COMPETING IN THE 21ST-CENTURY SKILLS RACE

Graham Orpwood, Bonnie Schmidt and Hu Jun

In international comparisons, Canada's education system ranks highly in terms of basic literacy, numeracy and high-school completion rates. But our country receives a much lower grade when it comes to participation in post-secondary science, technology, engineering and mathematics programs — fields that have been shown to have a direct impact on innovation, productivity and economic growth. If we fail to address this problem, Canada risks falling further behind in the 21st century skills race.

Au jeu des comparaisons internationales, le système d'éducation canadien se classe très bien au chapitre de la littératie, de la numératie et de l'achèvement des études secondaires. Mais il fait piètre figure pour ce qui est de l'obtention d'un diplôme d'études supérieures en sciences, en technologie, en génie et en mathématiques, soit les domaines qui influent directement sur l'innovation, la productivité et la croissance. Faute de s'attaquer à ce problème, le Canada se retrouvera en queue de peloton dans la course aux compétences du 21e siècle.

Over several decades, Canada has witnessed the decline of many of its traditional manufacturing industries in the face of competition from low-wage, low-skilled Asian economies. Much of our clothing now comes from countries such as India, Pakistan, Sri Lanka and Bangladesh; our televisions and stereos come from South Korea; our cars come from Japan; and seemingly everything else comes from China. Canadians, meanwhile, have moved on to other industries and more value-added activities. While still benefiting from a rich supply of natural resources, we have developed expertise and achieved success in a range of high-skilled fields, such as financial services, telecommunications, biotechnology and aerospace.

But the global economy is evolving in ways that continue to challenge Canadian workers and companies. The so-called Asian Tigers — a term originally applied to Singapore, Taiwan, Korea and Hong Kong — have established themselves as world leaders in high-technology manufacturing. But now India, China and other previously low-skilled economies are moving up the value chain and churning out increasing numbers of highly educated, highly qualified workers. Given the overwhelming size of their populations, even a modest increase in their post-secondary participation rates can have a significant impact on Canada and other developed nations.

It is time for a frank assessment of Canada's ability to compete in this skills race. This article seeks to contribute to this assessment by contrasting aspects of education and skill development in Canada with those of China (as an example of an Asian economy undergoing rapid transformation) and by examining the options for Canadian governments, educators, companies, nongovernmental organizations and individuals.

Just two generations ago, in the immediate aftermath of the Second World War, a much lower level of education was required for Canadians to participate fully in the economy of the day. In 1948, an estimated 54 percent of all Ontario students were dropping out of school by age 16, R.D. Gidney notes in *From Hope to Harris: The Reshaping of Ontario's Schools*. Of the entire 15-19 age group, fewer than 40 percent were still in the classroom. Such levels of education were suited to a still largely rural economy with a growing urban manufacturing sector.

By contrast, employment prospects today for those who fail to graduate from secondary school are poor. A recent federal government labour market study predicted that, over the next decade, nearly three-quarters of all new jobs will be in categories usually requiring post-secondary education. This rate of change is striking, and Canadians must ask themselves whether their public- and private-sector institutions are up to the task of producing the highly skilled labour force our economy requires. The issue is not just how much education and training is required for individuals and the economy as a whole, but what kinds of education, which specific skill sets, and for whom these skills will be of most value in the global knowledge economy.

Literacy and numeracy — the abilities to read, write and use numbers in ways that enable active participation in society — have long been recognized as essential building blocks for all higher-level skills. However, these needs have not remained constant over time. Rather, they have increased in complexity as life and work have grown more sophisticated; it is now important that everyone reach a basic level of literacy and numeracy.

There is growing agreement that beyond this basic level knowledge and proficiency in the areas of science, technology, engineering and mathematics (so-called STEM skills) are closely related to a country's capacity to compete in those sectors of the economy in which technological innovation is most important.

Finally, there are skill sets and cultural attitudes that are not based on specific subject areas but are closely related to the capacity for innovation. These have variously been described as generic skills, advanced skills, enabling skills and 21st-century skills. All imply the blending of specialized knowledge with the ability to reason in appropriate ways; to be critical, creative and innovative; to collaborate; and to be adaptable, flexible and capable of taking risks. These skills are difficult to teach, at least in a direct sense, and they are even harder to assess. We therefore have little evidence as to their levels of achievement until after the period of formal education.

These three groups of skills — literacy and numeracy, STEM and innovation-related skills — are not mutually exclusive. Rather, they build on and reinforce one another. Individuals, organizations and nations that succeed in the 21st century are likely to be those in which the full range of skills have been developed in an integrated way. With this in mind, it may be useful to review some data for both Canada and China and consider where traditional advantages lie and where rates of progress are most significant.

Canadians have traditionally enjoyed high rates of literacy and numeracy. In the most recent (2009) report of the OECD Programme for International Student Assessment (PISA), Canadian 15-year-olds outperformed their peers from the majority of the 65 participating countries and urban economies in each of reading, mathematics and science. Only four — Shanghai-China, South Korea, Finland and Hong Kong-China — outperformed Canada in reading. Those countries, as well as Singapore, Chinese Taipei and Liechtenstein, outperformed Canada in mathematics. These results, together with other indicators of education and basic skills, led the Conference Board of Canada to award our country an "A" grade in its national report card in 2010, ranking Canada second only to Finland in a comparison of 17 peer countries.

In the Conference Board rankings, Canada and six other countries scored an "A" in high-school completion rates; Canada also earned an "A" on college completion, together with just Belgium and Japan. But when it comes to university completion rates, Canada drops to a "B," behind the Netherlands, Norway and the United States. We do even worse in participation in STEM education at the post-secondary level, dropping to a "C" grade based on Canada's relatively low proportion of graduates in these fields. (Ontario's College Mathematics Project has highlighted the alarmingly high failure rates in mathematics — a foundational subject for most technology and business programs — among first-year college students.)

It is at the postgraduate degree level, however, that Canada's performance is weakest. Ranked by the overall number of Ph.D. graduates per 100,000 people, Canada is in the lowest quartile, scoring a "D" grade. This led the Conference Board to conclude that our country needs more graduates with advanced qualifications and more graduates in STEM fields to enhance innovation and productivity growth "and ultimately to ensure a high and sustainable quality of life for all Canadians."

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In response to concerns about Canada's relatively low rates of participation in STEM fields, particularly at the post-secondary level, Amgen, a leading Canadian biotechnology company, and Let's Talk Science, a nonprofit organization dedicated to the promotion of science education, recently undertook the first benchmark study on science learning in Canada, entitled "Spotlight on Science Learning." Using OECD data, the study explored student participation in university-level STEM programs from 2004 through 2007. In Canada during this period, 10 to 13 percent of all newly granted university degrees were in science disciplines (life sciences, physical sciences, mathematics, statistics and computing) and 8 to 9 percent were in engineering-related fields (engineering and engineering trades, manufacturing and processing, architecture and building). The proportion of science degrees in China was similar but the proportion of engineering degrees was 30 percent in 2004, increasing to 37 percent by 2007.

At the doctoral level, Canada ranked 25th among 36 nations in science and engineering doctorates in 2006; here again, science disciplines (22 percent of all doctoral degrees) predominated over engineering (17 percent). By contrast, 37 percent of all doctorates in China were in engineering disciplines, compared with fewer than 20 percent in science.

The study also examined labour market trends and concluded that Canada faces a growing shortage of workers with undergraduate and advanced degrees in STEM programs. According to a 2010 Human Resources and Skills Development Canada report, "A Ten-Year Outlook for the Canadian Labour Market," the sectors with the highest number of future job openings include mining, information and communications technology, transportation equipment, oil and gas, science services and health care — all fields where STEM education is important. These findings are consistent with those of a 2010 study by Rick Miner, president emeritus of Seneca College, who projected that, in Ontario alone, half a million skilled vacancies in 2011 "will grow almost exponentially to well over a million by 2021 and approach two million by 2031."

Yet in spite of that, a 2010 Angus Reid survey of Canadians aged 16 to 18 revealed that only 37 percent were interested in taking even one science course at the post-secondary level. Our research indicates that Canadian students recognize the need for more people to study science but that a majority of them are not themselves attracted to such programs or careers. As the Amgen/Let's Talk Science study concluded, there appears to be a serious disconnect between Canadians' positive perceptions about the importance of science to society and young people's desire to pursue a science-related career.

Since its founding in 1949, the People's Republic of China has strongly emphasized education and skills development. In 1986 it became mandatory for Chinese students to receive six years of primary education and three years of secondary education. Age 15 marks the final year of compulsory education, after which students can enrol in a senior secondary school. The proportion of all students continuing in this way has risen sharply in recent decades and, in 2008, 65 percent of all students graduated from senior secondary school.

Responsibility for China's education system is shared between the Ministry of Education and the governments of China's 30 provinces, municipalities and autonomous regions. While policy is developed centrally and applies nationwide, implementation is local and may be more or less developed depending on the jurisdiction. Thus, while the PISA results for Shanghai students can be assumed to be representative of all students in that urban area, they may not be representative of China as a whole.

As is true of most Southeast Asian societies, Chinese culture puts great value on schooling, and Chinese parents have high ambitions when it comes to their children's education and careers. In a system where there is intense competition at each stage for entry into what are perceived to be the best schools, formal assessments — usually in the form of written examinations — are very important. Students in the last year of middle school, and again in the last year of senior secondary school, often work late into the night, and parents frequently pay for extra tuition to ensure that their children's marks are high enough to gain entry to a preferred school.

Over the years, China has implemented a series of major reforms to increase the capacity of its post-secondary education system and to stimulate educational excellence, both qualitatively and quantitatively. The growth in numbers of students participating in higher education over the past decade has been remarkable. According to the Ministry of Education, 2,206,072 students were enrolled in a university or college in the year 2000. By 2009, this had grown by nearly 290 percent to 6,394,932 (table 1).

Even more remarkable is that over the same nine-year period, the proportion of students enrolled in STEM subjects remained consistently over 50 percent, with the proportion studying engineering increasing by more than 280 percent. While the overall proportion of Chinese students attending a post-secondary institution is still less than that in Canada, the overall numbers are of course much greater and the proportions are also catching up.

It has been said that China is transforming itself from a nation rich in human resources into a nation rich in highly qualified human resources. During the period 2006 to 2010, the central government formulated and implemented the National Medium- and Long-Term Plan for Scientific and Technological Development, allocating RMB619.7 billion (about C$100 billion) for science and technology — representing an average annual funding increase of 22.7 percent. In addition, China plans to increase spending on research and development to 2.2 percent of GDP by 2015. At the governmental level, this translates into a strong commitment to STEM education as an essential driver of economic development.

There is much to be proud of in the Canadian education system. Literacy and numeracy levels are relatively high by international standards. Enrolment in

TABLE 1. ENROLMENT IN HIGHER EDUCATION (UNIVERSITY AND COLLEGE), 2000-09, CHINA

Year	2000	2003	2006	2009
Total enrolment	**2,206,072**	**3,821,701**	**5,460,530**	**6,394,932**
Science	202,466	329,656	281,691	335,354
Engineering	832,124	1,242,426	1,992,426	2,339,887
Agriculture	68,966	81,619	100,020	118,911
Medicine	149,928	257,681	380,083	453,312
STEM skills (n)	**1,253,484**	**1,911,382**	**2,754,220**	**3,247,464**
STEM skills (% of total)	**56.8**	**50.0**	**50.4**	**50.8**

Source: People's Republic of China, Ministry of Education (http://www.moe.gov.cn).
Note: STEM – science, technology, engineering and mathematics.

post-secondary institutions is also high and growing. And political momentum to support education has been growing in all provinces. But there are obvious challenges, particularly with regard to the number of postgraduate students and the relatively low rate of participation in STEM programs — areas in which high levels of knowledge and proficiency have been shown to have direct economic impact. In order to deal with these challenges we must ask a number of potentially awkward questions:

- How can Canada develop educational policies and plans geared to national economic priorities when our constitution gives the provinces and territories exclusive responsibility for education?
- What will it take to convince policy-makers and the public that education is an investment in our economic future and not merely a social cost?
- How will we meet the need for more scientists, engineers, technologists and skilled trades people when our post-secondary system is largely driven by student choice, and when insufficient numbers of students seem inclined to pursue such careers?
- In what ways can private-public partnerships, the not-for-profit sector and collaborations among formal and informal organizations — schools, colleges, universities, libraries, museums and other institutions — help to improve Canadian educational outcomes?

Without wanting to open up a constitutional debate about responsibility for education and skills development, we feel strongly that Canada lacks a forum in which the full range of stakeholders can address these issues. In our view, Canada urgently needs a national round table on skills to articulate a vision for the future and develop the path forward. Such a round table would require the participation of provincial and territorial governments, but also the federal government, the private sector, not-for-profit organizations, educators from both formal and informal settings, and citizens themselves.

If education is to be recognized as an investment in our future, a common vision and strategy must be created collaboratively. And if such a vision is to become reality, it should be backed with funding to support programs and activities aimed at the development of appropriate skills for all Canadians. The proposed round table must have the resources to assess the effectiveness of existing educational institutions and policies, and to make recommendations where changes are required.

In addition, we believe that governments and other stakeholders must work harder to recruit and retain young people in STEM programs and to support effective practices in these areas. One option would be to rethink traditional subject boundaries and develop multidisciplinary approaches to learning that would provide students with relevant and exciting contexts for their education. Another approach would be to establish better linkages between education and career awareness. Formal and informal educational institutions, as well as corporate and voluntary organizations, all have roles to play here.

As we consider how best to strengthen Canada's educational system, it is essential that we pay close attention to what other countries are doing to address their needs for highly skilled labour. For that reason, we support building a robust and long-term Canada-China academic exchange and collaboration system, with a particular emphasis on educational research. Such a system would enable Canada and China to understand and explore innovative trends in education. It would also improve Canadians' understanding of China as a world-class developer of skilled talent.

Even if literacy and numeracy are universally achieved, if STEM participation is increased substantially, and if the number of doctoral students is doubled — will this be enough to ensure Canada's continued prosperity in an increasingly competitive world? In the 19th century and for most of the 20th century, Canada achieved high levels of literacy and numeracy, which in turn fed impressive rates of economic growth. More recently, STEM skills have become the means by which countries such as Japan, Korea, Singapore, Taiwan and Finland have established leadership positions in key industries, leaving Canada struggling to maintain its place among the advanced industrialized economies.

As the 21st century progresses, we must consider whether a new skills race is developing, one that is still poorly defined and in which teaching, learning and assessment remain largely under-researched. Some of the most important skills of the 21st century are the ability to reason in innovative and creative ways, to collaborate and communicate using new and emerging technologies, to adapt rapidly, to solve problems and take calculated risks, and to continue learning throughout one's lifetime.

If we believe that these are the skills most needed for individuals and nations to succeed in the 21st century, we must ask ourselves whether our present educational institutions are the best vehicles for nurturing these skills or whether new arrangements and methods are required. Can institutions built on a centuries-old model of teaching and learning be expected to produce graduates who are innovative, critical, adaptable and flexible or do we need to develop new structures and strategies? If existing institutions are to continue to be the principal means of skills development, what reforms are required of them to ensure that graduates are ready for the world they will enter?

Graham Orpwood is professor emeritus at York University and visiting fellow at the Institute of Education at the University of London, United Kingdom. Bonnie Schmidt is president and founder of Let's Talk Science, a national not-for-profit organization offering diverse STEM learning programs for students and educators. Hu Jun (Joy) is associate professor at the China National Institute for Educational Sciences in Beijing.