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Improving Numeracy Skills of Postsecondary Students: What is the Way Forward?

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Higher Education Quality Council of Ontario

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Table of Contents

Abbreviations

CMEC: Council of Ministers of Education, Canada

CMP: College Math Project

CSAP: College Student Achievement Project

EASI: Essential Adult Skills Initiative

ESDC: Employment and Social Development Canada (formerly HRSDC)

EQAO: Education Quality and Accountability Office

ESO: Education and Skills Online

ETS: Educational Testing Service

HEQCO: Higher Education Quality Council of Ontario

HRSDC: Human Resources and Social Development Canada (now ESDC)

OECD: Organization for Economic Co-operation and Development

PIAAC: Programme for the International Assessment of Adult Competencies

PSE: Postsecondary education

Acknowledgements

In December 2019, HEQCO, in partnership with the Fields Institute for Research in Mathematical Sciences, convened a small group of faculty, administrators, government and other subject-matter experts to discuss opportunities for upgrading the numeracy skills of postsecondary students. This publication is an expanded version of the HEQCO-authored discussion paper prepared for that workshop.

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Introduction

In today's data-driven world, strong numeracy skills are crucial to employment success (Lamb & Chatoor, 2019; Organization for Economic Co-operation and Development (OECD), 2019; Durrani & Tariq, 2012). But the ability to make quantitative sense of the world around us is not just a job skill. The benefits of numeracy extend beyond the labour market to our everyday lives, from making household budgets to saving for retirement to interpreting medical information that is essential to our health and well-being.

Despite the wealth of research highlighting the importance of numeracy skills, questions about the quality and nature of numeracy education have emerged in recent years. Ontario has not been exempted from the conversation. Province-wide and international assessments have reported declining math and numeracy skills among Ontario students and adults, and a 2018 study by the Higher Education Quality Council of Ontario (HEQCO) found that nearly one-quarter of participating postsecondary students had achieved below-average numeracy scores on a large-scale assessment of essential skills (Alphonso, 2019; Hango, 2014; Weingarten, Brumwell, Chatoor & Hudak, 2018). Researchers in Ontario's college and university sectors have also identified points of concern. The College Student Achievement Project (CSAP) documented low math performance among roughly one-third of first-year Ontario college students (Orpwood & Brown, 2015), while a recent survey of students at five major Ontario universities found that on average, one-fifth of students reported having difficulty conducting tasks involving foundational math skills like percentage calculations and algebra (Grayson et al, 2019, p. 17).

Given the significant role that numeracy plays in positive employment, health and social outcomes — and given the postsecondary sector's commitment to producing highly skilled, employable graduates — these results oblige us to challenge the commonly held conviction that numeracy is solely the responsibility of the K-12 sector. We do not yet know what action is required. What is clear is that the postsecondary education (PSE) sector needs to play a role.

The Ontario government recently announced that it will roll out a revised math curriculum for kindergarten to Grade 12 students focusing on the fundamentals of mathematics and how to apply them (Ontario Ministry of Education, 2019b). To advance the numeracy discussion at the PSE level, HEQCO is exploring ways that numeracy skills can be taught effectively and efficiently in higher education. In December 2019, HEQCO, in partnership with the Fields Institute's Centre for Mathematics Education, hosted a workshop that brought together government, university, college and K-12 numeracy experts from across Ontario. The purpose of the workshop was to explore the following question:

> **How can we best and most effectively upgrade the numeracy skills of students over their postsecondary education in ways that will serve them well in their personal and professional lives?**

This paper is an expanded version of the discussion paper provided to workshop participants and incorporates some of the insights and recommendations that emerged over the course of the workshop. We begin with an overview of what numeracy is and why it is important. We then discuss the place of numeracy in Ontario's postsecondary system, as well as some current numeracy initiatives in Ontario's colleges and universities. Finally, we share some considerations for improving numeracy education at the postsecondary level that emerged from the December 2019 workshop.

Numeracy Defined

> *"Numeracy is not the same as mathematics, nor is it an alternative to mathematics. Today's students need both mathematics and numeracy. Whereas mathematics asks students to rise above context, quantitative literacy is anchored in real data that reflect engagement with life's diverse contexts and situations."*
>
> *Steen, 1997*

Without a clear definition of what we mean by "numeracy" it is difficult, if not impossible, to productively discuss how numeracy can be improved. Steen's quote provides a good place to start.

There are a number of terms that are used synonymously with numeracy, including quantitative literacy, quantitative reasoning, mathematical literacy and mathematics (Roohr, Graf & Liu, 2014). While there are subtle (and not so subtle) differences among these terms, the distinguishing feature of numeracy is that it takes into account the wider practical uses of mathematical knowledge and skills that are needed to function in the workplace and in everyday life (Dingwall, 2000; Orpwood & Brown, 2015). Whereas mathematics involves thinking *about numbers* (and thus moves into abstractions), numeracy is thinking *with numbers,* always within authentic, true-life contexts (Manaster, 2001).

The OECD's definition of numeracy is quoted in many Ontario Ministry of Education documents:

> The ability to access, use, interpret and communicate quantitative information and ideas, in order to engage in and manage the quantitative demands of a range of situations in adult life (OECD, 2016b, p. 24).

It is worth emphasizing that "mathematics" and "numeracy" require different approaches to instruction and learning. Contemporary strategies of introducing "real-life" applications into mathematics courses (both K-12 and postsecondary) are appropriate methods of illustrating and demonstrating the relevance of mathematical concepts to students — but are inadequate for numeracy instruction. Successful numeracy instruction requires unique approaches to teaching, often with modified pedagogies and new resources.

The OECD definition is supplemented by the concept of "numerate behaviour," which is defined as "managing a situation or solving a problem in a real context by responding to mathematical information and

content represented in various ways" (OECD, 2016b, p. 24). As we consider the role of numeracy in postsecondary education, it is worth bearing in mind the following description of numerate behaviour provided in the OECD's numeracy framework:

> [Numerate behaviour] depends not only on cognitive skills or knowledge bases, but also on enabling factors and processes … These enabling processes involve the integration of mathematical knowledge and conceptual understanding of broader reasoning, problem-solving skills and literacy skills. Furthermore, numerate behaviour and autonomous engagement with numeracy tasks depend on the dispositions (beliefs, attitudes, habits of minds, etc.), prior experiences and practices that an adult brings to each situation. (OECD, 2012, p. 38)[1]

The OECD's definition of numerate behaviour illustrates numeracy's multifaceted character, which incorporates "… each individual's mathematics, communication, cultural, social, emotional and personal aspects in a real-world situation" (Tout et al., 2017, p. 26).

On this basis, we propose using the following six principles to ground a discussion about improving postsecondary students' numeracy skills:

1. **Numeracy skills are not limited to a specific aspect of life**. Numeracy skills are needed in all aspects of our lives, from the workplace to our personal lives. For this reason, the ability to "'see' or notice when mathematics is embedded in a real world situation — how to recognize the mathematics and to potentially take the next step and act on it" is a crucial facet of proficiency in numeracy (Tout et al., 2017, p. 9).

2. **Advanced mathematical skills are not required to be numerate**. To be a numerate person, you do not require advanced mathematical skills such as calculus or linear algebra, but you must be able to use foundational levels of mathematical knowledge in everyday situations, whether in terms of number sense, estimation or spatial reasoning (Steen, 1997; Dion, 2014). Mathematical knowledge may include quantity and numbers; dimensions and shapes; patterns, relationships and change; and data and chance (OECD, 2012). All of these topics are covered in Ontario's elementary and secondary mathematics curriculum, generally up to and including Grade 10.

1 The OECD definitions of numeracy and numerate behaviour provide the foundation for the numeracy assessment component of the Programme for the International Assessment of Adult Skills (PIAAC) and its commercial counterpart, Education and Skills Online (ESO). The OECD also identifies four dimensions for the use and assessment of numeracy that are rooted in the above definitions. These dimensions, which were used to structure PIAAC's numeracy component, include content (quantity and number; dimension and shape; pattern, relationships and change; data and chance), representations of mathematical information (objects and pictures; numbers and symbols; visual displays and texts; technology-based displays), cognitive strategies (identify, locate or access; act upon or use; interpret, evaluate or analyze; communicate) and contexts (work-related; personal; society and community; education and training). Note that while communication is identified as a cognitive strategy within the OECD's numeracy framework, the PIAAC does not assess the ability to communicate numerical or mathematical information. (See OECD, 2016b, pp. 24–25.)

3. **Being/becoming numerate is a lifelong process.** Given that numeracy involves using knowledge and skills in real-world situations, being numerate should be considered an ongoing process of sustaining and building numeracy skills throughout one's life.

4. **Numeracy is interconnected with other higher-order skills.** It is clear that numeracy is more than a list of specific tasks such as calculating sales tax or determining travel times (Madison & Steen, 2008). It involves thinking critically, problem solving, reflecting and communicating. The National Numeracy Network describes numeracy as, "the power and habit of mind to search out quantitative information, critique it, reflect upon it, and apply it in their public, personal and professional lives" (Madison & Steen, 2008).

5. **Numeracy involves engaging with quantitative information that may be represented in multiple ways.** Being numerate involves communicating in different ways including objects, pictures, numbers, symbols, formulas, diagrams, maps, graphs, tables, text and technology-based displays (OECD, 2012).

6. **Beliefs and attitudes are part of being numerate.** A numerate person is able to determine when and how to use number sense and quantitative reasoning to solve problems or make decisions. For this reason, one's disposition toward numeracy is an important factor in developing proficiency (Tout et al., 2017). Math anxiety and negative attitudes toward mathematics are barriers to increasing numeracy (Burazin & Lovric, 2019; Lovric, 2018; Orpwood & Brown, 2015).

Numeracy Matters

> *"Decisions in life are so often based on numerical information; to make the best choices, we need to be numerate."*
>
> National Numeracy, 2019

We are confronted daily with questions and tasks that require numerical solutions. From personal finance and spending decisions, to understanding the dosage instructions for prescription medication and interpreting political platforms when deciding our votes, we are constantly sifting through and evaluating information to make meaningful and evidence-based decisions (Burazin & Lovric, 2019; Lovric, 2018). It is therefore not surprising that proficiency in numeracy can affect our economic and social well-being.

The benefits of strong numeracy skills in the labour market are clear. Higher numeracy skills have been linked to higher earnings (Council of Ministers of Education, Canada (CMEC) & Employment and Social Development Canada (ESDC), 2016; OECD, 2016a; Hango, 2014; Hanushek, Schwerdt, Wiederhold & Woessmann, 2013; Human Resources and Social Development Canada (HRSDC) & Statistics Canada, 2005)

and a higher likelihood of being employed in permanent, full-time roles (Lamb & Chatoor, 2019). Further, since numeracy skills are transferable and applicable to a range of professional and personal contexts, proficiency in numeracy is often flagged as a valuable attribute in an era where job loss and job change are increasingly common. In the words of Pichette et al., "Ontario's economy is changing rapidly, and while we cannot accurately predict which job-specific skills workers will require to occupy which jobs, we can predict with certainty that employers will continue to demand transferable skills such as literacy, numeracy and critical thinking" (2019, p. 19).

Proficiency in numeracy is also associated with positive health and social outcomes (OECD, 2016a). Researchers have described the positive correlations between numeracy and outcomes like social trust, volunteerism, political efficacy and health status as an indication of the extent to which information-processing skills are woven into our social fabric (Grotlüschen et al., 2016). Numeracy plays a particularly important role in understanding health information, personal health management and assessment of risk (Jonas, 2018).

It is no surprise that governments around the world are concerned with tracking and implementing initiatives to improve numeracy,[2] or that HEQCO and Fields were inclined to convene experts for a discussion about how to effectively upgrade the numeracy skills of Ontario postsecondary students.

Numeracy in Ontario

Numeracy is making headlines in Ontario. The conversation is driven by a concern that students do not have the numeracy skills needed to be successful in life and work. Declining math scores on assessments conducted by the Ontario's Education Quality and Accountability Office (EQAO) and the OECD's Programme for International Student Assessment (PISA) have led the province to revisit how numeracy education is delivered in elementary and secondary schools (Alphonso, 2019; Orpwood & Brown, 2015; Orpwood, Schollen, Leek, Marinelli-Henriques & Assiri, 2012). For instance, the Ontario government recently announced that a revised math curriculum for all students in elementary and high school will be rolled out over the next four years with the goal of imparting a strong foundation in the fundamentals of mathematics (Ontario Ministry of Education, 2019b). Furthermore, the Grade 10 careers curriculum is being revised to include a greater emphasis on financial literacy and transferable skills in order to better align the curriculum with the needs of the labour market (Ontario Ministry of Education, 2019a). Though numeracy remains a hot topic among parents, teachers and politicians, and there is much debate about the most appropriate methods of instruction and assessment, stakeholders more or less agree on one key point: Our students should be proficient in numeracy.

2 For instance, the Common European Numeracy Framework initiative is working to establish a common language and best practices for high quality numeracy education among European adults (Hoogland, Auer, Díez-Palomar, O'meara & van Groenestijn, 2019).

The postsecondary conversation around numeracy is different, in part because numeracy has generally been viewed as the responsibility of the K-12 system. *However, we believe that this view is rooted in an outdated concept of numeracy that conflates numeracy with mathematics.* Our understanding of numeracy has evolved. We know that numeracy is not merely a synonym for applied mathematical skills and that its proficiency requires habitual practice. And there is reason to worry that postsecondary students are out of practice. For example:

- In an analysis of Canada's 2012 results on the OECD's Programme for the International Assessment of Adult Competencies (PIAAC), Statistics Canada reported that 19.5% of Canadian-born university graduates between the ages of 25 and 29 scored below Level 2 (of 5) on PIAAC's numeracy component (Hango, 2014, p. 5). As Hango puts it, "one would expect university graduates to be at least able to have skills corresponding to the third proficiency level, since many high skilled occupations require competencies at this level" (2014, p. 11).

- HEQCO's Essential Adult Skills Initiative (EASI) project used the Education and Skills Online (ESO)[3] assessment to measure the literacy, numeracy and problem-solving skills of first- and final-year students from 19 Ontario colleges and universities. Though the primary goal of this study was to test the feasibility of large-scale skills assessment in Ontario's postsecondary system, researchers found that roughly one-quarter of participating final-year students scored at Level 2 or below on ESO's numeracy component (Weingarten et al., 2018).

Though the conflation of mathematics and numeracy has likely contributed to numeracy being under-studied at the postsecondary level, math education and remediation projects have also provided some indication that insufficient proficiency in numeracy is an issue in Ontario's colleges and universities. The projects described below found that some students lack the fundamental math skills and knowledge that numeracy depends on. For example:

- Over a period of nine years, CSAP (and its predecessor, the College Mathematics Project) analyzed the mathematics performance of all incoming students at Ontario's 24 public colleges. This initiative found that roughly one-third of first-year Ontario college students in first-semester math courses (about 12,000 students per year) were at risk of not completing their program due to poor math performance. This trend was consistently observed over five years. Furthermore, when the initiative examined the remedial courses that Ontario colleges had developed to assist these students, it found that they largely focused on skills that had been introduced prior to secondary school — in Grades 6, 7 and 8 (Orpwood & Brown, 2015).

3 Education and Skills Online is the commercial version of PIAAC. Like PIAAC, it is a product of the OECD. Its development has been supported by the European Commission and, in Canada by CMEC. It is administered by the Educational Testing Service. The ESO was designed and validated on PIAAC's conceptual framework, with roughly half of its literacy and numeracy test items coming from PIAAC's item pool (OECD, 2018). As such, the ESO also uses PIAAC's five-level scale to describe its literacy and numeracy results.

- Faculty from University of Toronto Mississauga, University of Toronto Scarborough, University of Waterloo, Western University and York University studied student-reported skill deficiencies and the impact of perceived skill deficiencies on university outcomes like anticipated grades, thoughts of leaving prior to degree completion and student satisfaction. The study found that on average, one-fifth of students surveyed reported having difficulty conducting numeracy tasks involving basic math skills like percentage calculations and algebra. The researchers also observed a statistically significant relationship between student-reported difficulty with numeracy and thoughts of dropping out of university (Grayson et al., 2019, pp. 17, 27).

Again, math remediation and mathematics in general are not interchangeable with numeracy. But these findings — particularly those concerning fundamental math skills — oblige us to consider the numeracy skills of PSE students.

Assessment, Data Collection and Quality

These studies do not present a comprehensive picture of the state of postsecondary students' numeracy skills. The data required to establish such a picture is not readily available. While PIAAC is a good source of data on adult skills, it is conducted every 10 years, with the next cycle set to take place in 2021. Furthermore, since PIAAC targets the adult population in general, it is limited in terms of what insights it can offer on postsecondary student skills in Ontario.

Ontario's colleges and universities also lack data on the development of their students' numeracy skills. Few higher education institutions specifically measure or report the attainment of transferable skills like numeracy, and though standalone assessments like the Ontario College Math Test are occasionally used for diagnostic or placement purposes, the data is not publicly shared or reported. We do know that six of Ontario's 22 English-language colleges test some of their students' math skills before classes begin, but no skills-based exit test is conducted (Ingleton & Fricker, forthcoming).[4] So even when assessments are conducted, they are not used in a way that would permit a cross-sectional or longitudinal analysis of student performance.

Again, mathematics is not numeracy — but math assessments can give us some insight into students' proficiency with the fundamental math skills that numeracy relies upon. But as it stands, we have no means of determining the impact of postsecondary education on the development of numeracy skills even when using mathematics as a proxy. While there are a few psychometric numeracy tests on the market, such as the ESO and the HEIghten Quantitative Literacy assessment, it is challenging to accurately capture numeracy's multidimensional, multifaceted character in large-scale assessment frameworks (Tout et al.,

4 Six colleges use math testing for post-admission placement, three colleges use math testing for program admission and 20 colleges use math testing as a component of equivalency testing pre-admission. Given the small number of students that are tested for equivalency purposes, these institutions were not included in the statistic reported (Ingleton & Fricker, forthcoming).

2017). Just as numeracy instruction requires unique approaches to teaching and learning, so too does numeracy assessment.

These circumstances have led many, including HEQCO, to call for more data collection, with greater methodological rigour and transparency. Such data could be used to support the development and identification of skills-measurement tools and could also guide the evidence-based development and evaluation of interventions or teaching approaches (Moffatt & Rasmussen, 2016).

System Design

Even though our understanding of postsecondary students' numeracy skills is incomplete, we know a number of things about numeracy's place in Ontario's postsecondary system.

Despite high rates of secondary school completion, there are concerns that students are arriving to Ontario colleges and universities without the necessary mathematics knowledge and skills they will need to succeed academically (Lane & Murray, 2019; Orpwood & Brown, 2015). These students are at increased risk of not graduating on time (e.g., if counselled to take a remedial math course prior to completing a different, required math course, or if obliged to re-take a failed math course) and of dropping out of their academic programs altogether (Grayson et al., 2019; CSAP, 2015).

High school course selection appears to have some impact on postsecondary mathematics achievement. For instance, CSAP found that only 55.8% of first-year college students who had not taken a Grade 12 math course received good grades in first-semester college math courses (2015).[5] The role of streaming in postsecondary preparedness has also been widely discussed (CSAP, 2015; People for Education, 2019). It is also worth noting that many postsecondary programs in Ontario do not require completion of any secondary-school math courses for admission, nor do they require students to take any math or numeracy courses during their time at university or college.

Still, completion of advanced secondary-school mathematics courses, such as Grade 12 Advanced Functions or Calculus and Vectors, does not guarantee proficiency in numeracy. Many STEM programs require completion of one or more Grade 12 mathematics courses for admission, and generally include a significant mathematics component. But as we have discussed, mathematics and numeracy are not equivalent, and course hours spent learning abstract formulas and equations will not automatically translate into a student's ability "to search out quantitative information, critique it, reflect upon it, and apply it in their public, personal and professional lives" (Madison & Steen, 2008, p. 9).

A strong link has been found between numeracy performance and the regular use of these skills, suggesting that numeracy, like literacy, is like a muscle that needs to be continually exercised (Jonas, 2018). And yet our secondary and postsecondary programming lacks a consistent numeracy "strand." Fundamental numeracy

5 The Ontario high school curriculum does not require students to complete a Grade 12 math course in order to graduate, though completion of a Grade 11 math course is a graduation requirement.

skills fade out of the math curriculum even before students progress to more advanced mathematical content, and depending on their field of study, students may not even need to take a math course — let alone one in financial literacy, for example — from Grade 11 through to completion of their diploma or degree. In other words, the current system is not geared toward the development of numeracy skills among students, nor the production of graduates with strong numeracy skills.

Current Numeracy Initiatives

> *"Numbers arise everywhere, so the responsibility for fostering intelligent numeracy should spread broadly across the entire curriculum. Quantitative literacy must be regarded as much more than the responsibility of the mathematics classroom alone."*
>
> Steen, 2001

There are many initiatives aimed at improving college and university students' numeracy skills, and there are many people in the postsecondary sector who genuinely believe in the value of upgrading students' numeracy skills. Unfortunately, it is difficult to track or even find out about such projects because they are often small or specific to one professor or department.

There are two general approaches to upgrading numeracy skills. One approach involves teaching numeracy as specialized units and the other involves integrating numeracy within a disciplinary context. Both approaches have their pros and cons, and they are not mutually exclusive.

Specialized units include numeracy or financial literacy workshops, courses or initiatives. Many institutions have math centres, online resources, supported learning groups, tutoring (by peers and staff) and other resources available to their students. These supports are an integral part of numeracy and math remediation strategies at many colleges and universities (Dziwak, 2014).

While these initiatives can be developed and offered relatively quickly and at a low cost due to their small scale, many of them are focused on developing specific math skills and not necessarily to increasing students' numeracy skills. It is easy to conflate numeracy with math remediation, since both involve strengthening individuals' grasp of basic mathematical knowledge and concepts. Remedial or supplementary mathematics initiatives are often crucial to student success but are typically designed to help only select groups of students — generally those enrolled in programs with a mathematics component. So how do we ensure that, for example, art history majors — who are not required to take any math credits to graduate and might not have taken a Grade 12 math course — get the numeracy skills they need to be successful in their personal and professional lives? And how do we ensure that students whose postsecondary coursework may involve a great deal of mathematical abstractions — thinking *about* numbers, to return to Manaster's definition — are able to think *with* numbers when they leave the classroom?

An integrated approach to teaching numeracy requires programs to weave numeracy into all courses aiming to develop numeracy skills in a disciplinary context. In this approach, "numeracy — just like literacy — must be recognized as an intrinsic part of every subject" (Moffatt & Rasmussen, 2016, para. 13). To this end, the CSAP final report recommended incorporating the idea of "numeracy across the curriculum" into Ontario's curriculum policy, as well as including numeracy-specific concepts and skills in all secondary-school math courses (2015, p. 73). However, it is unclear what this incorporation would look like in practice. As previously mentioned, postsecondary students' numeracy skills are rarely evaluated, which makes identifying which practices are or are not successful in developing student numeracy very difficult.

Examples of Current Numeracy Initiatives from Ontario Colleges and Universities

MATH 2UU3: Numbers for Life, McMaster University
This popular upper-year elective course covers "principles of quantitative reasoning, problem-solving and critical thinking, discussed in contexts related to, and relevant for, our daily lives, our society and the environment we live in" (Lovric, 2020).

Numeracy Development Initiative (NDI), University of Toronto Mississauga (UTM)
This project, based at UTM's Robert Gillespie Academic Skills Centre, "works with instructors to support projects that integrate instruction and learning activities on numeracy (quantitative literacy) into core courses across the curriculum" (UTM, n.d.).

Mo' Money Financial Literacy Resource Centre, Mohawk College
This resource centre provides free workshops and one-on-one advising to students on budgeting, credit and debt, saving plans, big purchases and insurance, with the goal of helping students to become more financially literate (Mohawk College, n.d.).

HEQCO and Fields Institute Numeracy Workshop

Though Ontario's postsecondary system may be lacking a consistent numeracy "strand," there are a number of people throughout the sector who have devoted considerable time and energy toward the improvement of students' mathematics and numeracy skills. With this in mind, HEQCO collaborated with the Fields Institute's Centre for Mathematics Education to organize a workshop in December 2019 around the following question: How can we best and most effectively upgrade the numeracy skills of students over their postsecondary education in ways that will serve them well in their personal and professional lives? This workshop brought together government, university, college and K-12 numeracy experts from across

Ontario, with the goal of exploring how HEQCO and our stakeholders can most effectively contribute to the improvement of postsecondary students' numeracy skills.

To anchor the day's activities, HEQCO prepared a discussion paper on numeracy education in Ontario's postsecondary system.[6] The paper included a number of discussion questions, which were organized around four broad themes. Participants were asked to read the paper in advance of the workshop and come prepared to share thoughts or questions on the subject.

The discussion questions and themes identified in the paper were used to guide the workshop's working group discussions. The questions served as starting points for conversations that examined various points of view, challenged assumptions and hopefully created new common ground. The questions were not mutually exclusive, as often discussing one question overlapped with or presented a number of other issues.

Each working group was assigned one of the themes listed below, and asked to discuss opportunities, challenges and considerations for implementing numeracy education initiatives and policies in Ontario's PSE system. Participants were assigned to one of the four working groups based on their area of expertise and its relevance to the group's theme.

1. **Context, connections and continuity between K-12 and PSE:**
   Does proficiency mean the same thing in PSE as in K-12? Does it mean the same thing for students in different disciplines? How can we leverage existing models of numeracy education and assessment in K-12 when considering how to improve numeracy among postsecondary students? What can we do to better streamline K-12 and postsecondary expectations around numeracy?

2. **Factors for successful initiatives:**
   What can government and institutions do at the system level to promote successful numeracy initiatives? In general, what can we say about the characteristics of successful initiatives? What are the challenges and problems that any numeracy program must contend with? What are the best practices for helping postsecondary students develop and practice numeracy skills?

3. **Assessment:**
   How can government and institutions contribute to the assessment of students' numeracy skills and the assessment of numeracy initiatives? What can we say about characteristics of successful assessments? What are the challenges to assessing students' numeracy skills? Can we be more specific about which students at the postsecondary level have weaker numeracy skills so we can figure out how to best help them develop skills? How can we use assessment results to inform teaching pedagogy?

6 The workshop discussion paper was the basis for this paper.

4 **Advocacy, change and partnership building:**
The support network for numeracy is often very thin. What would be useful with respect to professional development networks, resources/tools and conferences for numeracy? What should be the priorities of governments and institutions with regard to research on numeracy? How can educators, policy-makers and institutions work together to advocate for improved numeracy education in Ontario's postsecondary system?

Takeaways

Workshop participants offered a number of promising suggestions in response to the discussion questions. These suggestions included:

- Designating numeracy leads among postsecondary faculty who can share information about numeracy education, facilitate communities of practice and assist their colleagues in developing and integrating numeracy activities into their courses
- Creating a repository of numeracy modules, resources and assessments that all public Ontario institutions can access
- Exploring the potential of problem-based learning and related pedagogies for effective numeracy instruction
- Expanding professional development opportunities for teachers and instructors, administrators and policy-makers to learn about and collaborate on cross-sector numeracy education initiatives
- Developing a better data picture of how, where and how effectively numeracy education is being delivered

Conclusion

As the evidence grows that proficiency in numeracy may impact the quality of our health and socioeconomic outcomes, it becomes increasingly clear that numeracy is an important skill to possess. Researchers have documented positive correlations between proficiency in numeracy and outcomes such as income, likelihood of permanent, full-time employment, social trust and personal health management. Numeracy, like literacy, undergirds our ability to navigate and engage with the world around us.

We opened this report with a question: How can we best and most effectively upgrade the numeracy skills of students over the course of their postsecondary education in ways that will serve them well in their

personal and professional lives? Before we can definitively answer this question, however, we must tackle a much simpler one. What is the state of numeracy education in Ontario's postsecondary system? Even this question is complex, in large part because of the commonly held conviction that numeracy, like literacy, is not the postsecondary system's responsibility. As a result of this attitude, numeracy education at the postsecondary level has been under-assessed and under-studied. We lack a comprehensive data picture of postsecondary students' numeracy skills, and we lack validated, reliable strategies for teaching numeracy in college and university classrooms.

The conflation of mathematics and numeracy as concepts — which is also very common — makes it a challenge to get a firm grasp on how numeracy does or does not factor into our college and university programs. Indications that insufficient numeracy skills may be an issue in PSE have been raised by mathematics education research, which has found that some postsecondary students lack fundamental math skills and knowledge. Math remediation and mathematics in general are not interchangeable with numeracy. Mathematics deals with numbers in the abstract, while numeracy is anchored in real-world data and problems. But numeracy *does* require a strong grasp on basic mathematical concepts and skills like arithmetic, the order of operations, fractions and percentages. Hence, the results of initiatives like the College Student Achievement Project oblige us to take a closer look at the numeracy skills of postsecondary students *as well as* their proficiency in mathematics.

Ontario's postsecondary system is not optimized for the development nor the practice of numeracy skills among students. While some educators and institutions are working to change this, their efforts are often (by necessity) limited to a single course, department or discipline. The HEQCO and Fields Institute numeracy workshop was an important first step toward advancing numeracy education in Ontario's colleges and universities, pooling the expertise of numeracy and mathematics education specialists from across the province. It is imperative that we maintain that forward momentum.

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