

IS SCIENCE UNDER ASSAULT?

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At the 2019 meeting of the Royal Society of Canada, there was ongoing discussion about the perceived decline in public trust in science, the apparent assault on science and the role of scientists in addressing these issues. Over the past few years an anti-science movement appears to be growing. We set out to look at the evidence and, in this article, share results from recent surveys. We point to the ongoing importance of engaging youth in STEM [1] with the goal that, as adults, they will be better equipped to participate as informed citizens and for work in a world that is increasingly underpinned by STEM [2]. We highlight potential barriers that may be keeping youth from pursuing STEM in general, and physics, specifically. Despite the importance of physics to the global technological transformation now underway, only approximately 15% of Canadian high school students complete grade 12 physics [3], a rate that has not changed in decades. Finally, we close with an overview of Canada 2067, a recent initiative led by Let's Talk Science that generated strong national interest in, and alignment about, shaping the future of STEM learning.

Assessing the level of public trust in science is complicated. Emotionally charged media coverage of issues such as the impact of vaccines and negative or confusing headlines about the evolution of scientific knowledge point to a growing mistrust of science. Furthermore, product marketing that makes inappropriate scientific claims and the rapid rise in the availability of false information online can also foster skepticism. Results of a 2018 survey conducted by the Ontario Science Centre [4] indicated that 54% of Canadians believe that Society is turning away from science in favour of ideas that lack evidence or data. A 2019 study [5] by the Pew Research Center shows a positive trend in the American public belief that scientists generally mean well, but wariness exists over questions of scientific integrity, transparency and bias.

SUMMARY

Assessing evidence about the current state of public trust in science indicates that it may be declining. However, in Canada, science skeptics remain the minority, and public support for science continues to be strong. Thanks to a growing outreach ecosystem, it is an excellent time to (re)build trust and public engagement.

At the same time, there has been an unprecedented global show of public support for science through initiatives such as March for Science and the climate strikes inspired by Greta Thunberg. In Canada, the inclusion of science advisors at different levels of government and programs [6] that provide opportunities for scientists to become policy fellows in government indicate a growing intent to include scientific data when developing public policy.

In September 2019, 3M released its State of Science Index [7], an international poll conducted by Ipsos, which garnered headlines about the erosion of trust in science around the world and catalyzed discussion at many events. While there was some evidence validating the negative headlines, a deeper look at the results indicate that science skeptics are still the minority in Canada. Public doubt has grown since the previous survey, however, nine out of 10 respondents said they still trust science with 85% indicating that they believe in scientific claims. However, about one third of respondents reported being skeptical about science and a shocking 30 per cent of Canadian respondents said they (24% somewhat and 6% completely) only believed science that aligned with their personal beliefs! It is not clear from the presentation of data whether the skeptics and believers are the same people, making this contradictory information even more difficult to reconcile.

Despite some skepticism, the results indicated positive attitudes and a strong interest in encouraging young people to pursue science. This may in part be the result of significant effort over the past decade to draw public attention to the importance of engaging youth in science for future employment.

Canadians appear to be more positive than the global average. Seventy-six per cent of Canadian respondents said that "curious" best described their perspective about science, while 11% said "intimidated". Further, 86% of Canadian respondents said they were optimistic about science in the next 20 years. Ninety-two percent responded that science was now somewhat or very important to their lives. Eighty-four percent of Canadian respondents said they trusted scientists. Similarly, positive results have been found by Let's Talk Science [4] and the Ontario Science Centre [4].

Despite the overall belief that science was very important, specific fields including physics, math, engineering and computer science continue to be unpopular (perhaps



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misunderstood), with very few respondents believing that they would lead to satisfying careers [7]. These beliefs likely contribute to the low school participation rates, with fewer than 15% of Canadian high school students graduating with a senior physics credit [3]. Disengaging from STEM courses at the senior level limits future education and career options.

There clearly is work to be done to reverse declines, improve public attitudes towards science, and increase participation in science, including physics, but a positive foundation upon which to build does exist. Change is possible. For example, over the past twenty years, concerted attention to improving the performance of girls in science has yielded positive results [8]. As indicated in results of PISA [9] 2015 and 2018, the gender gap in science and math performance has closed. PISA 2018 again showed that more top performing girls aspire to STEM careers than boys, however they lean towards life and health sciences.

It takes time, focused attention and investment to impact issues that are largely related to culture. When Let's Talk Science launched as a small project in 1991, very few scientists were engaged in outreach and even fewer publicly admitted to it. Thankfully, attitudes about the importance of public communication amongst scientists and engineers (and the granting councils) have changed significantly within the span of one generation. There now exists a STEM education and outreach sector, which is starting to show signs of maturity. With respect to physics education, the Perimeter Institute is known globally for its outreach. The Canadian Space Agency supports youth engagement. Physics and astronomy departments across Canada regularly invite the public to observatories. Canadian Nobel laureates all support and engage in public awareness activities. Last year, about 30% of Let's Talk Science's volunteer outreach workshops alone addressed physics.

Understanding root causes of attitudes and key barriers to participation offers insights about changes that are most likely to be successful. For example, science skepticism may be rooted in a general lack of public understanding about the nature of scientific inquiry (i.e., how science works). Too often, school science focuses on presenting scientific outcomes and facts rather than engaging students in developing a deeper understanding of inquiry processes. If most people disengage from science education well before high school graduation and lack understanding about the nature of science, then it shouldn't be surprising that skepticism sets in when scientific advancements are made and the facts change.

Key barriers [10] to STEM participation by youth include:

- (i) lack of perceived relevance of STEM;
- (ii) lack of understanding of post-secondary pathways and career opportunities;
- (iii) teachers who lack resources and training to teach STEM in meaningful and experiential ways; and
- (iv) lack of diverse role models.

These barriers were identified by the OECD in 2006 as part of an international study into the (then) trend of declining enrolment in post-secondary science studies. The barriers continue to be relevant today although gains are being made in each of them. In addition to these barriers, we know that parents can have a significant influence on their children's high school course choices. It is important to provide parents with access to the information on educational pathways and the importance that STEM plays in those pathways [3].

Let's Talk Science's research and evaluation efforts continue to validate the importance of understanding the role these barriers play in shaping youth attitudes and intentions. For example, several years ago, we conducted a small case study into the impact of select online articles on the attitudes of early teens. Teachers selected the articles, stating that the content was highly relevant for their classroom needs (e.g., one article was about antibiotic resistance for use in a health science class). During the class in which the article was used, student rating of relevance varied widely with some commenting that it was *not at all* relevant — the reason being that they were not ill themselves at that time! This simple example underscores the importance of beginning with a good understanding of audience perspectives as outreach initiatives are designed.

Let's Talk Science is committed to being a change agent by striving to address the barriers and working with the STEM community to offer a robust approach to STEM engagement across Canada. For example, we partner with 50 post-secondary education sites to mobilize thousands of inspiring role models, the majority of whom are women in STEM. With a goal of building science literacy, we offer 'citizen science type' classroom projects that are relevant and highlight the nature of scientific inquiry. We showcase diverse people in diverse STEM careers that follow different post-secondary pathways, including university, college, and apprenticeships. Importantly, we help early years to Grade 12 educators develop their abilities to support student learning in STEM. Students need to be engaged from a young age, made aware of the many diverse career opportunities, and provided with relevant and timely post-secondary and career pathways information.

Let's Talk Science programs are making a positive impact on participants. In a recent survey approximately 78% of school-aged youth who participated in Let's Talk Science Outreach programming responded that they have a better understanding of the role STEM plays in their lives; 75% reported they were more likely to pursue optional STEM courses in high school and 75% said it increased their desire to have a career that uses STEM. After participating in a professional learning session, teachers report gains of more than 33% in their confidence using an inquiry stance in their classrooms. A recent evaluation of the impact of our career profiles showed a 12% gain in student awareness and interest in STEM careers.

As the pace of global change accelerates, Canadian schools are under increasing stress. Canada's network of provincial/

territorial public education systems was established over the past 150 years to address the demands of a largely agrarian, and then industrial economy. Now, faced with demands to provide more personalized learning that develops new skills, Canadian schools are evolving — albeit too slowly. With the goal of driving continued change, during 2016-2018, Let's Talk Science spearheaded Canada 2067 [11], an ambitious initiative to collaboratively develop a national vision and recommendations for the future of education, starting with STEM learning.

Canada 2067 began with a review of global policy initiatives [12] that focused on STEM learning. Six common areas of focus were identified and used to frame subsequent discussions and surveys. These common areas are:

- How we learn (pedagogy, curriculum and assessment)
- How we teach (teacher pre-service education and professional learning and development)
- What we learn (skills and competencies)
- Who's involved (stakeholders, partnerships, leadership and coordination)
- Where education leads (career information and education guidance)
- Equity and Inclusivity (learning opportunities for all students)

Then, over the course of approximately 12 months, input to these pillars was gathered through:

- five summits with Grades 9/10 students [13];
- six Global Shapers hubs across Canada engaging millennials through roundtable discussions [14];
- a unique national leadership conference [15] that brought together provincial and federal deputy ministers with education, community and corporate leaders; and
- online surveys and polling that garnered over 500,000 inputs

The resulting Canada 2067 vision is “*All students develop the full range of skills needed to navigate an increasingly complex world and have equal opportunity to study and pursue diverse career paths*”. Overall, 18 overarching recommendations anchor the Canada 2067 Learning Roadmap [16] (in total, more than 80 recommendations were documented from all audiences). All Canada 2067 audiences identified the importance of engaging youth in relevant, issues-based learning that integrated subject areas and prioritized skill development over content memorization.

In conclusion, there appears to be strong alignment about what is needed to evolve STEM learning in Canada and a growing ecosystem of partners ready to support the necessary transformation. The world needs science to solve critical global issues. And science needs people. We must build upon research, our collective experiences, and the current foundation of public trust and curiosity to continually build understanding and engagement.

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11. Let's Talk Science recognizes the importance of several Canada 2067 program collaborators including Andrew Parkin, Groundswell Projects, Institute without Boundaries (George Brown College), Global Shapers, Hill + Knowlton Strategies, and the Canadian Commission for UNESCO. Supporters included Amgen Canada, 3M Canada and the Trottier Family Foundation. Please see Canada2067.ca for all reports and outcomes.
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