

Raising a Scientifically Literate Citizenry

How Collaboration in STEM Enrichment is Making a Difference

What is Scientific Literacy and Why Increase our Collective Focus on It?

Is being a scientist the same thing as being scientifically literate? The answer is a little more complicated than a simple 'yes' or 'no'. Scientists, presumably, are scientifically literate, but being scientifically literate is a characteristic we want for every single member of society. Provide repeated experiential learning opportunities that pique STEM (science, technology, engineering, and mathematics) interest for young scientists throughout elementary school years, and this impact may very well be long-lasting.

Astrophysicist Neil deGrasse Tyson was once asked if he hopes that his children will follow in his footsteps and become scientists. Tyson's response was that, above all, he hopes to raise children who are scientifically literate.

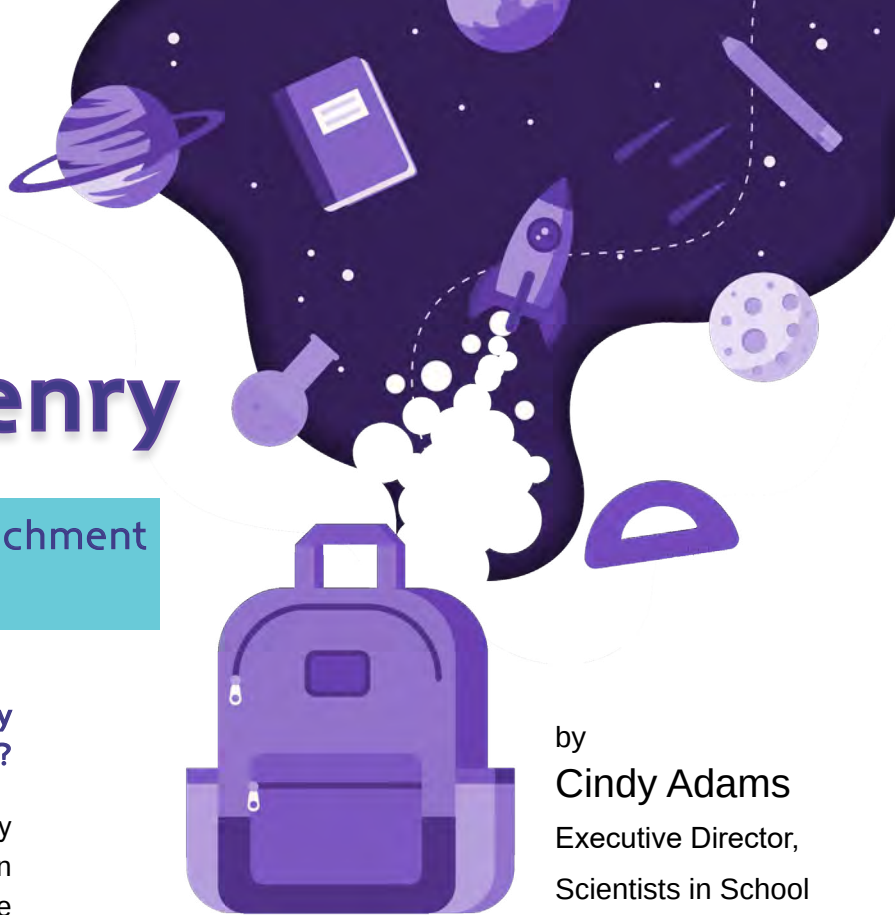
Being scientifically literate is not about **what you know**. An understanding of the speed of light, the Pythagorean Theorem, or Bernoulli's principle does not necessarily make you scientifically literate. Being scientifically literate is about **what you do** with new information. It is grounded in "*being able to engage with science-related issues, with the ideas of science as a reflective citizen, and with a willingness to engage in reasoned discourse about science and technology*" (OECD PISA Framework, 2015). In other words, when you are presented with new observations, studies, or data, you comfortably draw from an understanding and appreciation of scientific concepts and processes to ask, find, and explore

this new information critically. It's about having the necessary skills, confidence, and scientific knowledge to question intelligently, learn through discovery, and analyze the validity of this new information. It's about being able to reasonably evaluate the arguments put forth so that you can draw meaningful conclusions and make informed decisions. And – most importantly – it is the underpinning for a thoughtful citizenry for Canada.

Coming through a year where COVID-19 and climate change have delivered harsh blows has been extraordinarily tough for Canadians. But we are seeing that science-based issues can be solved by science-based solutions. A silver lining from the magnitude of these particular challenges is that they illuminated the importance of scientific literacy for every citizen, including young children. This is important, given that these and other big challenges such as clean drinking water for all, require innovative solutions and united action.

So, how can educators and STEM-enrichment organizations leverage our collective sense of disequilibrium, especially with pandemic restrictions in place? How can we work together to ensure that we

by
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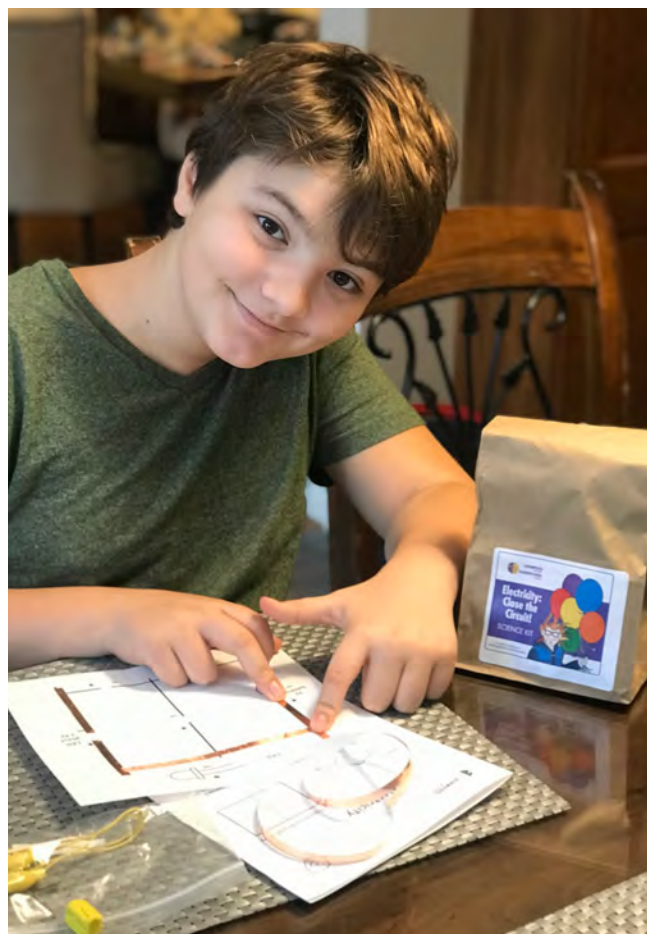


support every child to be more passionate, confident, and engaged in science, ultimately improving their level of scientific literacy, critical thinking, and problem-solving competencies?

One way is by working with STEM enrichment organizations to bring even more hands-on science into the classroom, particularly during the formative Kindergarten to Grade 8 years. Interestingly, this was a core premise upon which the charity Scientists in School was founded in 1989 as a local project of the Ajax-Pickering Branch of The Canadian Federation of University Women. The CFUW is a national organization that encourages its members to act on issues that empower women and/or benefit society, especially in the area of education. Their members realized a need to foster a love for science, technology, engineering, and math in all children, especially in the most reluctant and/or underserved STEM learners. They saw an opportunity for local scientists, engineers, and STEM experts to help support and enrich elementary education, and to get students excited about science through engaging curriculum-aligned workshops that mirror real world science and engineering. They brought visiting scientists into elementary classrooms and noticed collaboration happening: teachers were absorbing new ideas to help science lessons mirror the real world, and visiting scientists were deepening their pedagogy knowledge and refining skills for working with the age groups. This multiplied the impact that either alone could have for the students.

We believe that children need to become scientists to gain an interest for and appreciation of STEM and the world around them. Peek into our workshops and you will find children highly engaged, as they figure out the components of Vitamin C, design electrical circuits, identify the prey eaten by an owl through dissection of regurgitated owl pellets, and learn that in science there are no mistakes – only discoveries. Scientific literacy comes from discovering and exploring; from varying tests to see the effect on the outcome; and from not being afraid to make mistakes.

The vision from the outset was always one of collaboration with elementary teachers, who benefit from new ideas, support, plentiful materials/equipment, and extension activities. Visiting scientists



flourish from the opportunity to ‘watch’ teachers’ student interactions. Our organization’s name reflects the children becoming ‘scientists in school’, but also captures the visiting scientists. Allowing children to see themselves in science is important: a high proportion of the workshop presenters are females, helping to combat girls’ confidence and interest erosion, which we (and others) have identified as starting to become significant around grade 6, especially in science areas connected with physics and engineering.

Ultimately, there are many contributors to a child’s long-term interest in STEM, both inside and outside of schools; experiential STEM experiences are important ones.

We Use a Measurement Approach to Understand and Maximize Impact

In a typical year, approximately 20% of teachers take the time to complete our post-workshop survey. Here are key 2019-20 results, the last pre-pandemic school year:

97% of teachers said Scientists in School was very to extremely effective in encouraging students to make discoveries

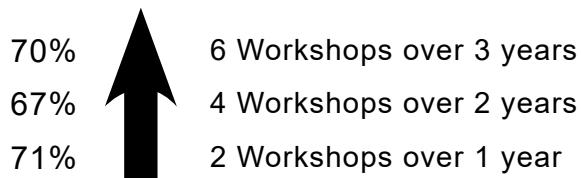
92% of teachers said Scientists in School was very to extremely effective in enhancing students' interest in STEM

92% of teachers said Scientists in School was very to extremely effective in enhancing students' understanding of scientific principles

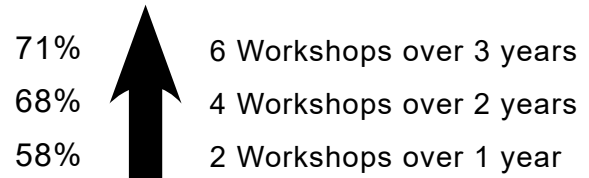
Just ahead of COVID-19, Western University researchers, led by Dr. Isha DeCoito, completed a largescale longitudinal research study to help inform our focus on maximizing key STEM outcomes. The study included approximately 2,000 middle school students in marginalized urban communities,

surveyed twice in each year of participation. All of the classes received two workshops from our topic selection in each of grades 6 to 8. The researchers further reconnected with almost 300 of them during grades 10 to 12 to probe for evidence of lasting impact. The results during the elementary years portion of the research showed amongst other findings that: students who had two Scientists in School workshops starting in grade 6 and through to grade 8, had highly positive responses for key outcomes – interest, confidence, and understanding the relevance of STEM in the world around them. What was most encouraging was that the degree of positivity for interest and confidence of the girls grew with multiple workshop experiences, to the point that with six workshops over three years, gender gap differences for a suite of STEM outcome indicators between grade 8 girls and boys shifted from sizable to insignificant. The results below, from two questions and three years of grade 8 classes data, illustrate this:

"Scientists in School workshops help me better understand the STEM we do in class"

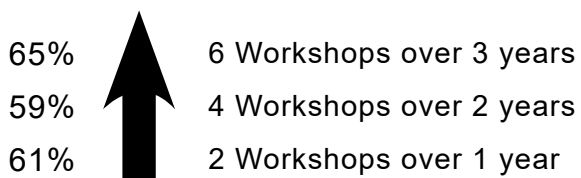


GRADE 8 MALES

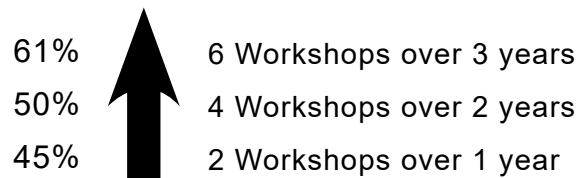


GRADE 8 FEMALES

"Scientists in School made me more interested in STEM"



GRADE 8 MALES



GRADE 8 FEMALES

In the high school phase, what was exciting was the lasting impact and strong positive memories of the workshop experiences into the upper high school years, for both genders. High level findings from this phase include:

90% of Grade 11 students who had six workshops in elementary school and 55% of Grade 12 students who had four workshops in elementary school responded that the workshops taught them skills that they were able to use in high school.

87% of Grade 11 and 12 students strongly agreed or agreed with the statement: “Scientists in School workshops in elementary school were an important part of learning about STEM.” The consistent reasons they gave were that workshops were an interesting and/or fun hands-on experience that increased their interest in STEM, understanding of STEM concepts, and awareness of careers.

The top skills they consistently highlighted as being strengthened were:

1. Collaboration and group work.
2. Preparation for the high school STEM curriculum.
3. Communication, critical thinking, and creativity.

As educators, we cannot underestimate the importance of hands-on experiential collaborative STEM opportunities to build a thoughtful, scientifically-literate citizenry who will use their knowledge and critical thinking skills to tackle some of the world’s most pressing issues.

Making a Difference for the Next Generation

At Scientists in School, we are determined to make a difference for the next generation. We are a vibrant social enterprise charity, built on in-person connections. Pre-COVID, we inspired over 700,000 Kindergarten to Grade 8 student scientists in 25,000 classroom and community setting workshops annually. Equitable access to our programs is a priority for us; 10% of workshops delivered are funded by donors and free to schools in low-income communities. We know the need across the country is greater than this, though, so we are always looking for new donors who





(STEM), and the environment, but we also help them to develop the 21st century global competencies that they will need to succeed not only in the careers of tomorrow, but in the world of tomorrow.

In every workshop, our mission is to ignite scientific curiosity in children so that they question intelligently; learn through discovery; connect scientific knowledge to their world; are excited about science, technology, engineering, and math; and have their interest in careers in those fields piqued.

Today they're scientists in school, tomorrow they're our leaders and innovators.



are passionate about STEM education to help us to increase the number of free workshops we can offer.

COVID-19 halted us in our tracks; no longer able to enter schools and community locations, our team was emboldened to reimagine our in-person workshops into an innovative new virtual delivery model with plentiful live interactions between the students and our visiting scientists. Individually-packaged mini science bags that students get to keep are sent ahead of each workshop, and provide deep engagement through highly investigative experiences, leading to continued exploration in the class, or at home.

With overwhelmingly positive feedback in our original in-person service areas of Ontario and Alberta, having a virtual workshop model has encouraged us to pursue a long-time dream of a national offering, using our new investigative Virtual Workshop model, where the travel barrier restriction is no longer an issue. A workshop presenter living in Ottawa can visit a class in Surrey, a Lethbridge presenter can visit a class in Toronto, and so on. By engaging children across Canada in real-world experiences that spark curiosity and nurture their inquisitive young minds, not only do we help them to discover the fascinating and fun side of science, technology, engineering, math

**Scientists in School in British Columbia:
We Make It Easy to Bring
Scientific Enrichment
to the Classroom**

We are thrilled to announce that Scientists in School is now offering virtual investigative STEM workshops for Kindergarten to Grade 8 classrooms in British Columbia!

Our 60-minute workshops are curriculum-enriching, hands-on, engaging, and led by a topic expert who is a scientist. The workshop is LIVE and students are able to ask questions and share ideas as they explore. All teachers need to do is connect to the presenters at the time of the workshops and distribute the individually-packaged mini science bags sent ahead of each workshop with all the materials needed for full participation.

Check out our [BC Catalogue](#) to see available topics; more will be added throughout the school year.