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THE SCIENCE GAP IN CANADA: A POST-SECONDARY PERSPECTIVE

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Despite having its students score among the top in the world in mathematics and science, the level of science literacy and participation in science-related fields in Canada is relatively low. In the context of the economic and societal benefits afforded by science, this article reviews what is already being done in support of science, technology and engineering, as well as identifying some missing pieces that may explain declining interest in its pursuit. The focus is primarily on the role of post-secondary institutions in addressing the challenges from both organizational and student-centred perspectives.

Introduction

As a scientist, I have always enjoyed volunteering in judging at the regional science fair in our city. Top students from each school in the region compete here and the winners then go on to the Canada Wide Science Fair competition. Each year I am always impressed by two things. First, many of the senior projects which are in areas of science, engineering and technology, are more at the undergraduate level then they are at the high school level. At least, I cannot remember science at high school being so advanced in my day. Secondly, the younger competitors (Elementary level Grades 4-6) are more like real scientists than the older students. They get excited when they tell you about their research and discoveries. They are not afraid to experiment with all sorts of things no matter how ridiculous it might seem to us. If it does not work, they are content to report it and go on to try something else. In contrast, the older students are more self conscious of making mistakes. Their projects and presentations are carefully polished and they tend to look at your reaction in hopes that they have given the right answer. Unfortunately, that attitude can accompany many students well into their post-secondary education. Something seems to happen along the way with these young scientists that make them take a dimmer view of science as they grow up. Quite frankly, many do not get their sense of discovery back until they are much further on in their studies—many more just opt out of science altogether.

This is not a new problem in Canada or many other places, but it is one that has been growing in both terms of national importance and in terms of relative numbers. The Canadian government has recently released its national science strategy entitled, *Mobilizing Science and Technology to Canada's Advantage* (Industry Canada, 2007). There are also numerous public and private initiatives underway in terms of science promotion across the country. Unfortunately many of these initiatives are not coordinated, so both duplication and gaps occur. One of the bigger missing pieces, in this whole science picture, is happening right at the post-secondary level. This article looks at the science context in higher education in Canada. It will identify some of the gaps and discuss how institutions are dealing with these challenges. We start by taking a more global perspective by examining the role of science and some of the more critical connections to science and technology.

Science in the Marketplace

Science and technology (S&T) is a principal driver for a country's economy (Easton, Harris & Schmitt, 2005) and education in science, where mathematics and science are the most important contributions (Habermeier, 2007), is a mandatory prerequisite for sustainable economic performance. This fact seems to be generally recognized and is of particular importance to many more affluent economies around the globe. In Canada we are moving from a resource-based economy to a knowledge-based economy. Economists regard knowledge (particularly technical knowledge) as a factor of production. It is probably the most important factor in producing wealth, the other two being labour and capital. Statistical studies that attempt to assess the relative importance of the three factors confirm that knowledge can account for up to 75 percent of the value of output (J. Newark, personal communication, January 10, 2008). That knowledge can be considered both a part of human capital in terms of education and skills or as a separate discrete body of information such as an invention or innovative process or a fundamental scientific principal. In the latter case, it is research and development (R&D) that produces this knowledge. From the discovery of insulin to innovations like the Canada Arm, there has certainly been a proud history of R&D in Canada.

The performance indicators of our publicly funded research do well on the world stage. From an input perspective, Canada ranks second within the Organisation for Economic Co-operation and Development (OECD) countries on investment in higher education R&D as a function of Gross Domestic Product (GDP). From an output perspective, we have obtained excellent ranking in both publications per capita (sixth) and quality of publications (fifth) (Industry Canada, 2007). However, Canada's R&D indicators in the private sector do not fair nearly as well. Canada ranks fourteenth on business expenditures on R&D as a percentage of GDP and sixteenth on high-quality patents per million population within the OECD countries (OECD, 2006). Furthermore, Canadian business investment in advanced machinery and equipment lags behind international competitors ranking nineteenth in the OECD and last among the G-7. New machinery and equipment investment embodies the latest ideas and technologies and is therefore seen as an indication of industry support and use of R&D advances (Industry Canada, 2007).

There are also a few interesting observations around knowledge as a part of human capital. From the perspective of the individual we know that personal income increases with higher education. In addition, those working in S&T related fields, in particular, earn the second highest wages after those in management occupations (Statistics Canada, 2007). This would suggest that a career involving high level S&T skills would be fervently sought after, but this is not the case.

The number of people working in S&T related fields rank fifth out of ten occupational groupings identified by Statistics Canada and represent only 7.3 percent of the total workforce (Statistics Canada, 2007). As a share of total employment, Canada ranks seventeenth in the OECD for number of people in S&T occupations. In terms of total employed PhDs, most countries with the exception of Canada and the United States have more than 50 percent in S&T (McKenzie, 2007). Furthermore, the general demand for university graduates in the Canadian private sector is smaller than in the United States and graduates in Canada tend to be paid less than their counterparts in the United States. We see from Figure 1 that Canadian firms generally appear to hire at a lower educational level in all sectors. This trend of hiring at a lower level is even more pronounced when one looks exclusively at the S&T sector (Figure 2). These lower market incentives may partly explain why there are proportionately fewer people working in advanced S&T occupations than in the United States and most OECD countries (Industry Canada, 2007).

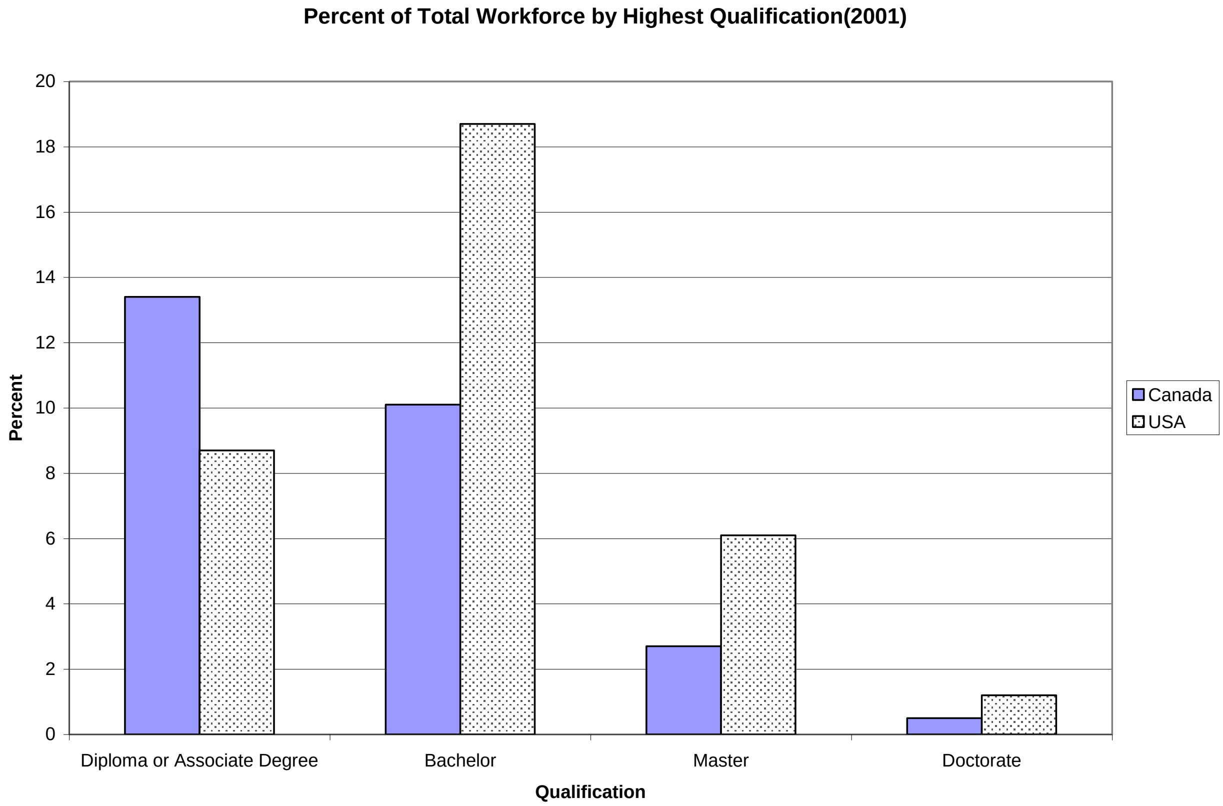


Figure 1. Percent of total workforce by highest qualification in 2001 (Statistics Canada, 2004; US Census Bureau, 2002).

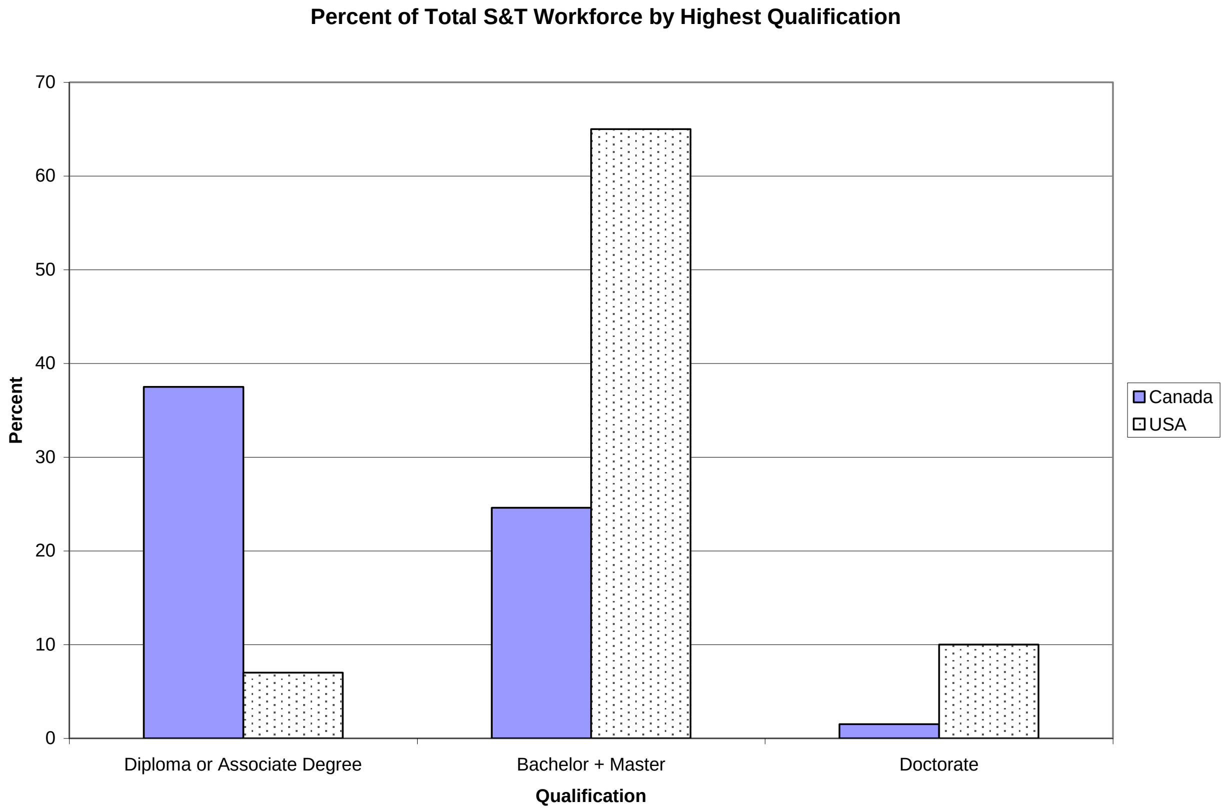


Figure 2. Percent of total S&T workforce by highest qualification for Canada 2001 (Statistics Canada, 2004) and USA 2000 (National Science Board, 2004).

Yet, there is evidence of demand for S&T workers now and in the future. One should keep in mind that specific predictions of future job markets have tended to have near zero success rates. There have also been past call to arms to deal with the crisis of looming shortages of highly qualified S&T personnel, which have not fully materialized. Both of these have eroded the credibility of forecasting demand. However, we do know that the number of R&D S&T positions has been increasing at about 4.4 percent a year (Thompson, 2002). Domestic spending on R&D as a fraction of GDP has also gone up from 1.66 percent (1997) to 1.94 percent (2006). In addition, there are predictions of demand focused on specific sectors. For example, Ph.D. level individuals filling staff faculty positions at universities represent a significant portion of graduates produced in Canada. There are currently about 40,800 full-time faculty at Canadian universities. The Association of Universities and Colleges of Canada (AUAC) have forecast that in the next ten years about 30,000 new faculty members (about 9000 in S&T) will need to be hired to accommodate growth and replace retiring faculty (AUAC, 2007).

While there are several indicators showing demand for science in the marketplace, there are two facts that are the most convincing:

1. Canada has historically been a net importer of skilled S&T workers. In 2001 the Canadian workforce was composed of 20 percent immigrants and non-permanent residents. This goes up to 28 percent when you only consider the area of S&T. For higher skilled talent we are even more dependent on importing. Only one third of all S&T PhDs employed in 2001 were Canadian-born.
2. Canada, like many other nations, is actively encouraging growth in S&T. Groups like the OECD or the European Union are linking S&T, education, and the economy to produce strategies to stimulate both supply and demand of scientific and technological knowledge. Both the United States through its *COMPETES Act* and Canada with its *Mobilizing Science and Technology* plan are recently launched national strategies aimed at boosting S&T and encouraging economic activity.

Science Literacy

To really flourish it is not enough to just train and develop more S&T experts, there also needs to be a robust science culture that will support a scientifically driven knowledge-based economy. In any discussion around science promotion the topic of science literacy invariably comes up. Although the exact meaning of the term science literacy has been debated over the years (Hodson, 2005), it generally includes knowledge of basic scientific processes and concepts, science-related attitudes and skills (e.g. problem solving), as well as an appreciation of its strengths and limitations.

It is sometimes helpful to describe science literacy in terms of what it is not. Science literacy is not the possession of specialized expert knowledge often described in seemly obscure jargon. You do not need to have a working knowledge of the International Geomagnetic Reference Field Model to understand how a compass works. Science literacy is also not technology literacy. Operating a computer is not science. So, why do we need to understand science?

There have been numerous arguments put forth to increase science literacy including personal satisfaction, cultural health of a nation, simple aesthetics, economics, and intellectual coherence (Hazen 2002; Thomas & Durant, 1987). However, the most frequent argument has been to cultivate a better informed electorate that can actively participate in a democratic system, because more political decisions now involve scientific considerations. I am reminded of a movie about a bushman of the Kalahari entitled *The Gods Must be Crazy* (1980). In the opening segment the narrator describes the urban dwellers as a comparator to the bushman's life.

> And here you find civilized man.
> Civilized man refused to adapt himself to his environment.
> Instead he adapted his environment to suit him.
> So he built cities, roads, vehicles, machinery.
> And he put up power lines to run his labour-saving devices.
> But he didn't know when to stop.
> The more he improved his surroundings to make life easier, the more complicated he made it.
> Now his children are sentenced to 10 to 15 years of school, to learn how to survive in this complex and hazardous habitat.
> And civilized man, who refused to adapt to his surroundings now finds he has to adapt and re-adapt; every hour of the day to his self-created environment.

As with any good humour this passage contains a grain of truth. We do live in a world that is becoming increasingly complicated and we certainly have to take responsibility for much of that.

However, it would be unfortunate to view science literacy as simply a means to master nature or as merely a part of our education to cope with the surroundings we created for ourselves. Science literacy enables us to understand and hopefully make positive connections between science, technology, innovation, the economy, our environment, and our society.

Canadian students tend to score high on international science assessments. The results of the most recent the Programme for International Student Assessment (PISA) put on by the Organisation for Economic Co-operation and Development (OECD) look quite good for Canada. Among a group of 57 participating countries, students from only Hong Kong-China and Finland outperformed Canadian 15-year-olds on the combined science scale and Canadians ranked fourth in the area of mathematics (Bussière, Knighton, & Pennock, 2007). In 2001 Canadians were sixth in mathematics and fifth in science among 31 countries (HRSDC, Statistics Canada & CMEC, 2001). As a nation we can take some pride in that we have some of the best educational systems in the world. However, having high standings achieved by Canadian youth does not seem to translate into a high level of science literacy in the general population. It is estimated that fewer than 20 percent of the Canadian adults are regarded as scientifically literate (Miller & Pardo, 2000). Which is interesting considering in that same time frame 52 percent of adults (more than 15 years in age) possessed a high school diploma (Statistics Canada, 2001). What is even more surprising is that 29 percent also held some post-secondary qualification. There seems to be a real disconnect.

We are not alone in this. In Canada and other industrialized countries around the globe post-secondary institutions are producing graduates with a low level of science literacy. An informal poll at a Harvard University commencement showed that not more than ten percent of graduates could explain why it is hotter in summer than in winter (Hazen & Trefil, 1990). On the surface this sort of illiteracy may seem funny, but there are potentially serious consequences. For example, in the United States the Delaney Clause was enacted in 1958 to regulate chemicals in foodstuffs. This clause prohibited the sale of food if it contains any quantity of a food additive that has been found to induce cancer in humans or animals (National Academy of Sciences, 1987). Although the legislators were well meaning, the notion that an absolute zero amount can be realized, of any compound found in the environment, is a physical impossibility. Analytical chemists can quite literally detect and quantitate almost any analyte in any sample chosen. The clause was eventually revised in 1996 after decades-long debates and legal actions.

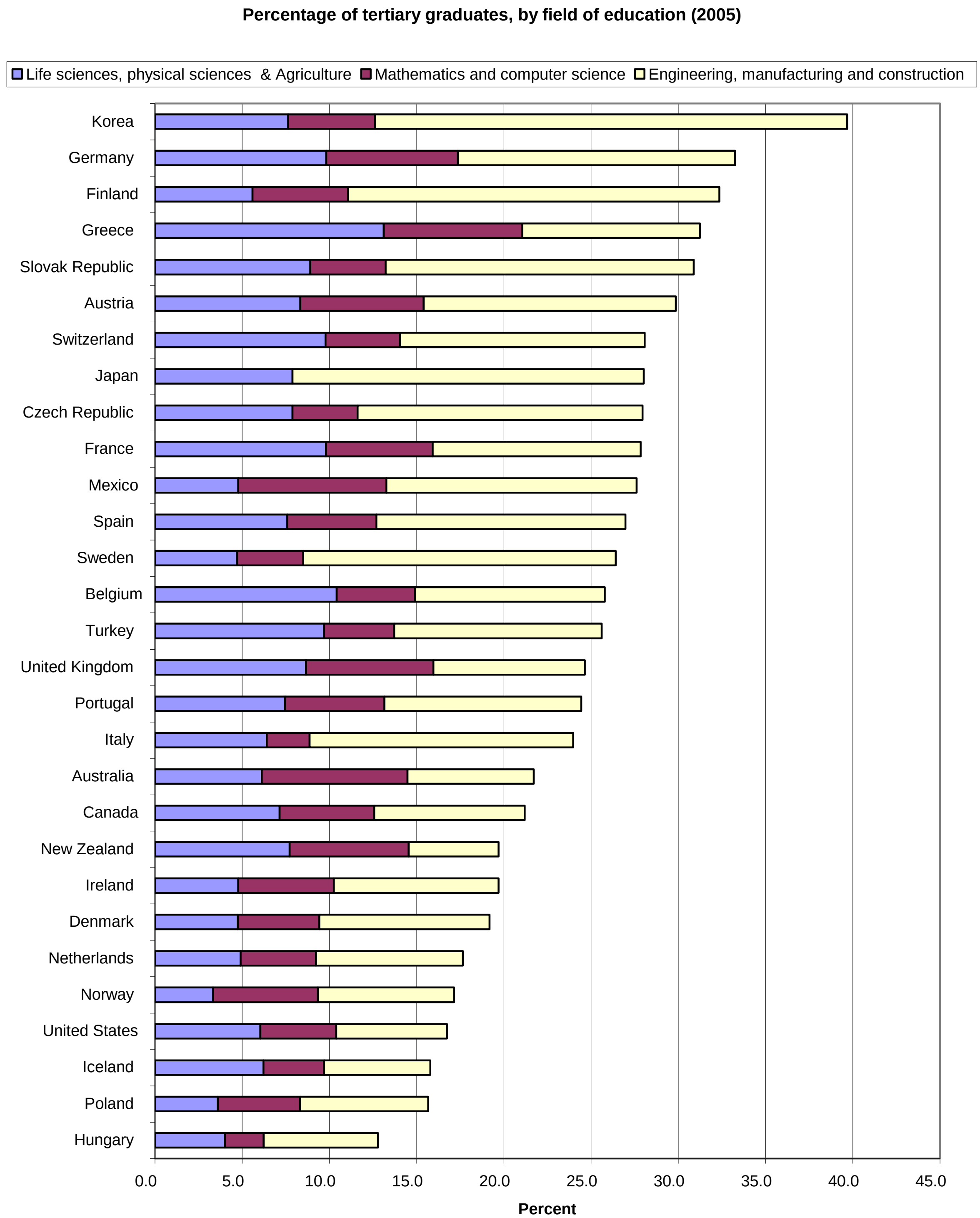
Science Education and Training

So, considering the increasing demand for skilled S&T people and the recognition that improvement of science literacy in the general public is advantageous in a knowledge-based society, what is being done to foster science education? The quick answer is that there are already a lot of initiatives underway to promote science at different levels, but the collective emphasis of these initiatives is not evenly distributed across the board resulting in some missing pieces.

From the perspective of science literacy the emphasis is mainly on K-12 within the formal school system, as well as informally within the general population. On the surface Canada seems to be doing an exceptional job of laying the science literacy foundation in schools. However, this is mostly limited to students actually participating in mathematics and science courses. We have already seen that Canada's K-12 systems score well internationally. Yet the participation of students in science and mathematics declines dramatically in the higher grade levels (Bordt et al, 2001). For science literacy and the general population, there are also numerous science centres, museums, popular science magazines, television programs, and science outreach initiatives across the country that offer an opportunity for more informal science learning or free-choice science education. Free-choice science education is driven by the personal interests of the learner who decides what, where, and when learning will occur (Falk, 2001). This not only serves to complement existing formal science curricula, it is one of the few opportunities for learners outside a formal education system to access science information in an entertaining and motivating way. In short, most initiatives for science literacy are targeted towards either school children taking mathematics and science courses or the general population where the take up is voluntary and self-directed. The quality of science education is high, but the important missing piece in both situations is the lack of full participation.

Canadian post-secondary education also enjoys a solid reputation around the world. Its market share of international students appears to be growing. In absolute terms, full-time visa university students have grown from 25,600 in 1996 to 70,000 ten years later (AUCC, 2007). Canada ranks fifth overall with 21 universities listed in the top 500 top rated universities around the globe (Centre for World-Class Universities, 2008). More significantly on the domestic front, Canada ranks first in the OECD for share of population with tertiary education (Industry Canada, 2007). Freshly minted students trained as scientists, engineers, and technologists are among the most skilled in the world.

However, there are two major problems with this post-secondary picture. First, once these S&T students leave their institutions they are often left to continue their learning on their own through their work or professional associations. There are few opportunities to pick up additional formal training that would accommodate adult learners. It can also be challenging for new Canadians with S&T skills to get into the professional or educational system and have those skills fully recognized. Finding facile entry or re-entry points to the formal education system can be problematic. Secondly, the participation rate in S&T at the post-secondary level is very poor in Canada, especially at the graduate level. The weak graduate level participation is also exacerbated by capacity issues (AUCC, 2007). Although Canada ranks first among the OECD countries with respect to share of population with post-secondary education, it is eighteenth in producing PhDs and twentieth (Figure 3) for S&T degrees as a share of total degrees. In brief, Canada’s formal S&T education is of high quality, but we have low participation rates starting in upper secondary and at the post-secondary level (especially at higher levels) and we do not have good mechanisms in place for adults to continue formal S&T education once they are out of the system.



Lack of interest in Science

Figure 3. Percent S&T tertiary graduates (OECD, 2006)

So what is the problem? First, there has been a well-documented and progressive decline in student participation in mathematics and science at both school and university levels in several industrialized countries around the world (James, 2007). In Canada many upper secondary students (58 %) stop taking mathematics and science courses citing that they are difficult or boring (Bordt, 2001a). Surprisingly, this includes students who have previously done well in science and mathematics and who believe these subjects are important to their future success. A survey of what subjects upper secondary students liked showed that physics (49.9 %) and chemistry (55.2 %) were the most unpopular—even more so than mathematics (66.2 %). Earth science (70.9 %) and biological science (71.6 %) were the most popular science subjects (Bordt, 2001b).

The OECD recently formed a working group on the declining interest in S&T studies among young people. The behaviour observed with S&T participation rates is consistent with other reports. However, there were several key findings that also give some insights on perceptions and attitudes (OECD, 2006).

- S&T student numbers have been declining in relative terms. Mathematics and physical sciences are hardest hit.
- Women are still strongly under-represented in S&T studies.
- Student choices are mostly determined by their image of S&T professions, the content of S&T curricula, and the quality of teaching.

The image of science and scientists remains largely positive, but S&T professions have become less attractive. The perception is that income is low relative to the amount of work required and the difficulty in completing studies in the first place (OECD, 2006). Interest also seems to be intensely influenced by personal experiences (rather than just performance) in previous S&T

courses. Furthermore, there is a strong gender-dependency with differing attitudes between boys and girls, which eventually determines choice of profession. The role of expectations in all this from families, teachers, and career advisors on S&T career paths for women was also cited. With respect to gender, it is not clear whether this is solely a lack of interest in these careers by individuals or rather a problem with lack of support and perceived barriers to access.

To some extent differentiation in choice preference was also observed for minority groups in the various countries. For example in Canada, the weak representation of Aboriginal people in S&T fields is an area of serious concern (CCL, 2007). There have been increasing efforts to support Aboriginal students generally at various educational levels. At the post-secondary level this includes bridging courses, Aboriginal focused programs and credentials, access programs, specialized built-in on campus supports, and other initiatives across Canada (ACCC, 2005; Holmes, 2006). Still, S&T fields present their own particular challenges to Aboriginal students. In addition to barriers such as lack of science role models, poor preparation for post-secondary studies, and little to no mentoring, there are also real cultural differences around how science and the learning of science are appreciated.

Many potential science students view S&T fields as a foreign land. Their attitudes, expectations, and perceptions greatly influence whether they will venture there. Participation rates in S&T seem to have little to do with ability. It may not be exactly like the old saying, "reality is nothing, perception is everything," but it is pretty close.

The Role of Higher Education

A person's higher education experience is usually a very important part of their life. For many it is not only a means to a career and a secure income, it can also be very transformational in their growth as a person and their view of the world. Whether one is in an S&T profession or not, S&T is certainly becoming a more important aspect of that world. It is becoming vital to have leadership within the institution that understands science and education. To their credit, a lot is already being done to support science at post-secondary institutions across Canada. So what are the missing pieces? The evidence seems to be that more could be done to (1) encourage participation in S&T studies and (2) insure a good level of science literacy across all programs.

Although this article is primarily focused on science, we view many of the initiatives to address science literacy in terms of general education. Science majors can and do benefit from exposure to non-science educational experiences and so many of the cross-pollination initiatives described below are equally applicable in broadening science programs. The following are a small example of strategies and intiatives being employed by institutions locally to address science program participation and science literacy.

Strategies to Increase Participation

- Communicate about S&T careers in a credible manner that does not just focus on science itself, but on the reality of the profession. Students and their parents often overestimate the cost and underestimate the value of a tertiary education. This seems particularly true when considering S&T professions. However, decisions to pursue S&T studies and careers are often linked to better knowledge. Surveys indicate students are more likely to choose this career route if they have a family member working in S&T or at least have some professional contacts (OECD, 2006). A good communication strategy might include initiatives like accessible information sources for students (as well as faculty and advisors) or engaging professional societies to jointly approach students within the institution and the high schools. A increasingly popular strategy is to put on open houses and special camps for students at the secondary level (or earlier). However, the emphasis of these programs is chiefly on the awareness and fun of science, technology, and engineering itself. While this component is desirable, usually there is little information on what one might expect at higher level studies or work itself if one chooses a career in science.

- Improve the number of entry and re-entry points into the S&T career pathway. A recent in-depth study confirmed that participation rates in S&T are greatly influenced by increasing entry points and decreasing drop-out risks (van Langen & Dekkers, 2005). This essentially means creating more opportunities such as, offering preparatory or bridging courses (even an entire preparatory year), conditional acceptance to programs while missing curriculum gaps are filled, and better recognition and articulation of previous work. Some institutions have initiatives that not only advertise, but provide support for entering the system. For example, the University of Calgary's *Return to Learn Workshops* targets transfer and adult students coming back. Increasing entry points would also serve other purposes, such as offering better access for new Canadians. Increased services to support immigrant integration are being lead by community colleges and technical institutes across the country (ACCC, 2007).
- Value good teaching and mentoring in faculty. The curriculum and quality teaching profoundly influences student perceptions about a discipline and therefore their future choices. There is strong evidence that student success is driven by a good student experience—especially at the first-year college level (Upcraft, Gardner, & Barefoot, 2005). The need for re-thinking teaching in the sciences so that it is more intentional and better suited has been identified by several Canadian institutions. The UBC scientist and Nobel laureate Carl Weiman (2006) recently noted:

> There are currently great needs and great opportunities for improvement in post-secondary science education. We need to provide a large fraction of our students with complex understanding and problem solving skills in technical subjects. Emerging research indicates that our colleges and universities are not achieving this. However, there are great opportunities to improve this situation using advances in the understanding of how people learn science and advances in educational technology.

- Target support for under-represented groups in S&T programs. This means first trying to understand, where possible, why certain groups under perform or under participate (Seymour & Hewitt, 1997). For example, at the University of Toronto the *Girls Rock Science* program puts on workshops that introduce high school girls (Grades 9-12) to the physical sciences. University of Saskatchewan researchers in consultation with Aboriginal Elders are integrating and fostering understanding of Aboriginal and Western science in the *Rekindling Traditions* program (Grades 6-12). In the United States, some colleges had found that they were losing many minority students in the sciences in the first year. Although they did well in high school, they struggled as soon as they were in the post-secondary environment. This has lead to several colleges not only going directly into the high schools to encourage students (similar to the *Girls Rock Science* program), but also bringing them and their families on campus to discuss their education. This would be followed up by systematic support including financial assistance, mentoring, and creating communities of learning during their studies.
- Provide supports to retain students who have already chosen S&T studies. Some institutions have set up either a student mentoring system or have provided the structure for a science community among the students (e.g. the *Science Mentor Program* and the *Science Cohort Program* at the University of Alberta). At McGill University small groups

(15) of first-year science students in the *Freshman Interest Groups* program get together informally every two weeks to meet professors, guest speakers, and each other. They can explore topics not normally covered in the classroom, that range anywhere from careers in science to the structure of universities. In each of these examples, a learning community is created in an attempt to get at retention through student engagement and building social connections. Creators of these initiatives claim a range of benefits including increasing the quality of learning. However, it has been shown to be particularly successful approach in addressing a student's transition from high school to university (Laufgraben & Shapiro, 2004).

Strategies to Increase Science Literacy

- Develop a really good science course for non-scientists that would include science ethics and philosophy. Make it a core program requirement and have it taught by your best professors. Many institutions already have science courses open to non-major students, but not necessarily mandatory. For example, Simon Fraser University has a course entitled "Chemistry in Your Home, Work, and Environment" as a part of their *Quantitative and Breath-Science Courses* that is open to everyone. There are always challenges of course ownership and content. However, the biggest obstacle is that they are seen as low priority compared with the desire to achieve discipline-specific goals in the short time frame of a program (i.e. packing in the right content).
- Incorporate some science into other subjects areas by integrating some science across non-science programs and courses. Science is often thought of as a separate entity, so that scientific knowledge and method are often not seen at the university level by non-science

majors. This type of cross pollination becomes an important part of the general education of any undergraduate. For example, George & Straton (1999) have successfully used the critical thinking path to introduce science in a general sense. However, there are numerous opportunities to make science connections or use science-oriented examples in any of the non-science disciplines. Shaping the curriculum in this manner is not trivial, but worthwhile and sometimes rewarding (George & Straton, 1999).

- Rethink how introductory science courses are being taught from the non-major perspective. This is an extension of the valuing good teaching idea suggested previously. Many times introductory courses are aimed at the minority of students continuing in that particular discipline. Teach as if it were the last course a student would take in the subject, not just grounding course for further study in that particular discipline.
- Structure programs so students do not become locked into one discipline too early. This is probably more appropriate for longer programs of study. There are some examples of existing programs across the country including *Science One* (University of British Columbia), *Science 100* (University of Alberta), and *Dalhousie Integrated Science Program* (Dalhousie University).). At McGill University they have a series of short lunch time science research presentations entitled *Soup and Science*, which allows student to discover what is being done within and outside their departments. It also offers an opportunity to mingle and become part of the university's science community.
- Get students involved in community science outreach. This could be programs developed locally (e.g. science camps and science fairs) or part of nation-wide efforts like the *Let's Talk Science Partnership Program*. Although the primary aim is to increase science

awareness and literacy of K-12 students, there is an added benefit of developing and reinforcing the same in the post-secondary volunteers leading the activities.

One important tool that is being increasingly used to promote both science participation and literacy is digital technology. The ability to provide exciting presentations, simulations, and interactive opportunities, coupled with access, flexibility and independence for the student makes this appealing. Many science educators are exploring digital technologies as a means to make the teaching and learning of science more engaging, realistic and relevant.

The fact that so many post-secondary institutions have activities and strategies that try to address participation and literacy indicates a recognition that these are areas of serious concern. These gaps are perceived by educators and administrators as genuine. With some stategies, such as communicating career expectations, providing adequate entry and re-entry points for study, and introducing some science in non-science curricula, one can find little effective activity. With many of the other strategies local authorities claim success, but often without genuine evidence. What is needed is more assessment of local initiatives with the intention of repeating that success at other locations or within other environments. We have already seen this work in Canada at the K-12 level with schemes like the *Let's Talk Science Partnership Program* that moved from scattered local initiatives to a national system. While a nationally coordinated system to address participation and literacy may not be a desired end goal, understanding and sharing effective approaches would be.

Conclusion

Having both highly qualified people in the S&T area and a strong science culture holds tangible benefits for a country and its society as a whole. There are also advantages from the perspective of the individual, whether pursuing a career or pursuing an interest. The benefits are well recognized in Canada and are reflected strongly in such things as the educational system, policies and strategies, public R&D funding, as well as public support of museums and science centres. Still, there are some areas which need to be strengthened, such as increasing private sector investment in R&D and investment in the education of employees, as well as public funding to expand capacity especially at the graduate level. From a post-secondary institutional perspective there are also some missing pieces: (1) post-secondary student participation in S&T studies (especially at higher levels) is small and (2) there is a surprisingly low level of science literacy among all graduates.

What can be done about that higher education science gap? From an institutional perspective, academics and administrators alike need to be aware of the magnitude of the problem and may need to go outside their usual comfort zone in seeking solutions. The problem will require serious reflection that should lead to fundamental changes including redesigning curricula and transforming deep-rooted insitutional processes and policies. From a national/provincial perspective an increased commitment to policies that identify, evaluate and encourage effective strategies is needed. One might anticipate renewed efforts in that direction driven by the "Obama effect" recently seen in the United States. In his inaugural speech President Obama pledged to "… restore science to its rightful place…" (New York Times, 2009). This excitement and expected upcoming changes around science will almost certainly spill over to Canada.

The problems around science participation and science literacy are not new to post-secondary institutions and there have been many individual initiatives launched to address them, with varying degrees of success. We have mentioned some of these initiatives that specifically target these concerns to give a better flavour of what is already being done and hopefully catalyze ideas for further approaches. It is important to keep in mind that although each institution has its own particular environment and circumstances, one does not always have to reinvent the wheel. The question becomes: How do we now scale up programs and strategies nationally that have been shown to work well locally?

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