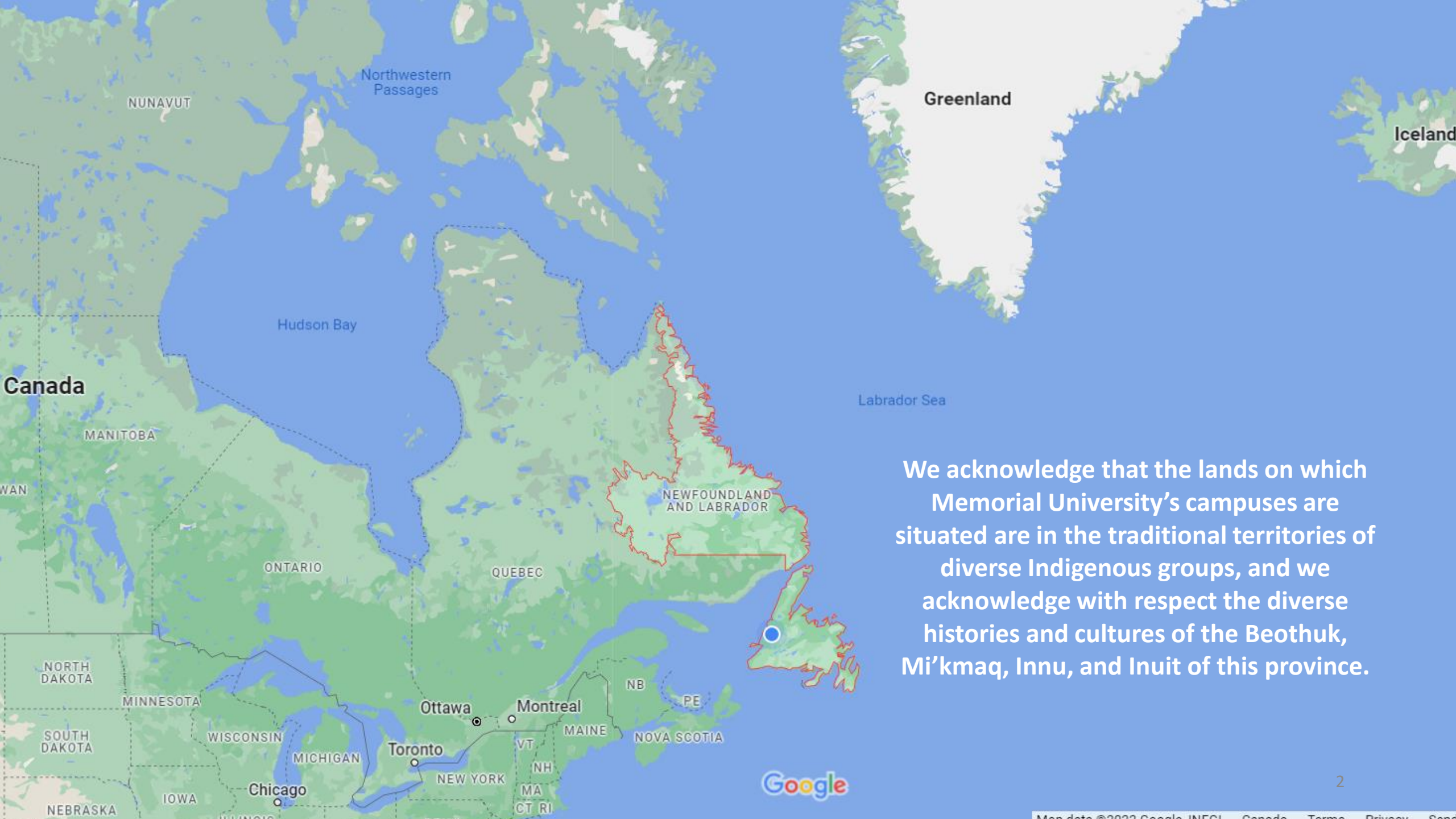
Self-Evaluation Tools in Canadian STEM Outreach Programs

Svetlana Barkanova, Garrett Richards
Grenfell Campus, Memorial University of Newfoundland
Corner Brook, NL, Canada

Canadian Association of Physicists
SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA



We acknowledge that the lands on which Memorial University's campuses are situated are in the traditional territories of diverse Indigenous groups, and we acknowledge with respect the diverse histories and cultures of the Beothuk, Mi'kmaq, Innu, and Inuit of this province.

Abstract

We report the results on the self-evaluation tools used in Canadian STEM outreach activities reported by representatives for English-language NSERC PromoScience programs.

The approaches to evaluation are categorized such as output vs. outcome, quantitative vs. qualitative, metrics vs. surveys, and general vs. specific.

While qualitative answers are useful for informing changes to the event/program in the short term, quantitative answers may be useful for analysis as data is collected over time.

In general, programs tend to favour low-cost methods (i.e. simple metrics recording, brief post-event surveys) and few programs make an effort to measure their long-term impacts (i.e. track actual outcomes, not just potential outcomes). Thus, this study is more able to demonstrate which tools are common, as a potential proxy for what is effective, than demonstrate which tools are effective directly. The directions for future work are discussed.

Initial Motivation

In 2018, MUN launched a large-scale program promoting natural sciences to youth in Newfoundland and Labrador, particularly to youth in rural and remote areas, girls, and Indigenous students.

We build on the complimentary knowledge and resources at MUN's Grenfell Campus, Labrador Institute, the Qalipu First Nation and Parks Canada to deliver a wide range of activities such as tours, lectures, workshops and cultural events on campus, in schools, parks, and online. The program is funded by NSERC PromoScience.

But how effective are these activities in attracting our youth to science-related careers, and how do we find out?

[PROMOSCIENCE]
Encouraging youth to get exposed to science

Events

https://www.grenfell.mun.ca/campus-services/Pages/community/obse...

Not syncing

For the Community

- A Living Memorial
- Art Gallery
- Extended Learning
- Grenfell Art Gallery
- Gym Rentals
- Kids University
- Observatory
  - **Events**
  - Virtual Tour & Image Gallery
  - Astronomy Courses
  - Science Outreach

No tours at the moment due to Covid-19 pandemic, unfortunately, but please join us for webinars!

Events (mun.ca)

Monday to Friday, May 2 – 5, 2022

Careers of the Future: Skills You Will Need and How to Get Them

Presenter: Dr. Svetlana Barkanova, Physics, Grenfell MUNL
Time: By request, 45-60min, May 2-5, 2022
Location: Online, set up by schools

Where do you see yourself in 10 years? In 20? In 30? Lots of jobs of the future have not been invented yet, so how do you prepare for a job that does not yet exist? The answer is simple – focus on skills. But which skills are they? The talk will describe skills what will likely be in demand in the future and suggest university programs that will give you best chance to develop these skills.

Please contact Dr. Barkanova at sbarkanova@grenfell.mun.ca if you would like to schedule this talk for you class.

Thursday, March 24, 2022

Grenfell Campus Physics Society Presentation Night

Hosted by: Grenfell Campus Physics Society (GCPS)
Time: 7:00pm - 9:00pm NDT

A Living Memorial
Art Gallery
Extended Learning
Grenfell Art Gallery
Gym Rentals
Holidays 2020
Kids University
Observatory
- Events
- Virtual Tour & Image Gallery
- Astronomy Courses
- Science Outreach
- Resources
- FAQ

Theatre

Tuesday, November 9, 2021

Events (mun.ca)

Meteorology: A Possible Career Path for Students in Physics & Math

Presenter: Dale Foote, Meteorologist/Program Supervisor, Environment and Climate Change Canada (ECCC), Newfoundland and Labrador Weather Office, Gander
Time: November 9th, 2021, 4:00pm – 6:00 pm NST.
Location: Online, Click here to join the meeting

Abstract: Meteorology is an often overlooked but rewarding career path for students enrolled in Physics and Math programs. Dale Foote, a MUN Physics graduate, will share experience with a career in meteorology and discuss the role of FSWEP in staffing ECCC summer student positions.

Saturday, October 16, 2021

Our Mysterious Moon: Physics, Exploration, and Mi'kmaq Moon Stories

Presenter: Jonathan Barrett, Physics & Math Major Student, Grenfell, MUNL
Time: October 16th, 2021, 2:00pm -3:00pm NDT.
Location: Online — Link

Abstract: International Observe the Moon Night which is on October 16th this year, is an annual worldwide celebration of lunar science and exploration. Join the Grenfell Physics Team to explore the Moon's phases, structure, and surface features, hear fascinating Mi'kmaq Moon stories, and learn about NASA's ARTEMIS program - an ambitious return to the Moon.

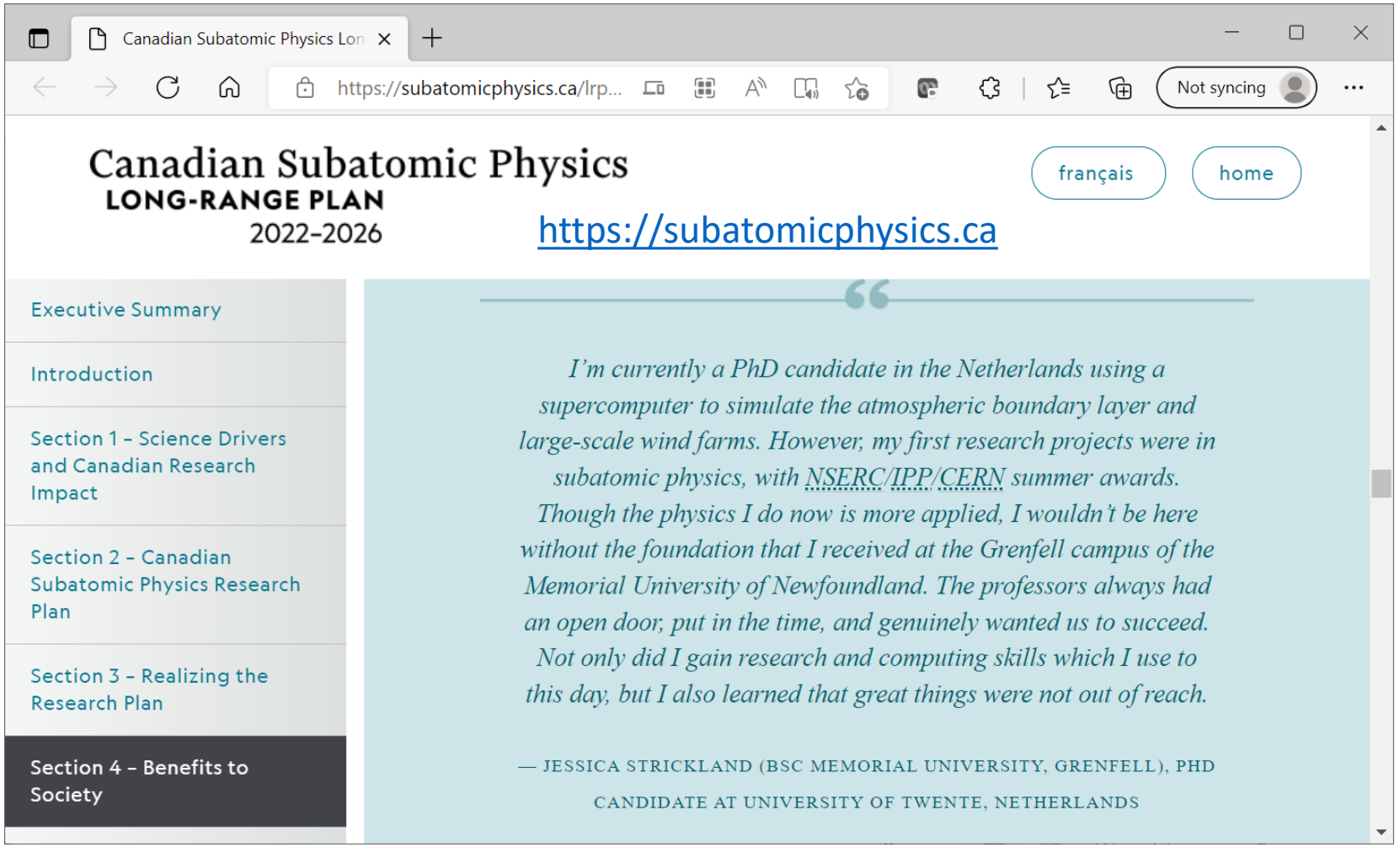
Got a question about the Moon? Send it to Jonathan Barrett at jcbarrett@grenfell.mun.ca by October 14th.

Solar Power Workshop, Corner Brook, NL, September 2021

Our Role Models: Jessica Strickland was the fist MUN student to receive the highly-competitive CERN summer scholarship, with only five Canadian students selected per year. Jonathan Barrett was selected in 2022. Jonathan will be sharing his story with the high-school students in the fall, so please keep an eye for the dates to be posted on Events (mun.ca).

Heads Up:

See Jonathan's talk "Fully Immersive VR in Teaching and Science Outreach" at 3:15pm on June 8 (W3-4 DPE V).



Literature Review: Highly-Cited Literature on STEM Evaluation

- Clark et al. 2016 - two programs that train scientists in communication through outreach activities (mutual benefit)
- Franklin et al. 2013 - a science summer camp evaluated for learning outcomes rather than simply increased interest
- Dubetz/Wilson 2013 - workshops using hands-on activities and female mentors improve science interest and confidence for girls
- Kerby et al. 2010 - theatre-based science outreach leads to increased student interest and learning outcomes
- Laursen et al. 2007 - a short-duration outreach program demonstrating benefits possible for different groups: students, teachers, and scientists
- Haywood/Besley 2014 - a unified framework of indicators to assess both science outreach and citizen science (i.e. knowledge, interest, attitude, behaviour, skills)
- Varner 2014 - an evidence-based model for effective outreach (i.e. goals, collaborate, tailor, activity, check, evaluate, share)
- Vennix et al. 2018 - survey of student perceptions across 12 outreach programs in the US and the Netherlands; variance in measured motivation and attitude mostly explained by activity characteristics (e.g. workshop format and out-of-school component are positive)

- Still needed – Large-N, Canadian studies

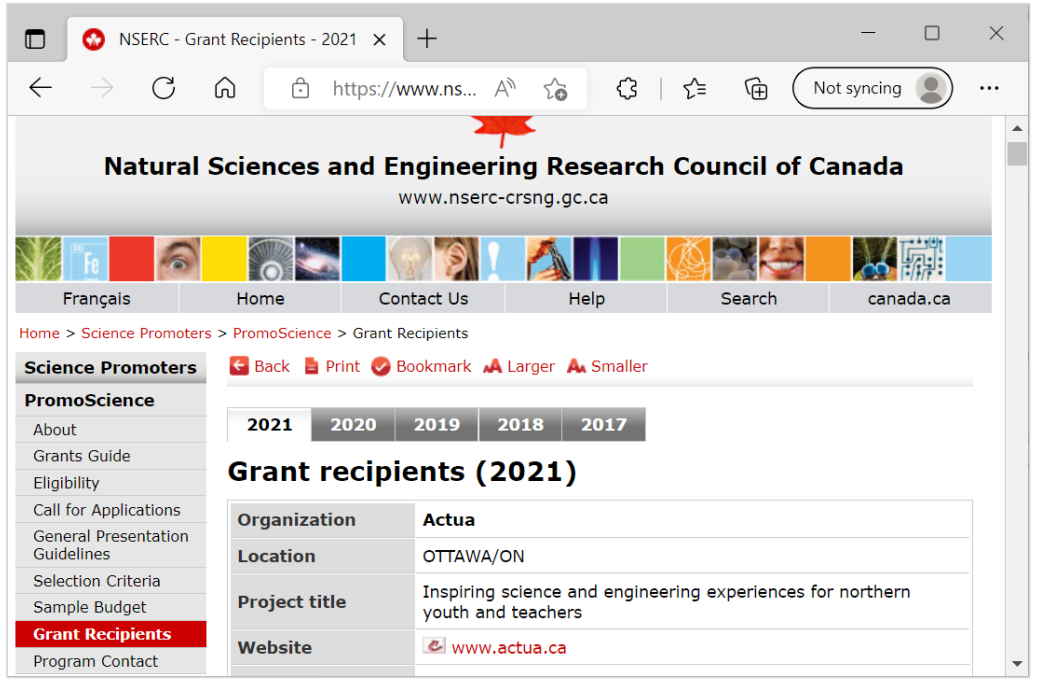
Methods

We set out to collect information about the self-evaluation tools used in Canadian STEM outreach programs by sending email inquiries to representatives for all English-language NSERC PromoScience programs.

We contacted 199 programs and received full responses from 96 of them, for a response rate of 48.2%. Of those 96 programs, 87 of them used some sort of formal evaluation tool.

Most common are:

- Participant Survey (55.9%)
- Teacher or Chaperone Survey (25.0%)
- External Metrics, e.g. N of participants, N of events (20.6%)
- Facilitator Survey or Observation (8.8%)
- Discussion or Focus Group (5.9%)



Master List of Evaluation Items Used with Each Evaluation Tool

A) Evaluation Tool: Participant Survey

-demographics [location, age, rural, Indigenous, immigrant, minority, gender]
-best part (qualitative, multiple choice)
-inspiring (yes/no, likert)
-age appropriate (yes/no, likert)
-more interested (yes/no, likert, qualitative)
-would participate again (yes/no)
…

B) Evaluation Tool: Teacher or Chaperone Survey

-number of participants (number)
-foster growth/creativity/collaboration (likert, qualitative)
-more interested (number, % range)
-understand better (number, % range)
-likely to take course (number, % range)
-pursue career (number, % range)
-suggestions for next time (qualitative/categories)
…

Master List of Evaluation Items Used with Each Evaluation Tool

C) Evaluation Tool: Facilitator Survey

D) Evaluation Tool: Quiz

E) Evaluation Tool: Pre-Survey

F) Evaluation Tool: Discussion
-overall quality (qualitative)
-educational/facilitated learning (qualitative)
-best part (qualitative)
-what did they feel (qualitative)

G) Evaluation Tool: Interviews

H) Evaluation Tool: Separate Testimonials
-opportunity to provide in survey

I) Evaluation Tool: External Metrics
-schools/organizations
-locations
-number of participants
-gender breakdown
-time required
-number of female applicants
-did community partake again
-rate of return

Results

The most common tools are participant surveys, chaperone surveys, and external metrics (e.g. tracking number of events, number of participants, demographic information, repeat visits). Less common tools are facilitator surveys, discussions, testimonials, host organization feedback, pre-surveys, written submissions, longitudinal tools, quizzes, and interviews.

The most common quantitative survey questions focused on: enjoyability, learning, interactivity, usefulness, and potential outcomes (e.g. whether the participant was more likely to take a course or pursue a career related to the topic).

The most common qualitative survey questions emphasized: strengths of the event/program, weaknesses of the event/program, suggestions for the event/program, what was learned, and general feedback (i.e. a space for any other comments).

Some programs attempt to predict longer-term outcomes (e.g. asking if participants are more likely to consider a STEM career) but very few attempt to measure longer-term outcomes (e.g. follow-up surveys with participants over time).

Implications: Common vs Effective

This study is more able to identify which tools are common than to evaluate directly which tools are most effective.

It is possible that certain tools are common because they are perceived to be effective, but other factors could also explain their popularity (e.g. familiarity, simplicity, cost).

The most common tools (e.g. simple metrics tracking, brief post-event surveys) appear to require little investment. This could mean that many programs are missing out on more beneficial tools due to cost and perhaps unfamiliarity.

For example, discussions and interviews could allow for a deeper understanding of how participants experienced a program, while longitudinal tools could allow for measuring long-term outcomes as opposed to simply outputs or predicted outcomes.

Implications: Range of Tools

Although this study does not evaluate which tools are most effective, it does provide a possible first step to more effective outreach evaluation and therefore more effective outreach.

The range of tools we collected (to be published) - and range of items or questions within each tool – can serve as a toolbox, opening up new possibilities for program design and evaluation, acknowledging that different tools are useful for different purposes.

Even appreciating the range of questions used by the most common tool (i.e. participant survey) has implications for design; qualitative answers are probably more useful for informing changes to the event/program in the short term (i.e. formative evaluation), whereas quantitative answers may be useful for analysis as data is collected over time (summative evaluation).

The toolbox could also serve as the foundation for further research to directly evaluate which tools are most effective. Researchers could interview representatives of different programs using different tools over time to get a clearer picture of what each tool can offer and whether any are particularly cost-effective.

Implications: Enhanced Design and Ethics

The prevalence of quantitative tools for STEM outreach evaluation (i.e. external metrics, surveys with mostly quantitative questions) may mean that scientists tend to use tools they are more familiar with from their own practice for the purposes of outreach evaluation as well.

Collaborating with social scientists (e.g. this project as an example) familiar with qualitative tools and survey design may be a simple way to enhance design.

Keep in mind that you may need approval from the appropriate Research Ethics Board to conduct the evaluation. See the Tri-Council Policy Statement on Research Involving Humans (TCPS 2): https://ethics.gc.ca/eng/policy-politique_tcps2-eptc2_2018.html.

Although the program evaluation for internal use does not count as "research" under the TCPS 2 (see Article 2.5), you may need approval if you start to view your outreach evaluation more broadly (e.g. intent to publish evaluation results, or ask questions with implications beyond a single program).

Thank You! Questions?

Svetlana Barkanova, Garrett Richards
Grenfell Campus, Memorial University of Newfoundland
Corner Brook, NL, Canada

Canadian Association of Physicists
SUPPORTING PHYSICS RESEARCH AND EDUCATION IN CANADA

Please join us for DGEP ([Division for Gender Equity in Physics](#)) Networking Session 3:15pm – 4:30pm on June 8 (W3-5)!

Everyone is very welcome!