecting the very different attitudes that society had at that time towards women pursuing a career in science compared to men.

Brook's letter of resignation clearly expresses her frustration and unhappiness with these attitudes: 'I think it is a duty I owe to my profession and to my sex to show that a woman has a right to the practice of her profession and cannot be condemned to abandon it merely because she marries. I cannot conceive how women's colleges, inviting and encouraging women to enter professions can be justly founded or maintained denying such a principle.'

Taken from *'Remembering Harriet Brooks: Canada's first female nuclear physicist'* by Ingrid Birker.⁹

Candidates for banknote status are required to have been dead for at least 25 years, so Maud Menten, Harriet Brooks and Alice Wilson were scientists in an era where attitudes were openly biased against women scientists. Certainly, times have changed and barriers to the full inclusion of women and other under-represented groups in science have been dismantled to some extent. However, real diversity in science is still not present in Canada and the lack of equity and inclusion has been recognised as a barrier to economic development and innovation.

Stereotypes

Stereotypes about women and science still exist in many parts of the world, including Canada. For instance, the 2015 L'Oreal Foundation Report found that '67% of Europeans think women lack abilities to become high-level scientists'. Some disciplines, such as physics, have openly acknowledged their own diversity problems¹⁰ while at the same time struggled to come to terms with a culture of sexism and harassment.¹¹ In Canada, Statistics



Harriet Brooks (1876-1933)

Canada data suggest that the proportion of women graduating from STEM programmes in recent years is about 39% and, while these numbers may be encouraging, they say little about the experience of those women.

Various studies (including my own work) suggest a common feeling among young women in science of self-doubt and a prevalence of imposter syndrome. The feeling of 'not belonging' dissuades women from pursuing STEM careers as academic scientists leading to the over-used metaphor of the 'leaky pipeline'.¹² There are many problems with this metaphor, including the concept that there is something wrong with those (the 'drips') who chose to leave the pipeline – as if there is only one path. Obviously this is nonsense and, if anything, there is no such thing as a pipeline. I have suggested frequently that we consider, instead, the metaphor of a manifold.

Indeed, the idea of women (and other under-represented groups) 'dripping' out of some optimal pathway only compounds a sense of guilt and failure. Ironically, science (elsewhere in Canada) struggles to view itself as objectively and I continue to be surprised at how un-scientific some of my colleagues in science are, when it comes to data and evidence that demonstrate bias against diversity in STEM. I continue to encourage my colleagues to read *Through Both Eyes: The Case for a Gender Lens in STEM* produced by the organisation Science Grrl (2014).



Top left: Eden Hennessey, Top right: Vanessa Vakharia, Bottom left: Imogen Coe, Bottom right: This is what science looks like at Ryerson University

The new federal government in Ottawa appears to appreciate the value and importance of diversity in STEM, so there is optimism that the situation for women in science will improve and that mechanisms and programmes will be put in place to remove barriers to full inclusion, allowing diversity to happen. A number of national forums are now clearly promoting and celebrating Canadian scientists (who just happen to be women). For instance, Canadian Science Publishing, a national organisation supported by the National Research Council (NRC) of Canada, has produced a popular women in science blog.¹³

Among my own network, there is a remarkable number of talented women in science and/or education, who are committed to challenging stereotypes and removing barriers to allow diversity to flourish in STEM in Canada. Vanessa Vakharia, is the founder and chief inspiration officer of a studio devoted to developing skills and confidence in maths. She is, literally, the maths guru and says: “We love showing students that their brains are like kaleidoscopes and that math and science are simply part of the stained glass.” Vanessa’s approach to mentoring and tutoring young women in maths is evidence-based. Her master’s thesis, from the University of British Columbia, is entitled ‘Peace, Love & Pi: Imagining a World Where Paris Hilton Loves Math’ and is widely recognised as one of the first academic studies in Canada to investigate the influence of marketing and media on perceptions of maths education. Vanessa is passionate about empowering young women in STEM and frequently talks to schools, the popular media providing advice for parents and students.



Vanessa also challenges stereotypes in that she is the maths guru as well as a talented musician who regularly performs with her band, Goodnight Sunrise (<http://www.goodnightsunrise.ca/>).

Another remarkable young woman making a contribution to the dialogue about diversity in STEM is Eden Hennessey (advised by Dr Mindi Foster) who is conducting doctoral research in social psychology at Wilfrid Laurier University. Hennessey’s dissertation assesses whether female confronters of sexism in STEM perceive and incur greater consequences than other women. She also explores how virtual mentors and strong scientific identities impact the consequences of confronting sexism in STEM. Eden’s recent research indicates that when STEM women imagined themselves confronting sexism in a non-STEM context they felt less psychological distress and believed others would view them as more competent. However, when they imagined confronting sexism in a STEM context, women perceived a science subject as more difficult. These findings suggest that women in STEM find non-STEM contexts more conducive to confronting sexism.

Hennessey received international media coverage when she created a photo-art installation based on her research in collaboration with photographer Hilary Gauld titled ‘#DistractinglySexist: Confronting Sexism in Canada’s Tech Triangle.’ The title reflects women’s responses to controversial remarks by a British Nobel Prize laureate who referred to females in the lab as ‘distractingly sexy’. Eden’s work attracted the attention of the Canadian press (<http://www.cbc.ca/news/canada/kitchener-waterloo/distractinglysexist-exhibition-highlights-sexism-in-science-and-tech-1.3236499>) and beyond. For example, her exhibitions have now reached people in her local community of Kitchener-Waterloo (known as ‘Canada’s Silicon Valley’), the Cambridge YWCA, Engineers Without Borders, but also in New

York, Los Angeles, and Texas. Hennessey's installations are inspired by her ongoing work as student research co-ordinator for the Laurier Centre for Women in Science (WinS) – an active research centre that supports and facilitates research by and about women in STEM.

Hennessey is following up the initial installation with a larger project, again in collaboration with Hilary Gauld, called '#DistractinglyHonest', which further illustrates experiences of STEM women and their allies. Her call for participants for the larger project was met with an enthusiastic response from women across a much broader region than the original project, reflecting the intense interest in the topic of women in STEM.

Diversity

There is no shortage of creativity and innovation among those interested in and inspired by STEM in Canada. The key is to ensure that real opportunities to contribute to and participate in STEM disciplines exist for all members of our national community. At Ryerson University in Toronto, we fully recognise the value of diversity, reflected in the existence of the award-winning Diversity Institute (<http://www.ryerson.ca/diversity/>). Within the Faculty of Science at Ryerson University, we have made 'Humanity in Science' and 'Access and Impact' two of our six guiding principles. These principles recognise the value and importance of making science at Ryerson reflect humanity, in all its glorious diversity, while ensuring that we engage scientifically, socially and culturally with our diverse communities and provide access to those who might not otherwise have connections to science.

Diversity is recognised to be a driver of innovation and creativity¹⁴ and, given the complex problems that face us, locally and globally, it is imperative that Canada fully embraces and mobilises as much intellectual power from its population as possible. Major challenges remain in raising awareness of the reality of the existence of barriers to inclusion, such as the cultural conditioning that enforces stereotypes¹⁵ and excludes participation.

With increasing equity, diversity and inclusion of all members of the community, Canada is well positioned to build on the contributions of the pioneers in science, such as Maud Menten, Alice Wilson and Harriet Brooks. A future that embraces diversity and encourages the contributions of all members, regardless of gender, race, ethnicity or sexuality, will be a more promising future for everyone.

- 1 <http://www.cbc.ca/news/politics/woman-money-bill-1.3481848>
- 2 <http://www.cbc.ca/radio/checkup/blog/new-banknote-should-honour-women-in-stem-scientist-1.3530617>
- 3 <http://www.paneuropeannetworks.com/special-reports/science-returns-to-centre-stage-in-canada/>
- 4 <http://www.universityaffairs.ca/news/news-article/nsercs-big-plans-for-the-next-five-years-funds-pending/>
- 5 <http://thechronicleherald.ca/opinion/1248003-we-ve-created-a-warped-celebrity-worship-world>



Dr Imogen R Coe and her trainees, Ryerson University, Toronto, Canada

- 6 <http://oicr.on.ca/news/portal-news/lifetime-achievement-dr-maud-menten>
- 7 <http://www.cihir-irsc.gc.ca/e/48767.html>
- 8 <http://publications.mcgill.ca/reporter/2011/03/women%E2%80%99s-day-profile-remembering-harriet-brooks-canada%E2%80%99s-first-woman-nuclear-physicist/>
- 9 <http://www.loreal.com/media/press-releases/2015/sep/the-loreal-foundation-unveils-the-results-of-its-exclusive-international-study>
- 10 http://www.iop.org/policy/briefing/page_59167.html
- 11 <http://www.nature.com/news/2008/080423/full/452918a.html>
- 12 <https://www.insidehighered.com/views/2015/03/03/essay-calls-ending-leaky-pipeline-metaphor-when-discussing-women-science>
- 13 http://www.cdnsiencepub.com/blog/Women_in_Science_.aspx
- 14 <https://www.scientificamerican.com/article/how-diversity-makes-us-smarter/>
- 15 http://www.huffingtonpost.ca/dr-imogen-coe/gender-stereotyping-stem_b_7423048.html

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