

## The Canadian Crisis in Mathematics Education

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Canadians should be very concerned about the current level of mathematical literacy of its citizens. Recent results from the Organization for Economic Co-operation and Development’s (OECD) *Programme for the International Assessment of Adult Competencies* (PIAAC) test suggest that Canadians between the age of 16 and 65 have below average numeracy skills (Scerbina et al., 2013). The results also show that “the proportion of Canadians at the lower level is greater than the OECD average” (Scerbina et al., 2013, p. 3). When we consider change over time using data from the 2003 *International Adult Literacy and Skills Survey* (IALSS), more Canadians are doing poorly in numeracy compared to a decade ago (Scerbina et al., 2013; Statistics Canada, 2005).

The lack luster performance on PIAAC is Canada-wide. Participants from all provinces scored either the same or below the overall Canadian score (Scerbina et al., 2013). The numeracy component of PIAAC focused on mathematics of everyday life. Questions were designed to measure respondents’ understanding of “mathematical content and ideas (e.g., quantities, numbers, dimensions, relationships), and the representation of that content (e.g., objects, pictures, diagrams, graphs)” (Scerbina et al., 2013, p. 7). Below is an example of a question used in the assessment (see Figure 1). The question asks participants to look at the graph and check all the boxes that represent the years in which there was a decline in births. This is a relatively simple question. Yet, it seems that many Canadians had challenges with questions such as these.

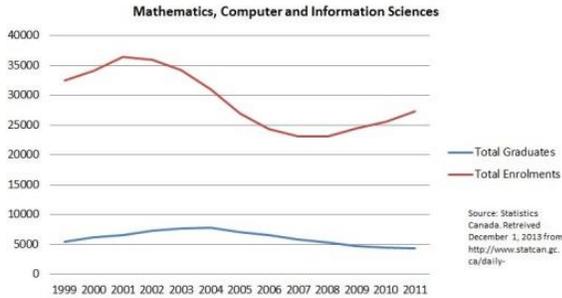
Figure 1  
*Sample PIAAC mathematics question*



Since 2008 there has been an increase in the numbers of student enrolling in undergraduate mathematics programs (Statistics Canada, 2013; see Figure 2). However, simultaneously there has been a decrease in the number of students completing undergraduate mathematics degrees. Similar trends can be seen at the graduate level as well. While women outnumber men in all fields of study Canada, this does not hold true for mathematics. Fewer women study mathematics. Across all the 24 participating countries of PIAAC, men did better

than women (Scerbina et al., 2013). Challenges in mathematics worldwide seem to also be gendered.

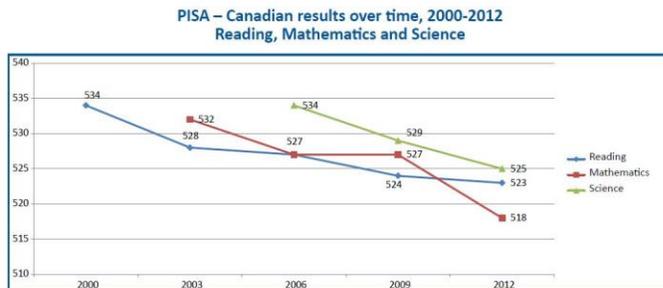
Figure 2  
*University undergraduate enrolment and graduation data*



A crude estimate of attrition in undergraduate mathematics degrees can be taken by considering enrolments at a point in time and then fast-forwarding four years later to graduation data. For example, in 2006 there were 26,985 undergraduates enrolled in mathematics programs (and computer and information sciences) in universities. In 2009, there were 4,761 undergraduate students who graduated. This represents more than an 82% attrition rate. If the attrition rates in mathematics were the attrition rates in the post-secondary sector more generally, a national crisis would be indisputable. Recent research suggests that 75% of students are at least two or more levels behind in terms of their readiness to study post-secondary mathematics (Strother, Campen, & Grunow, 2013), and so the attrition rates may not be altogether surprising – especially when we also consider the PIAAC evidence.

Shifting the current trends in Canada in the near future is not looking tremendously promising. Recent *Programme for International Student Assessment (PISA)* data shows a decline in mathematics scores in Canada amongst 15 year olds (Council of Ministers of Education Canada (CMEC), 2013; see Figure 3). When we consider standardized testing scores from the elementary sector in Ontario, last year’s results suggest that there is a decline in scores amongst grade 3 and grade 6 students, and this decline has been persistent for a number of years (Education Quality and Accountability Office/EQAO, 2013).

Figure 3  
*PISA results*



Source: Council of Ministers of Education Canada (CMEC). (2013). *Measuring up: Canadian results of the OECD PISA Study. The performance of Canada’s youth in mathematics, reading and science 2012. First results for Canadians aged 15*. Ottawa, Canada: Authors. Page 4.

Taking the below average levels of numeracy amongst Canadians and the relatively few that succeed in post-secondary mathematics, Canada is left with a number of pressing questions. Is the demand for more mathematically literate individuals in Canada expected to increase, decrease, or stay the same in the future? Is the demand for more mathematically advanced individuals expected to increase or decline? Is there an attrition problem? How do we foster learning environments that encourage and support increased success and participation in mathematics for all Canadians, and women in particular?

I would suggest that Canada will need more and not less mathematically literate citizens, and particularly more mathematically advanced citizens, to be able to address increasingly complex economic, social, environment, health, and so forth, challenges. Given the relatively few that make it through a post-secondary undergraduate mathematics degree, a crisis in Canada may already be unfolding. The industry and business sectors are already making the case that Canada has some serious concerns (Ovsey, 2013).

So, what can be done to potentially shift these trends? The most significant impact on long-term implications for future success occurs in early childhood (Alexander & Ignjatovic, 2012; Heckman, 2004). The basic skills learned prior to formal schooling are showing to be very important throughout the mathematical learning lifespan. For example, recent brain imaging research is showing the importance of basic counting skills which include an understanding of one-to-one correspondence (no repeat counting), cardinality (total of the set), stable order of numbers, order irrelevance (same cardinality regardless of where in the set one starts to count (Gelman & Gallistel, 1986). Researchers looking at the brains of senior high school students found that the brain regions responsible for basic mathematical concepts, such as counting, are the very same ones responsible more complex mathematics skills involved in algebra, complex geometry, or complex arithmetic (Matejko, Price, Mazzocco, & Ansari, 2013). Moreover, Matejko and colleagues (2013) found that these regions were shown to be related to success in standardized post-secondary tests of mathematical achievement. This research provides strong anatomical evidence for the links between early basic number and mathematics knowledge and later achievement.

The undeniable evidence about the importance of early childhood on subsequent mathematical knowledge does not minimize the necessity to provide all children during their formal schooling with (a) exceptionally prepared teachers ready to teach mathematics, and (b) mathematical curriculum that adequately prepares them for subsequent learning. For those remarkable students who come to post-secondary wanting to learn mathematics, the attrition rates are very alarming and should be of great concern to administrators, departments of mathematics, and Canadians more generally. A greater commitment to promoting success at the post-secondary level is necessary and this may mean rethinking how to provide a mathematics education to *today's* post-secondary students who make through the front door of a mathematics department.

The current international and national standardized test scores, coupled with trends in enrolment and graduation, should cause all Canadians to pause and reflect about our mathematical futures and our readiness as a country to engage in an increasingly complex, competitive, and evolving society without such individuals. Canada has a crisis on our hands.

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