

FOREWORD TO THE SPECIAL SCIENCE OUTREACH ISSUE

We live in a society exquisitely dependent on science and technology, in which hardly anyone knows anything about science and technology.

Carl Sagan

The debate about the role of science in modern society, the funding of basic research, and the future of science is not new [1]. Exactly 150 years after its founding, Canada finds itself at the proverbial “science and technology crossroads”. We, as a society, have to decide if our country is going to be amongst the world’s science leaders and innovators, or are we going to keep relying on our natural resources and become consumers of the science discoveries and technological innovations produced by others? Today, science funding and especially basic research funding in Canada is under continuous threat and it does not look like the situation is going to improve in the near future. As was pointed out in the March 2017 news release by the Canadian Association of Physicists (CAP), the proposed 2017 Federal Budget allocates little new spending for science in the upcoming year [2]. While the Budget attempts to emphasize innovation and a technology-driven economy, it is unclear how this goal can be achieved without a significant increase in support for fundamental research and for educating the next generation of Canadians who are interested in pursuing scientifically-oriented careers [3].

Inadequate funding for basic research and the lack of engagement by Canadian scientists in our political system have significant implications not only for the Canadian science community, but for our economy, healthcare system, and Canadian society at large. Therefore, there is an urgent need for scientists to communicate their work to the general public in a comprehensible and engaging way, so lay people (including most Canadian politicians) can understand and appreciate the contributions of science to our society and the ever-increasing role science plays in our lives. Interestingly, one of the greatest scientists in the history of physics, Michael Faraday (1791-1867) realized this almost 200 years ago. In 1825 Faraday established the Royal Institution Christmas Lectures that have continued to be held annually except during the Second World War.

Michael Faraday hosted 19 of these lectures and many other notable scientists followed in his footsteps. However, despite the increasing role of science and technology in our society and an increasing ability to watch lectures given by world-class scientists and popularizers of science, such as George Gamow, Richard Feynman, Carl Sagan, Stephen Hawking, Michio Kaku, Lawrence Krauss or Brian Green, online, the general public in Canada is by and large disengaged if not alienated from science.

It is somewhat paradoxical that the more we as society become dependent on the results of fundamental scientific discoveries (such as the general and special theories of relativity, quantum mechanics, atomic and nuclear physics), the less we are interested in and appreciative of science as an intellectual endeavour. This can be seen from the growing disengagement of Canadian youth from science, technology, engineering and mathematics (STEM) subjects and careers [4,5]. Similar trends are happening in other countries [6-9]. The problem of youth disengagement from STEM is so widespread that a number of governmental education agencies all across the world have attempted to address it by introducing new and often innovative STEM curricula [10-12] or inviting foreign scientifically-oriented skilled workers to do the jobs that that country’s citizens are not capable of doing [13]. For example, the focus of the new science curricula in British Columbia is on big ideas in science, the interplay between STEM fields, and applications of STEM to students’ lives. However, changing science curricula or educating better science teachers will not solve the problem, unless we also attempt to engage the wider population in science. For example, there is ample evidence that parents have an important influence on students’ engagement with STEM [14-16]. Therefore, if we want to change society’s attitudes about science and its value in modern society, we should consider how to engage parents in science as well as their children [14,15,17,18].

Considering the challenges of the graying population and the need for highly skilled workers facing Canada, it should not come as a surprise that the 2017 Federal Budget also proposes “new funding to help Canadians prepare for



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the economy of tomorrow by promoting the development of STEM skills and digital literacy, particularly for women, girls and underrepresented groups” [3]. This is a clear statement that in order to be competitive on the world stage, Canada needs to engage a wider share of its population in STEM fields. This can be done by increasing the emphasis on STEM outreach to the general public and scientists’ engagement in this outreach.

As the CEO of the American Association for the Advancement of Science, Rush Holt eloquently stated during the *Science Policy in the 21st century* session of the American Physical Society (APS) April meeting 2017 in Washington D.C.: “Science is not just for scientists” [19]. This is as true for Canada as it is for our southern neighbour or any other country for that matter. Science engagement should not be limited to formal educational settings, such as studying STEM subjects in K-12 schools. Science, like art, sports and music, should have a place in the lives of young and old, of students and their parents, of poets and of future prime ministers [20]. Science outreach should play a prominent role in this process [21].

Engaging all Canadians in STEM requires a concerted effort from universities, science research organizations, schools, museums, businesses, non-profit organizations and governmental agencies. The first step in increasing the engagement of Canadians in science is to acknowledge and consolidate public outreach initiatives that are already happening across Canada. Therefore, this special issue on science outreach in Canada is especially timely. We have invited scientists and science educators from all across the country to share public outreach activities they are involved in with the hope that their experiences can be adopted and adapted across the country. This way we will be able to learn from each other, exchange ideas and share experiences in order to build a more innovative, scientifically literate and prosperous Canada.

This issue includes 13 papers outlining various STEM outreach activities across the country. Theresa Liao and her collaborators from the University of British Columbia (UBC) Department of Physics and Astronomy report on the annual UBC Physics Olympics for secondary students that will celebrate its 40th anniversary next year. Marina Milner-Bolotin and her team from UBC Faculty of Education report on the Family Math and Science Day that engages future elementary and secondary teachers in STEM outreach to the general public. Stuart Shepherd and his collaborators from TRIUMF describe a special initiative – the IsoSiM Program – that trains the next generation of science leaders by providing rich and diverse experiences to graduate students in the production and application of radioisotopes. Sarah Johnson from Simon Fraser University in Burnaby reports on a semi-annual workshop series designed to encourage more young women to consider physics as a career path. Tracy Walker and her collaborators from the Canadian Light Source in Saskatoon describe educational programming for secondary students focused on promoting scientific inquiry and inspiring future scientists. Chitra Rangan at the University of Windsor shares a science outreach event, called Phunky Physics, that aims to provide

experiential learning opportunities for undergraduate and graduate students and promote science communication to the general public. Martin Laforest and the Communication and Strategic Initiatives team from the Institute for Quantum Computing at the University of Waterloo describe workshops they developed for students and teachers. They also outline a travelling museum exhibition built to raise awareness about quantum mechanics and quantum technologies. Shohini Ghose and her collaborators from Wilfrid Laurier University share a story of a very creative and innovative collaboration between the arts and the sciences – a provocative photo-research exhibit on sexism and science. Jo-Anne O’Meara from the University of Guelph describes a new initiative where undergraduate physics students are required to take the Physics Communication course and learn how to share their passion for physics with different audiences. Graham Pearson from Ryerson University Department of Physics reports on an outreach program designed to promote the field of medical physics to secondary students and to the general public in the Greater Toronto Area. The scale of the event described by Kelsey Miller – an Executive Director of Science Rendezvous – is very impressive. Science Rendezvous is the largest STEM outreach event in the country, annually reaching more than 300,000 visitors across all Canadian provinces and territories. In her paper she describes how a team of scientists and engineers, in the public and private sectors, as well as students and educators, has built a large-scale collaborative outreach event and what they have been able to achieve in the last decade. Lastly, Miriam Hewlett and her collaborators from Acadia University describe a different approach to high school outreach by post-secondary students. Their outreach effort was focussed especially on female high-school students in order to inspire them to pursue STEM post-secondary education.

As one can see from the selection of outreach initiatives outlined above, we did not try to make a survey of all public outreach in science happening across the country. Rather, we attempted to introduce the readers to some of these initiatives, especially programs with a physics focus, with the hope that scientists, science educators and educational leaders all across Canada might find an outreach activity that will inspire them to organize a similar event at their institution or in their community. While there is no universal recipe for successful science outreach, there are common elements that make these events memorable and successful: informative and entertaining science activities, clear and jargon-free science communication, an ability to engage the audience, and an openness to positive interactions between scientists and the general public. We also attempted to illustrate the benefit of science outreach activities for the people who facilitate them – undergraduate and graduate students, faculty members and research staff, as well as future teachers. We hope this special issue will illustrate the value of science outreach for the outreach providers, as well as for the general public.

We hope this issue will inspire more exciting STEM outreach activities across Canada. If, as a result of reading the papers in this issue, the readers decide to communicate with some of the

authors with the goal of learning more about these exciting initiatives in order to organize similar events at their institutions, we know we have achieved our goal.

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Comments of readers on this editorial and this issue are more than welcome.

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