The Canadian Scene

Developing an Innovation Culture through Science & Technology Engagement

March 26, 2007 Roundtable
Background Paper

Developed by
Tracy Ross and Bonnie Schmidt

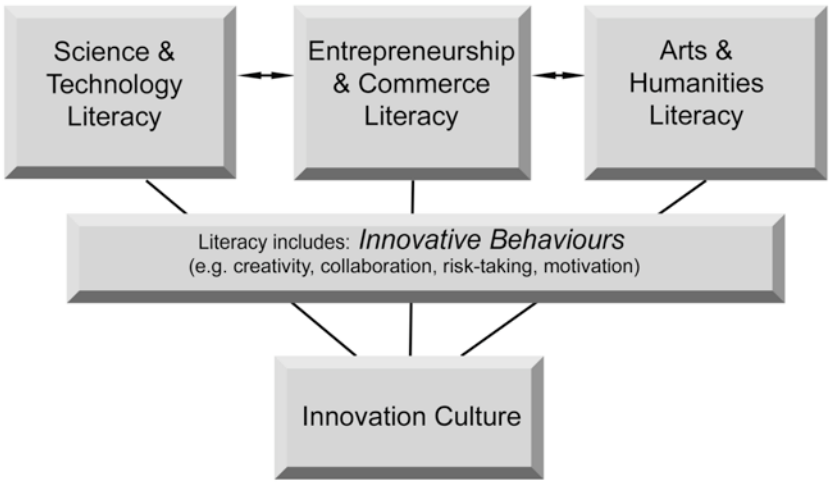
1. Introduction

Canada's future prosperity and quality of life are directly related to our ability to compete in a knowledge-based, global economy in which science and technology play a pivotal role. The 21st century demands a highly skilled, well-educated workforce that welcomes change, is prepared to take measured risk, and creates new ideas to drive innovation. Given our country's small population, it is increasingly important that Canada supports an innovation culture and invests in the development of human talent to meet the demands of a global, knowledge-based economy[i].

Most definitions of "*Innovation"* include the application of new ideas or approaches to a process or product. In this way, the word has been used extensively by those examining the commercialization of new ideas or organizational behaviour in business. The concept of an 'innovation culture' is more elusive and has been the subject of considerable discussion. *Culture* is a reflection of a group's beliefs and values. An *innovation culture* therefore, might be defined as a population that understands and embraces the importance of innovation. It demands that all people in the defined group are engaged in innovation; not only a small subset of people who are specially trained.

Canadians have not reached consensus about what defines an innovation culture despite the use of the phrase for over a decade. Nor have we agreed upon the path that we should take in order to achieve an innovation culture. The discussion is further complicated because the phrase has been interchanged with others including 'culture of entrepreneurship', 'culture of commerce', and 'science culture'.

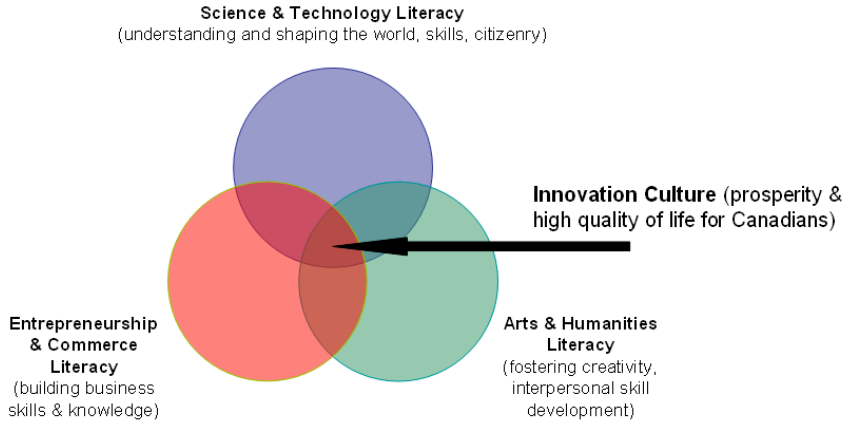
The authors suggest that the development of an Innovation Culture is ultimately dependent upon improving literacy and innovative behaviour across the boundaries of science & technology; arts & humanities; and entrepreneurship & commerce as shown in the following figure.



It is important to note that there is significant overlap between all components of Innovation Culture. Additionally, this model assumes that citizens possess basic reading, writing, numeracy and communication / comprehension skills.

Participants have been invited to the March 26 Roundtable to discuss the development of an Innovation Culture, which inevitably cuts across science, technology, business, and the arts.

We have much ground to cover in order to move from recognizing that there are several components inherent in an Innovation Culture to creating an environment in which the following is the Canadian norm:



We can start by focussing on science and technology literacy, which is integral to the development of an innovation culture. ***Science and technology literate people are interested in science; they have a basic understanding about what science 'is', how science 'is done' and how science 'affects their life'.***

It was recently suggested by Derek Hodson[ii] from the Ontario Institute for Studies in Education at the University of Toronto (2006) that a reasonable definition of science literacy should include:

- a general understanding of some of the fundamental ideas, principles, and theories of science
- some knowledge of the ways in which scientific knowledge is generated, validated, and disseminated
- some ability to interpret scientific data and evaluate their validity and reliability
- a critical understanding of the aims and goals of science and technology, including their historical roots and the values they embody
- an appreciation of the interrelationships among science, technology, society and the environment
- an interest in science and the capacity to update and acquire new scientific knowledge and technological knowledge in the future.

What this definition misses, however, are the skills and behaviours that characterize the practice of science. We suggest that Innovation Culture does not just include knowledge, but also behaviours and skills important both to the practice of science and an enabled, innovative society.

Characteristic behaviours of individuals within an *innovation culture* have been described in several studies, largely from the business world[iii]. Such characteristics include:

- motivation through inspiration,
- creativity and imagination,
- problem-solving skills,
- collaboration, and
- risk taking and the tolerance of uncertainty.

These behaviours are also found to a significant degree in the successful practice of science[iv]. If we can encourage these behaviours throughout our culture, then individuals will be better equipped to contribute to society.

Improving science and technology literacy in an innovation culture is important for three primary reasons:

1. Ensuring engaged citizens and politicians who can:
    a. deal with the complex issues of modern society
    b. focus in a world overloaded with information
    c. thrive in an increasingly market-driven global environment
    d. develop public policies that are based on good science
2. Ensuring an adequate supply of scientists and engineers, along with adequate financial resources for research, that are needed in academia and business
3. Improving quality of life

Science literacy and innovative practice can be enhanced through active participation in science and technology experiences – called science engagement in this paper.

This backgrounder was developed to provide a framework for the March 26 Roundtable discussion and offer a brief snapshot of Canadian activities in the area of science engagement to address the following questions:

1. What audiences benefit from science engagement?
2. What types of science engagement activities are available?
3. Who offers / funds science engagement activities?
4. What opportunities and challenges exist?

Over the past decade, there has been an increased awareness of the importance of building science and technology literacy and innovative behaviours through science engagement activities. There has been a tremendous increase in the availability of engagement activities as well.

What can be done in Canada to bring coherence to the efforts? How can we ensure that all Canadians are engaged? What framework for action will work best in Canada?

Other countries are rising to this critical challenge as articulated in the accompanying international background paper. As participants prepare for the Roundtable, we urge you to consider the following observations that were provided in a recent study commissioned by Industry Canada[v] based on studying the national strategies for science and technology promotion in seven other countries:

- They are announced at the highest level and promoted widely
- They set specific targets
- They are long-term, multi-year commitments
- The level of spending is significant, especially in Japan, Australia and the Netherlands
- They involve partnerships and collaborations between the national government, regional and local authorities
- They focus on experiential learning and links to national prosperity
- They attack on multiple fronts

It is possible to develop an innovation culture in Canada. The first step along the path is to develop a coherent vision and establish measurable goals. From there we can set priorities, make choices and build participation, meaningful collaboration and momentum.

2. Priority Audiences and Science Engagement 'Vehicles'

Science engagement audiences range from general (e.g. broad categories of students and teachers, families), to targeted (e.g. Aboriginal girls, parliamentarians). A larger study is needed to examine the scope and effectiveness of engagement activities currently available for each audience. However, if our overall goal is to build an innovation culture informed by science literacy, then two broad segments of the population deserve special attention:

- *Informed, enabled citizens and engaged public decision makers*

Canada benefits from a population that is, in general, highly supportive of science and technology. Recent survey evidence shows that Canadians generally have a favourable view of science and technology, they support spending more on R+D, and they would highly recommend a science and technology career to youth[vi]. So where is the problem? Why should engaging citizens be a priority?

First, in the same survey mentioned above, more than two-thirds of those asked felt they did not have enough information about how new discoveries would impact Canadians. One reason is that science communication is only beginning to emerge as a professional field in Canada[vii]. If Canadians are to have a global view of a complex marketplace of ideas, we need to nurture the field and make the most of every informal learning strategy available to inform Canadians.

Second, as family members are perhaps the most important influencers on children, their perceptions about the scope of career possibilities in science can be just as

important as those of their children. Engaging parents and caregivers along with their children is crucial.

Finally, while public decision makers may ultimately make priorities, they are influenced by a number of factors, not least of all the opinions of their constituents. In 2003 the SCOPE report, authored by 23 high-profile science advisors to the Government of Canada recommended that government "Embrace the concept of participatory S+T communications, where by audiences are engaged in dialogue, deliberation and decision making…" SCOPE report (e.g. energy, resources). Engaging citizens with a sophisticated approach to science and society is increasingly important. While media presents one alternative, other options, such as the increasingly popular Café Scientifique model, deserve attention.

- *Supply of Scientists…Igniting an Interest in everyone*

Inspiration is the first critical component. Either through the 'wow' factor of science demonstrations, or through contact with role models, first impressions matter.

And yet, maintaining the interest of students as they progress is often influenced by factors outside their ability in the classroom. For example, a recent OECD Conference has shown concern that persistent stereotypes of science and scientists turn prospective students away from enrolling in science and technological fields. Importantly, one study has shown that teenagers' decision to enroll in a science program was connected more to their personal interest in science than to their aptitude in mathematics.[viii]

Our actions that engage youth with science must use a myriad of strategies, both inside and outside the classroom, and they must start early in life. Evidence shows that out-of-school experiences, real-world applications, social learning opportunities and contact with role-models all leave strong memories on those who ultimately go on to scientific careers.[ix]

There are almost infinite combinations of audience (e.g. girls), "vehicle" (e.g. building competition), theme (e.g. trees), and presenter (e.g. Women in Science and Engineering.). The appendices provide a generic list of vehicles, as well as a preliminary capture of science and technology engagement organizations.

As you review the list of science engagement activities, it is worth considering the context in which they take place. Is the activity taking place in the formal education system, or is it an "informal education" or "free-choice" activity? Many agencies support the teaching of science in schools by providing school workshops, teacher training, scientist role models and program resources. However, in a world where people spend 80% of their waking hours outside of school, informal environments are an essential component of learning. We believe that the full potential of these sources remains under-recognized and even under-exploited. Indeed, many of the organisations in the appendices work within formal and informal education environments.

3. Who offers / funds science engagement activities?

Once priority audiences and desired outcomes are established, a thorough environmental scan is essential to identify best practices and pilot projects. Many of the strongest projects are community-based and involve partnerships between several organizations, while one organization may effectively engage several different audience groups. The following section provides a very preliminary sketch to demonstrate the scope of current efforts.

i) Government

Federal Departments

A recent report commissioned by Industry Canada found that many science-based Departments across the Federal government are engaged in public awareness and education initiatives, although no horizontal strategy exists. Initiatives range from online information campaigns to hands-on family activities. Annual investments in such activities are estimated to be over $25 million, some of which includes investments to third-party delivery organizations.

Provincial

While most provincial governments support science engagement activities to a limited extent, Alberta, Quebec, Ontario, and Manitoba contribute core support to small number of agencies as well as competitive funding to others. Further, a recent investment of $5 million in British Columbia resulted in enhanced student science learning province-wide.[x]

Municipal

Many municipalities offer science engagement activities through various recreational, fitness and learning programs. A few municipalities provide core funding support to science centres and similar organizations.

Research Granting councils

The following councils/agencies are some of those that support competitive funding competitions to support outreach activities or have their own programs.

- NSERC: PromoScience; Michael Smith Award for Science Promotion; Centres for Research in Youth, Science Teaching and Learning (CRYSTAL) Pilot Program
- CIHR SYNAPSE CIHR/STIHR: Youth Mentorship Initiative
- Canadian Space Agency: The Youth Grants and Contributions Program

An emerging trend for granting councils is to require grant recipients to spend a portion of their funding on science engagement activities. For example, the Ontario Ministry of Research and Innovation mandates outreach programs for their Research Excellence (ORF-RE) program and Early Researcher Award Program.

ii) Engagement Organizations:

A thorough environmental scan would better identify the scope of service of these organizations. All operate with a combination of public support, service or project fees, and private sector sponsorship.

Media

Outlets include television (e.g. Discovery Channel, TV Ontario), radio (e.g. Quirks and Quarks), magazines, (e.g. *Canadian Geographic*, *Découvrir)* and newspapers. Increasingly, outlets also offer an online complement of games and activities to their programming. The Canadian Science Writers' Association represents individuals interested in the field.

Outreach agencies

The number of outreach agencies and the range of programs, products and activities they create and offer have increased dramatically over the last ten years. Some organizations serve specific groups such as underprivileged children, girls, or Aboriginal youth. The appendix lists members of the Science & Technology Awareness Network (STAN). Science pour tous represents similar organizations in Quebec.

Science centres and Museums

More than 7 million people visit Canada's 43 science centres annually. Worldwide, the science centres are expanding their hands-on learning tradition to reach new audiences, encourage citizen involvement and foster lifelong learning. The appendix lists the members of the Canadian Association of Science Centres. Natural History museums, zoos and aquariums also have ongoing activities and programs to promote the learning and awareness of science and technology.

Universities/colleges

While public and youth engagement is not necessarily their primary mandate, most universities now offer science/engineering outreach programs. Increasingly, universities are recognizing the need to have campus-wide organizing committees and several have established full-time Science Outreach Coordinator positions.

Industry

At least one company has established a partnership with an engagement organization to share knowledge and best practices about learning in a research environment (e.g DuPont and the Ontario Science Centre). A few companies have established in-house outreach programs, including IBM. Others, such as TELUS and Imperial Oil provide financial support to other stakeholders. Marketing support is aligned with targeted audiences and programs, while Foundation support (e.g. RBC) is usually aligned with specific (e.g. youth) mandates.

4. Establishing Next Steps

This section is offered as a series of guiding questions that can be used to establish a framework for action. Innovation culture thrives on inspiration, creativity, collaboration, problem-solving and risk-taking. Science and technology literacy is a critical component of an innovation culture.

Improving science and technology literacy and developing an innovation culture will likely lead to the following outcomes:

- ***the development of attitudes, skills and behaviours that enable innovation across society***
- ***improved understanding of the processes, products, and value of science, technology and innovation***
- ***increased access to current science and technology research and discoveries***
- ***a greater proportion of students choosing to pursue and complete postsecondary studies in science and engineering***
- ***improved public support for research, which may lead to increased funding***
- ***public recognition of the value of commercializing Canadian intellectual property***
- ***increased confidence of Canadians in their ability to address and resolve the challenges of the 21st Century.***

Challenges that now impede the improvement of science and technology literacy and an innovation culture include:

- ***lack of national vision, goals and common definitions to drive efforts***
- ***lack of adequate funding to ensure that effective practices can be scaled up***
- ***lack of data about participation rates and impact***
- ***jurisdictional responsibility for education makes national initiatives challenging***
- ***belief that a culture of innovation is obtainable only by investing in post-secondary research – cultural shifts begin at a much earlier age and continue with lifelong engagement activities.***

i) Setting a Vision, Goals and Targets

What is the vision? Should the vision include both the principles of an innovation culture and science literacy?

Are the goals related to:

- Assessing Impact (e.g. enhancing techniques, testing tools, training for providers to assess learning outcomes.[xi])
- Youth Attitudes (e.g. number of youth excited by science; number of participants in science activities both in and out of school; access by under-represented audiences)
- Education (e.g. proportion of postsecondary students completing science and engineering degrees/diplomas)
- Adult Attitudes (e.g. interest and understanding of science within society; support for research; parental support for science engagement activities; confidence in own ability to contribute to public policy debate)
- Organizational Collaboration (e.g. linkages between informal and formal science education)
- Employment demographics; success in research & development (e.g. percentage of GDP spent on research, number of patents)
- Economic impact (e.g. number of profitable Canadian companies)

What are the desired outcomes?

- What are the immediate, short-term (3 years), mid-term (5 years) and long-term (20 years) goals?
- How can they be prioritized?

Considerable attention has been given to supporting post-secondary education over the past decade. However, do we understand why it is important to engage all people, from early years through adulthood in order to build an innovation culture? Do we understand the key outcomes / messages that are important at each stage?

How is success defined? How will success be measured?

- What will be measured?
- Are tools available to measure the desired outcomes?
- Who should be monitoring outcomes?

- What do we need to know in order to set priorities for action (e.g. how do we determine if there is a bigger impact by focusing near-term strategies on a particular audience segment or not)

ii) Framing Action and Scope

What can we learn from our past efforts and current effective practices?

Are we talking about coordinated activities and informal sharing of information? If efforts are to be coordinated – by whom?

How can we leverage existing efforts? How can collaborations be supported and strengthened?

How can we scale up successful existing activities to reach larger audiences?

Should we support existing networks (e.g. STAN, CASC, Science pour tous) that bring together innovators and practitioners; promote high standards in the field; support impact research?

How do we encourage collaboration (levies on research grants to support public communication activities encourage independent activity)?

Should we attempt to ensure that science and technology engagement activities also encourage the development of innovative behaviours?

Should we focus on building literacy in growing/emerging areas of national interest (e.g. stem cells, environment, climate change, biotechnology etc)?

What audience groupings are of the highest priority for short-term success? Medium, long-term?

Do we need national programs? Targeted regional initiatives? Community-based initiatives? How do we ensure quality?

Do we give a high priority to broad projects (e.g. promote celebrities or achievements) or do we focus on narrower projects such as one-on-one mentorship?

Can we determine an appropriate amount of money that should be spent on the Innovation Culture file (e.g. minimum 2% of federal R&D spending)?

5. Conclusion: Imagine This

A young girl, Isabella, reaches her first birthday and joins a child care centre when her mother returns to work. Her parents and the centre's early childhood educators understand their critical role in helping Isabella reach her full potential. They know that her trajectory for life-long behaviours, attitudes and health will be set before she is six years old. They also know that Isabella's desire to make sense of her world through exploration and play are critical for her learning. At home and at the child care centre, Isabella participates in meaningful learning experiences that expose her to the marvels of the world: her parents also take Isabella to children's museums and science centres.

When Isabella enters Kindergarten, she experiences a holistic learning program that brings together science, technology, arts, mathematics and language instruction. She participates in programs that allow her to continue exploring and learning about her world. As she grows, she engages regularly with people who enjoy talking about science; teachers who are comfortable, confident and properly resourced to teach science and mathematics. Isabella's creativity is nurtured, her skills broaden and her knowledge deepens. Thanks to regular opportunities to engage with her peers, she develops communications skills, team skills and empathy.

As Isabella reaches age 10, she's thinking about what she will do when she grows up. Although only in grade 4, she has already participated in summer science and engineering camps and reads a monthly science magazine. Her family regularly attends the science centre. Together they watch TV programs about the environment; they also listen to the weekend radio science show on the way to her music lesson. She hears her parents talking about politics and their views on emerging events in science, often based on the science Café's they attend. They have ongoing family discussions about ways to save energy around the house and it's Isabella's job to monitor the "smart metre". She has already met scientists, university science students, and science demonstrators who she thinks are quite 'cool'. A science career is definitely on her radar – possibly as a veterinarian, medical doctor, engineer, researcher or teacher.

Isabella's interest and creativity in science continues to be nurtured. When she's 12 years old in grade 8, her school holds a science fair. Collaborating with a partner, and with encouragement from her parents and support from a mentor from the local college, she wins her category. She starts high school eager to learn more.

As Isabella grows through her teen years, she interacts with people and places of science. It only seems logical to complete her high school science courses – after all, she wants as many career opportunities as possible when she begins her postsecondary studies. During those high school years, Isabella has many opportunities to pursue her interest in science and technology. She also begins to realize the infinite opportunities that exist for her to connect her love of science with her creative spirit in order to transform the lives of others by launching her own company. Thanks to a co-op placement with local company and an unforgettable summer entrepreneurship camp, she has tremendous practical experiences that are relevant to her life.

Isabella leaves high school comfortable with her role as an informed citizen. She values science and technology for their important role in her world – and her ability to shape it. The opportunities are endless for Isabella.

In Isabella's life, science and technology are not extra-special. It is understood by all significant adults in her life that she will participate in experiential science-based activities at all stages of learning. She will be inspired by career opportunities that await her. She will interact with science role models, ask questions and collaborate with peers. She will engage in out of school science-based activities. She will be proud of Canadian achievements in science and be able to put them in global context. She will realize her own capacity to shape the world and be successful.

She will be interested in science because science is interesting.

Isabella lives in, and contributes to, a Canadian innovation culture that is founded on science literacy and innovative behaviour.