

Driving Innovation: The Maker Mobile Initiative

ABSTRACT

As a leading non-profit STEM outreach organization with over 20 years of experience, we represent a network of 37 university and college-based member programs who annually inspire over 250,000 youth in 500 communities in hands-on science, technology, engineering and mathematics (STEM) experiences. The Maker Mobile Initiative, launched in 2017, engages youth (Grades 6-12) from across Canada in hands-on exploration and making, fostering problem-solving and innovation. Furthermore, this model of makerspace helps reach youth traditionally underrepresented in STEM, in particular Indigenous youth and youth in rural and remote locations.

Keywords

STEM; innovation; technology; maker mobile; youth; digital skills; coding; inclusive education

1. DESCRIPTION

1.1 Description of your setting

The Maker Mobile is a moving maker space full of technology like 3D printers, programmable circuit boards and more, inspiring participants to experiment with hands-on learning and to create their own innovations. The Maker Mobile's creation and first year of delivery was part of our involvement in Innovation 150 [1], a nationwide celebration of innovation and innovators for Canada's 150th anniversary. Facilitated and executed by two highly trained and engaging instructors, the first year of the tour began in Victoria, British Columbia in January, went north through the Rockies to Whitehorse, Yukon, down and across to Yellowknife, Northwest Territories, down through the prairies, and eventually right across to St. John's, Newfoundland and Labrador, and ended back in Ottawa in December of 2017. Because of Canada's widespread geography, with many communities being difficult to access, the Maker Mobile presented a creative solution to reach youth traditionally underrepresented in STEM, in particular Indigenous youth and youth in rural and remote locations. The Maker Mobile continues to do smaller tours within Canada, and the model has been adapted for use by several of our member programs.

By the end of the first year of delivery, the Maker Mobile had reached 14,638 youth participants through 368 workshops and events. The workshops were designed to target students in Grades 6-12, many of whom had no prior exposure to makerspaces, maker activities, or the technology deployed on the Maker Mobile. By providing an accessible entry point to making, the Maker Mobile helped break down barriers for participants. In total, 35,000 kilometers were traveled by the Maker Mobile team in the first year of delivery, reaching 69 communities across Canada in every region, including 24 Indigenous communities. Further, through our Outreach Team and network members, an additional 24,487 youth were engaged in Maker Mobile and Innovation 150 content in another 76 communities.

1.2 Description of the educational experience

The Maker Mobile's Innovation150 Workshops were designed to engage youth with meaningful and enriching experiences that foster a nationwide culture of innovation and builds their capacity and confidence to create a better future for Canada. In the 60-90 minute Maker Mobile workshops, youth design and build with sophisticated maker tools including 3D printers, laser cutters, micro-controllers, and block programming while they solve real-world challenges.

In addition the content and the Maker Mobile tour itself, workshop content, purchasing information, material templates and financial support were all made available to the national network. These workshops are all adaptable for club, camp, or weekend events. Below are the titles and descriptions of the seven experiences developed (each is 60-90 minutes in length):

- "Making Canadian Makers" - What's the difference between a good idea and an innovation? How do you become a maker, an innovator? In this hands-on unplugged workshop, participants will work in groups to design, iterate and prototype a product that can make the automotive industry safer in Canada, or improve their school experience. On the way they will learn the skills and attitudes of Canadian problem solvers and entrepreneurs before them. This workshop is perfect for youth Grade 3 and up, and can be completed using recycled materials, craft supplies, and basic (or sophisticated) maker tools!
- "Internet Everywhere" - Hardware and software come together in this offline programming and design challenge. Using visual "block" programming participants will write simple programs and then build physical interfaces to interact with them using littleBits, Makey Makey and Arduino microcontrollers, all customized to the age of the participants. Youth will interface with weather stations to create programs that alert communities to potential weather hazards.
- "Everyone Can Code" - How do you move from being a consumer of technology to a producer of technology? You gamify learning and design the front-end and back-end of an app! Using Swift, the programming language of all Apple products, this

workshop will give participants first-hand experience coding on iPads and designing the user interface for their own app idea. Everyone can code with the help of the Maker Mobile team and Apple Swift.

- "The Innovation Generation" - Designed to introduce concepts of the engineering design process, youth will learn to plan, prototype, experiment, and refine ideas to solve challenges faced by their local communities. The workshop will culminate in a design and build challenge where youth will bring their ideas to life with the help of 3D printers. In this workshop, participants will explore food security and see how 3D printers can ensure all Canadians have sustainable access to healthy food and clean water.
- "Dream it Design it, Make it" - Participants will learn the fundamentals of digital design by going behind-the-scenes with laser cutting technology. Using hands-on, kinesthetic math games, students discover how laser cutters use vectors, rastering, and run-length encoding to quickly prototype innovations and turn ideas into reality! Students will then apply this by prototyping a robotic space arm modelled off the Canadarm using laser cut materials created during the workshop.
- "Innovation Stations" - Designed to give "bite-sized" experiences with the tools and technologies used by innovators, these stations are designed to be self-guided by students promoting curiosity, risk-taking, critical thinking and problem solving. With up to six stations, experiences include engaging youth to map the Arctic ocean floor using mini robots, drive a mini Maker Mobile across Canada using Makey Makey and Scratch, and learn to code with an interactive game.
- "GE Digital Challenge" - This workshop was designed to engage adults with non-technical specialist knowledge in coding and electrical engineering experience. Small groups were challenged to code the inner workings of a national energy system. This required participants to focus on which sources of energy are the most sustainable, how data analysis can help guide how we invest in energy production, and how code can help us better manage resources. With facilitator support, participants then used block programming and microcontrollers to program their own smart power grid.

Because the Maker Mobile has the capacity to visit communities across Canada, it was important in workshop design to be flexible. Making content relevant to local context and adapting activities based on participants' needs was part of our approach. Further, provinces and territories across Canada have variations in their curriculum (there are 11 unique educational jurisdictions), meaning that some topics (e.g., electricity, environmental sustainability, climate and weather) are addressed at different grades. Rather than align to specific grade bands, the learning outcomes of the workshops instead focused on cross-curricular concepts and competencies and emphasized real-world connections. The workshops were used across a number of curriculum subjects, from science to math to literacy. Taking a competency-based approach to maker education, one in which creativity, critical thinking, communication, collaboration, and problem solving were all emphasized, meant that regardless of student interests or experiences they would find relevance in the activities. This approach also permitted greater adaptability for programs across Canada.

The Maker Mobile Initiative has documented activities, learnings, and recommendations for application for classroom educators. Sharing these findings with teachers, including best practices for mobile makerspaces inside or outside of a school environment, has enabled the educational experience of the Maker Mobile to be brought to even more communities since its launch.

2. INSIGHTS

2.1 Results

In its inaugural year, the Maker Mobile received excellent feedback from K-12 educators, non-profit and industry partners, funders, policy makers, and youth participants. Some of these testimonials about the experience are given below.

"This [workshop] is awesome, it's hands-on, it's problem-solving, it's the new curriculum, it's great! One of the best things we've done all year." - Teacher, British Columbia

"This is the second time that [the Maker Mobile] has been to my school since I've been teaching here and my students and I have learned something new every time. The workshop took a topic that we've worked on in class and made it hands-on and applicable in real life." - Science & Technology Teacher Resolute Bay, Nunavut

"Indigenous Works has been proud to [be a] partner [of this initiative], sharing our knowledge and expertise as you have built your model of successful practices in the engagement of Indigenous youth in STEM. [Their] work in building essential employability skills among Indigenous youth, developing authentic Indigenous community partnerships and proactively involving local Elders, Indigenous instructors and role models, is key to moving the dial towards developing a world class Indigenous workforce." – Kelly Lendsay, President and CEO, Indigenous Works

"It is excellent that youth have the opportunity to experience what it is to be an engineer or a scientist or a community leader through activities that involve simulated real life scenarios, problem solving and designing and building. [Their] involvement of

local industry representatives, researchers, and scientists as mentors also helps make the experience real for youth and helps them to see themselves in these roles in the future.” - Mayor, Jeannie Ehaloloak, President, Nunavut Association of Municipalities

“Wonder where Canada’s next great inventor, creator or startup founder might come from? Look no further than [this organization’s] workshops, classrooms and maker mobiles. With programs like Codemakers [2], [they are] inspiring this country’s next generation of technology builders. Google is proud to continue its support of [this] important work.” – Aaron Brindle, Head of Public Affairs, Google Canada (Funder)

“We want to help create a vibrant science culture in Canada and to do that our young people need a solid STEM foundation so they can take on the knowledge based jobs of the future. I look forward to working with organizations like [this] to help our young people get excited about science and research and to encourage them to pursue careers in STEM fields and take on these challenges for the betterment of all Canadians.” – The Honourable Kirsty Duncan, Minister of Science, Government of Canada

“To give our young people the best possible start, we will promote hands-on learning in science, technology, engineering, and math, especially for young women, girls, and Indigenous youth. Building on work being done by impressive organizations like Ladies Learning Code and Actua, we will encourage students to learn coding in the same way they learn to read and write, preparing our kids for the jobs of the future.” - Minister Bill Morneau’s 2017 Federal Budget speech to the House of Commons, recognizing our organization as a national leader in building skills and confidence in STEM among youth in Canada

"It's a prototype, it's meant to be flawed!" - Student participating in Maker Mobile Workshop

"I'm going to be an inventor when I get older." - Indigenous youth participating in Maker Mobile Workshop

The Maker Mobile is certainly one of our greatest achievements in the past two years. While in line with our previous work, the features that increased the challenge factor included the extended duration and scope of the tour, the workshop content development specifically around a maker theme within an effort to make social change, and the many, many, partners involved in the project due to its placement and funding within Canada's 150th anniversary year. However, the elevated profile and reach that the project gave the organization played a role in securing our next, and likely an even larger achievement, which was announced in January 2018.

This year, we secured significant funding from the Government of Canada’s Department for Innovation, Science and Economic Development through CanCode [3], Canada's first federal funding program for youth engagement in digital skills and coding. With this funding, we will deliver two years of coding and digital skills school workshops, summer camp, after-school programs, year-round clubs and community outreach initiatives for youth in Grades K-12 in every province and territory of Canada. Programs will specifically engage girls and young women, First Nations, Inuit and Metis youth, youth living in rural remote and arctic communities and youth facing other socioeconomic challenges. We will also engage thousands of teachers in training to support the integration of coding and digital skill development that meets provincial curriculum requirements. In the original Maker Mobile tour, we delivered sessions for pre-service teachers enrolled in Faculties of Education, to help build their knowledge and skills in maker education. We understand the value of building educator expertise, and as our teacher engagement efforts across Canada grow, we hope to create parallel opportunities for students learning alongside their classroom teachers, both through hands-on engagement.

2.2 Broader Value

Digital fabrication and making are at the heart of our Maker Mobile delivery. There were ten key design features to the Maker Mobile Initiative, which can be adapted and used by educators in both formal and informal educational settings. The value of these findings transcend the model itself, and are applicable not just for mobile makerspaces but for undertaking any sort of maker initiative, whether classroom-based or in an informal learning environment. These features, and the value they presented, are as follows:

1. Build personal relevance: Youth are challenged to design and prototype solutions to challenges they see in their lives, home, community, and in the world. The personal connection empowers youth and helps them to see themselves as innovators in their future career paths.
2. Create meaning: The Maker Mobile workshops intentionally frame the learning around real-life, tangible outcomes and social change benefits, and frame the digital fabrication and design skills as an important part of the meaningful solutions. This helps students to see connections to potential postsecondary and career paths, and increases engagement in activities.
3. Build cross-curricular connections: The Maker Mobile workshops are flexible for use across a number of curriculum subjects, from science to math to literacy. They were also designed and used across the country in our 11 different educational jurisdictions and to a number of different age ranges as well.
4. Take a holistic approach: The Maker Mobile workshops encourage youth to communicate, collaborate, create and think critically by working in groups to accomplish their projects. Further, by taking an approach to teaching and learning that spans multiple subjects and grades, involves diverse methods of engagement, and builds on various student strengths, a wider variety of project solutions can be generated.
5. Be process and product oriented: By placing emphasis on the engineering design process, including building empathy, identifying the need, prototyping, testing, and re-designing, students learn a framework for problem solving that can be taken into any context. Our maker experience emphasizes process and prototyping just as much as the end product.

6. Support teacher skills: For a makerspace to be successful (including our Maker Mobile), it is important to have teacher champions that not just understand the importance of this learning environment, but also are equipped with skills and competencies to embrace it themselves as professional learners. Our approach as informal educators is to engage classroom teachers and school resource staff (e.g., Librarians, Learning Commons Leaders) in the activities, and provide ways for teachers to continue the learning beyond the workshop.
7. Take an evidence-based approach: Our content development process is grounded in peer-reviewed evidence of our documented model. As educators, we are always iterating and improving the experience. Our programs were iterated through the duration of the tour, drawing on educator, student, and instructor feedback.
8. Transcend the tools: Although the Maker Mobile was crafted with specific technology on board, we focus on competencies and skill-building rather than the technology itself. Tech-based toys will change over time, but the underlying core competencies will endure and are a strong foundation on which to create maker experiences.
9. Connect community: Our experience was strengthened by strategic partnerships. We are grateful for the sharing of information by other similar ventures that went before it, including the SparkTruck, the Canada Learning Code Code: Mobile, the Vancouver Aquarium's AquaVan and the uOttawa Maker Mobile. We are fundamentally supportive of sharing our experience and content widely to benefit even more youth.
10. Build accessible programs: Our mission is centred around ensuring that youth from diverse backgrounds, especially those traditionally underrepresented in STEM [4], have the opportunity to achieve their potential. Our national programs such as the National Indigenous Youth in STEM, the National Girls Program, and Go Where Kids Are each have defined program models and supports available to remove barriers to participation. Through the financial support of our national funders, we reduce financial barriers to participation, and through program design and careful choice of tools and specific training for instructors, we ensure equity and accessibility in program delivery. Delivering a mix of plugged and unplugged activities in a safe, gender-neutral environment creates a more accessible environment. The Maker Mobile tour placed priority on engaging youth in rural and remote locations, Indigenous communities on and off reserve, and in inner urban communities facing socio-economic challenges.

2.3 Relevance to Theme

The theme “What role does Maker Education play in a world with growing social and environmental challenges?” is particularly relevant to the Maker Mobile Initiative. Our overall approach has been to ground students in competencies including communication, collaboration, creative and critical thinking such that they are prepared to face the global challenges of today and the future. Most of these complex problems necessitate interdisciplinary approaches to problem solving. In order to best prepare students to be the innovators of the future, we need to start building opportunities for them early, and often, to engage in cross-curricular endeavours that foster the attitudes they will need to face social and environmental challenges. Our vehicle to create these opportunities is the Maker Mobile, which has demonstrated an effective solution to reaching youth at a national scale with innovative maker education.

3. REFERENCES

- [1] CFI (2018). Innovation.ca. Retrieved from <https://www.innovation.ca>.
- [2] Actua Canada (2016, January 26). *Prime Minister Justin Trudeau participates in Codemakers* [Video file]. Retrieved from <https://youtu.be/lmb8VjEM5qA>.
- [3] Betakit (2018, January 22). Coding non-profit Actua receives \$10 million from government CanCode program. Retrieved from <https://betakit.com/coding-non-profit-actua-receives-10-million-from-governments-cancode-program/>.
- [4] Silcoff, S. (2018, February 21). Programming gender gap starts early, study suggests. Retrieved from <https://www.theglobeandmail.com/technology/programming-gender-gap-starts-early-study-suggests/article38040289/>.