Canada

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Introduction

Overview of Education System

In Canada, there is no nationally centralized education system. Rather, provinces and territories hold exclusive constitutional jurisdiction over their education systems. As such, provinces and territories are responsible for, and have the right to determine, the legislation that subsequently dictates educational policies and programs in their school systems. School systems are overseen by a Ministry or Department of Education in each of the 10 provinces and three territories.

There are various types of school systems across Canada: public, private, separate, charter, on-reserve, and homeschool. In public school systems, school boards (or divisions or districts) are demarcated by geography and language (i.e., anglophone or francophone). In private school systems, funding is usually fee based, with some provinces providing partial funding that is typically conditional upon certain criteria (e.g., employment of certified teachers). In three provinces (Ontario, Alberta, and Saskatchewan), students have the constitutional right to attend a publicly funded Catholic separate school.[1] Charter schools exist only in the province of Alberta. Indigenous student populations can attend on-reserve schools. Alternatively, parents may opt to have their children complete homeschooling.

Kindergarten to Grade 12 schooling in Canada is generally divided between two levels: elementary (i.e., primary) and secondary. Although kindergarten is only mandatory in one province (New Brunswick), a large majority of students begin schooling prior to Grade 1. For instance, in Ontario, students may begin junior kindergarten (JK) at the age of 4 or senior kindergarten (SK) at the age of 5. Formal elementary schooling begins in Grade 1, typically at the age of 6. Students transition to secondary school in either Grade 7 (in Quebec, Secondary Cycle One) or Grade 9 (in Quebec, Secondary Cycle Two), normally at the age of 12 or 14. Although most provinces and territories mandate schooling until age 16, some provinces (Manitoba, New Brunswick, and Ontario) require schooling until age 18. In Quebec, there is an additional level of publicly funded postsecondary nontertiary schooling: *Collège d'enseignement général et professionnel* (CÉGEP) or in English, general and vocational college. This level of schooling is unique to Quebec and is a prerequisite to university studies. Despite this structural difference between Quebec and the rest of Canada, students typically have a comparable number of years of compulsory schooling.

Streaming (i.e., tracking) begins at different grade levels across the provinces. Alberta, Quebec, Newfoundland and Labrador, and Prince Edward Island begin streaming students in Grade 10, while New Brunswick begins streaming students in Grade 11.[2] Ontario ended streaming of Grade 9 students as of September 2022.[3] Curriculum content is tailored to meet the demands of each academic stream and can differ in content and purpose. For instance, in Grade 10, courses may be differentiated between "applied" or "academic" categories, with applied courses generally centered on practical applications and concrete examples, while academic courses tend to focus on theory and abstract problem-solving. At the upper secondary level, courses are normally characterized by destination-based streaming, leading to university, college, or the workplace.

Canada's two official languages are English and French. As such, instruction generally occurs in one of these languages, with students typically enrolled in schooling in their first language. Moreover, French immersion programming is offered in the public school system for students interested in learning French as a second language. Students in immersion programs learn French through the delivery of other subjects in the French language. In the 2021–2022 academic year, approximately 477,480 students were enrolled in French immersion programming.[4]

In addition to programming in both official languages, there has been an increasing focus on developing Indigenous language education in Canada. Specifically, as a response to calls to action by the Truth and Reconciliation Commission of Canada to support Indigenous language learning, provinces and territories have created and expanded upon Indigenous languages curricula and teaching resources, with Manitoba, Nunavut, Yukon, and the Northwest Territories formally recognizing Indigenous languages.[5]

Other languages are offered through alternative programs. For instance, the Ministry of Education in Alberta offers provincewide programs from kindergarten to Grade 6 in nine international languages: Arabic, Chinese, German, Italian, Japanese, Latin, Punjabi, Spanish, and Ukrainian.[6] These programs provide students with an opportunity to learn an international language and culture with the goal of building communication and intercultural skills. Instruction in other subject areas is provided using the international language for up to 50% of the school day.

Overall, Canada continues to offer schooling through various programs to meet the diverse needs of students.

Use and Impact of TIMSS

Canada has consistently participated in TIMSS, from the first administration in 1995 to the most recent one in 2023. In 1995, nine Canadian provinces and two territories participated in TIMSS. In 1999, nine provinces participated at the Grade 8 level only. In 2003, only Ontario and Quebec participated, with the two provinces acting as benchmarking participants. In 2007, Alberta and British Columbia also participated, with Alberta participating at the Grade 4 level only. In 2011, Alberta, Ontario, and Quebec acted as benchmarking participants at both the Grade 4 and

Grade 8 levels. Five provinces participated in TIMSS 2015: Alberta (Grade 4 only); Ontario and Quebec (as benchmarking participants); and Manitoba and Newfoundland and Labrador (as part of the Canadian sample). In 2019, Alberta, Manitoba, and Newfoundland and Labrador participated at the oversampling level (Grade 4 only), while Ontario and Quebec continued to participate as benchmarking participants at the Grade 4 and Grade 8 levels. In 2023, the same five provinces participated at the Grade 4 level only (see Exhibit 1).

Exhibit 1: Canada's Recent Participation in TIMSS

2003	2007	2011	2015	2019	2023
• Ontario • Quebec	• Ontario • Quebec • Alberta • British Columbia	• Ontario • Quebec • Alberta	• Ontario • Quebec • Alberta • Manitoba • Newfoundland and Labrador	• Ontario • Quebec • Alberta • Manitoba • Newfoundland and Labrador	• Ontario • Quebec • Alberta • Manitoba • Newfoundland and Labrador

TIMSS data provide valuable cognitive and contextual information on student achievement in Canada. The results are used alongside those from other provincial, national, and international student assessments to monitor student academic outcomes. Findings from TIMSS—along with the Pan-Canadian Assessment Program (PCAP) and the Programme for International Student Assessment (PISA)—help to inform Ministries/Departments of Education on the program implementation of mathematics and science curricula in their respective provinces or territories. Moreover, TIMSS also provides researchers, policymakers, and educators with data to assess student progress—both within and across provinces—for various student population subgroups.

The Mathematics Curriculum in Primary and Lower Secondary Grades

In each province or territory, the mathematics curriculum specifies the official policy on numeracy. Mathematics curricula do not normally prescribe instruction methods (i.e., pedagogy); rather, they outline the expectations for outcomes that students should achieve by the end of each grade. To supplement curriculum documents, Ministries or Departments of Education typically offer additional supporting guides, reports, and resources to bolster numeracy instruction at various grade levels.

Mathematics curricula in Canada cover a majority of TIMSS 2023 assessment content. However, given that each province and territory is responsible for its own education system, some interprovincial/territorial variation occurs in the prescription and coverage of mathematics curricula in order to reflect the unique context of each province or territory. Despite these differences, there is considerable overlap, sometimes occurring through intentional collaborative efforts to create comparability in student learning. Specifically, certain Canadian regions have

constructed curriculum frameworks to build a common set of curricula to guide provincial/territorial curriculum development and implementation.

For instance, until 2014, the Western and Northern Canadian Protocol (WNCP) created frameworks to guide learning outcomes for four western provinces (Alberta, British Columbia, Manitoba, and Saskatchewan) and the three territories (Northwest Territories, Nunavut, and Yukon). The Common Curriculum Framework for K–9 mathematics provided a common curricular base to achieve consistency in student outcomes and transferability for students in their mathematics learning across these provinces/territories.[7] It outlined the following four major strands and their substrands:

- Number—Number Sense
- Patterns and Relations—Patterns; Variables and Equations
- Shape and Space—Measurement; Three-Dimensional Objects and Two-Dimensional Shapes; Transformations
- Statistics and Probability—Data Analysis; Chance and Uncertainty

The Foundation for the Atlantic Canada mathematics curriculum also proposed a common framework for the provinces of New Brunswick, Newfoundland and Labrador, Nova Scotia, and Prince Edward Island.[8] Learning outcomes were organized into four similar major strands.

The remaining two provinces of Ontario and Quebec propose similar strands. In Ontario's recent 2020 mathematics curriculum, there are six major strands, some of which align with the WNCP framework:[9]

- Social-Emotional Learning (SEL) Skills in Mathematics and the Mathematical Processes
- Number
- Algebra
- Data
- Spatial Sense
- Financial Literacy

In Quebec, five major strands are also organized similarly to the other provinces:[10]

- Arithmetic
- Geometry
- Measurement
- Statistics
- Probability

In addition to mathematical content, mathematics curriculum documents across Canada specify mathematical skills and processes that students are expected to learn and apply. These skills may be specific to mathematics learning or may equally apply to other subject matter. They include problem-solving, reasoning, proving, reflecting, selecting tools and computational

strategies, connecting, representing, communicating, visualizing, using technology, and completing mental mathematics and estimation, among others.

Instruction time can be prescribed either by the province's Ministry of Education or the local school board, district, or division. Otherwise, teachers have full discretion to determine instruction time per subject. In Canada, across the provinces and territories, approximately 15–30% of instruction hours in Grade 4 are devoted to teaching mathematics.

While curriculum renewal is generally an ongoing process across Canada, certain provinces are currently in the process of revising their mathematics curriculum. In Newfoundland and Labrador, the Department of Education is revising kindergarten to Grade 2 mathematics curriculum, while in Nova Scotia and Prince Edward Island, there are ongoing revisions to the mathematics curriculum.

The Science Curriculum in Primary and Lower Secondary Grades

Similar to the mathematics curriculum, science curriculum documents also vary by province/territory in terms of content prescription and coverage. The Common Framework of Science Learning Outcomes K to 12, a national framework developed through the Council of Ministers of Education, Canada (CMEC), specifies valuable curricular expectations in the development of Canadian students' scientific literacy.[11] The framework calls for the development of scientific literacy foundations to guide Grade 4 specific learning outcomes in the following ways:

- Foundation 1: Science, technology, society, and the environment (STSE)—Students will develop an understanding of the nature of science and technology, of the relationships between science and technology, and of the social and environmental contexts of science and technology.
- Foundation 2: Skills—Students will develop the skills required for scientific and technological inquiry, for solving problems, for communicating scientific ideas and results, for working collaboratively, and for making informed decisions.
- Foundation 3: Knowledge—Students will construct knowledge and understandings of concepts in life sciences, physical sciences, and Earth and space sciences and apply these understandings to interpret, integrate, and extend their knowledge.
- Foundation 4: Attitudes—Students will be encouraged to develop attitudes that support the responsible acquisition and application of scientific and technological knowledge to the mutual benefit of self, society, and the environment.

The framework defines science through three domains: Life Science, Physical Science, and Earth and Space Science. Exhibit 2 outlines the topics and learning expectations for each of the domains in Grade 4.

Exhibit 2: Grade 4 Topics and Learning Expectations in the Common Framework of Science Learning Outcomes K to 12

Domain	Topics and Learning Expectations
Life Science	**Habitats and communities** • compare the external features and behavioral patterns of animals that help them thrive in different kinds of places • compare the structural features of plants that enable them to thrive in different kinds of places • predict how the removal of a plant or animal population affects the rest of the community • relate habitat loss to the endangerment or extinction of plants and animals • identify a variety of local and regional habitats and their associated populations of plants and animals • describe how a variety of animals are able to meet their basic needs in their habitat • classify organisms according to their role in a food chain
Physical Science	**Light** • identify sources of natural and artificial light in the environment • demonstrate that light travels in all directions away from a source • distinguish between objects that emit their own light and those that require an external source of light to be seen • investigate how a beam of light interacts with a variety of objects in order to determine whether the objects cast shadows, allow light to pass, or reflect light • predict the location, shape, and size of a shadow when a light source is placed in a given location relative to an object • demonstrate and describe how a variety of media can be used to change the direction of light • demonstrate that white light can be separated into colors • compare how light interacts with a variety of optical devices such as kaleidoscopes, periscopes, telescopes, and magnifying glasses **Sound** • describe how the human ear is designed to detect vibrations • compare the range of sounds heard by humans to that heard by other animals • demonstrate and describe how the pitch and loudness of sounds can be modified • identify objects by the sounds they make • relate vibrations to sound production • compare how vibrations travel differently through a variety of solids and liquids and through air

Exhibit 2: Grade 4 Topics and Learning Expectations in the Common Framework of Science Learning Outcomes K to 12 (Continued)

Domain	Topics and Learning Expectations
Earth and Space Science	**Rocks, minerals, and erosion** • compare different rocks and minerals from their local area with those from other places • describe rocks and minerals according to physical properties such as color, texture, luster, hardness, crystal shape (minerals) • identify and describe rocks that contain records of Earth's history • relate the characteristics of rocks and minerals to their uses • describe ways in which soil is formed from rocks • describe effects of wind, water, and ice on the landscape • demonstrate a variety of methods of weathering and erosion • describe natural phenomena that cause rapid and significant changes to the landscape

Although the framework provides the domains, grade-specific topics, and learning outcomes to guide science learning across the country, the conceptualization and coverage of these may vary greatly between the provinces and territories. For instance, in addition to the domains, Alberta further classifies the Grade 4 science curriculum into five topics: waste and our world, wheels and levers, building devices and vehicles that move, light and shadows, and plant growth and changes.[12] In Ontario, science is conceptualized slightly differently, with four domains—Life Systems, Matter and Energy, Structures and Mechanisms, and Earth and Space Systems—across Grades 1 to 8 curricula.[13] In Quebec, domains are closely aligned (Material World, Earth and Space, Living Things) with the framework. Finally, in both Manitoba and Newfoundland and Labrador, the Grade 4 science curriculum is split into "clusters"[14] or "units"[15] that parallel the topics found in the Common Framework (i.e., habitats and communities; light; sound; rocks, minerals, and erosion). However, the learning outcomes in each curriculum document are considerably more extensive.

Anywhere between 5% and 15% of total instruction time is devoted to science instruction in provinces in which the Ministry or Department of Education prescribes the amount of time. While curriculum renewal is generally an ongoing process across Canada, certain provinces (New Brunswick, Manitoba, and Quebec) are currently in the process of revising their science curriculum.

In addition to content, curriculum documents may specify teaching and learning methods that are expected in the delivery of the curriculum. Teachers are encouraged to incorporate a variety of methods to effectively and equitably meet the global needs of their diverse students when designing their classroom mathematics and science programming. Some of these pedagogical methods are formally prescribed in curriculum documents across the subjects. The curriculum for science and mathematics goes beyond teaching the subject-specific knowledge

and skills that students are expected to acquire by the end of the academic year, emphasizing higher-order thinking and learning processes. The following examples demonstrate how the curriculum documents across Canada guide the pedagogical practice of teachers to promote deep learning in mathematics, science, and other subjects:

- cross-curricular and integrated learning—Opportunities to learn may go beyond one subject area so that students may acquire knowledge and skills in two or more subject areas during any given activity. Quebec, for instance, specifies "cross-curricular competencies" that go beyond a specific subject area and that all teachers, regardless of their teaching specialization, are expected to help students achieve.[16]
- alternative programming—To promote equitable opportunities to learn, the curriculum may be tailored to the unique needs of students. For example, if a student demonstrates certain individualized needs, Ontario teachers—with the support of other stakeholders—may create an Individual Education Plan (IEP) for the student. The IEP can prescribe two main forms of alternative programming: accommodations or modifications. Accommodations result in adjustments to the instruction, environment, or assessment of the student without changing the grade level at which the student is expected to perform. Modifications, however, may specify learning expectations from a different grade level (i.e., a higher or lower grade). Modified curriculum expectations may result in changes to the number and complexity of assigned tasks.
- Indigenous perspectives—For example, embedded in Manitoba's[17] and Alberta's[18] curriculum is the belief that student learning in mathematics must incorporate First Nations, Métis, and Inuit perspectives.
- gradual release of responsibility—To ensure that students are learning and applying knowledge and skills with the appropriate amount of support, teachers scaffold their instruction. With this pedagogical practice, teachers first model the work before mentoring and ultimately monitoring it. This pedagogical practice is outlined, for instance, in Newfoundland and Labrador's curriculum.[19]

Teacher Professional Development Requirements and Programs

Professional development requirements and programs are determined by organizational bodies, which differ by province/territory. In most provinces and territories, teacher professional requirements are regulated by a Ministry or Department of Education. However, in Saskatchewan and Ontario, a regulatory body of teachers oversees the teaching profession, including the requirements to enter and remain in the profession.

Depending on the intended grade level, professional preparation and/or development may be required to specifically teach mathematics or science. For instance, in Ontario, a preservice teacher who wishes to teach at the junior or intermediate level (Grades 4 to 10) must be qualified in a specialty subject, which can include mathematics or science, among

other subjects.[20] Obtaining basic qualification in either subject typically requires university-level coursework in addition to a degree in teaching. Moreover, in-service teachers may further hone their pedagogical skills and knowledge in a particular subject, such as mathematics or science, through professional development in the form of credentialed upgrading courses.[21] A combination of professional development courses can result in a postgraduate certificate, as is the case with British Columbia's postgraduate certificate in mathematics education.[22] Course reimbursement is sometimes available to support teachers in developing their specific mathematics pedagogical competencies.

Aside from formal credential-granting courses (i.e., additional qualifications, certificates, or graduate studies), a number of professional development opportunities exist for in-service teachers; teachers may or may not attend these programs during allocated professional development days. Professional development may occur in the form of workshops, conferences, professional learning communities, and more, and may be organized at the school, board/district/division, provincial/territorial, or pan-Canadian level.

For example, in Prince Edward Island, professional learning provided through the Department of Education is mandatory whenever mathematics or science is the focus of the professional development. Recently, Newfoundland and Labrador developed the Supporting Teachers/Educators in Lifelong Learning and Reflection (STELLAR) program, which is intended to support educators who have identified mathematics pedagogy or content as a professional learning priority, need, or interest. Through the STELLAR program's five funding streams, teachers can access financial supports for taking a university-level mathematics course, engaging in self-directed learning, establishing a professional learning community, participating in a mentorship program, or attending an institute or conference.

Monitoring Student Progress in Mathematics and Science

Student progress in mathematics and science is monitored at different levels and for different purposes. Assessments may be administered at the local level, such as in the classroom, or at the provincial/territorial, pan-Canadian, or international level through a large-scale assessment.

At the local level, teachers evaluate students through classroom-based assessment and report their students' achievement outcomes of curriculum expectations through progress report cards. Additionally, teacher surveys also provide opportunities to monitor mathematics and science programming.

Provincial assessments are typically administered at transitional times of student pathways, such as the midpoints and endpoints of elementary years (e.g., Grade 3 and Grade 6) and in the intermediate years (e.g., Grade 9). In order to graduate secondary school, some provinces require successful completion of an assessment, most of which are administered to students in either Grade 10 or Grade 12. In diploma exit exams, most provinces assess numeracy and literacy, with select provinces (such as Alberta and Quebec) also administering exams in science (i.e., biology, chemistry, and physics) and social studies (i.e., geography and history).

In Alberta, Grade 12 diploma exams are weighted at 30% of a student's overall grade, which is used for entry to postsecondary institutions. In Ontario, successful completion of a Grade 10 literacy test is one of three ways students can fulfill the literacy requirement, which is part of a larger set of conditions required to earn their secondary school diploma.

At the pan-Canadian level, Grade 8 classes across the country may be randomly selected to participate in the Pan-Canadian Assessment Program (PCAP), which assesses students with respect to their achievement of the curriculum expectations common to all provinces and territories in three core learning domains: reading, mathematics, and science. The information gained from this pan-Canadian assessment provides ministers of education and other stakeholders with a basis for examining their curriculum and other aspects of their school systems.[23] At the international level, assessments such as TIMSS, PIRLS, and PISA are used to obtain insight into areas of improvement in Canadian education systems.

Beyond assessments, students' progress in mathematics and science is measured outside of test settings. Indeed, Newfoundland and Labrador's curriculum specifies the many ways that teachers employ methods and tools to evaluate the progress of their students' learning. Depending on the grade level and activity, teachers may assess student understanding using anecdotal records, audio/video clips, case studies, checklists, conferences, debates, demonstrations, exemplars, graphic organizers, journals, literacy ability, photographic documentation, podcasts, portfolios, presentations, profiles, projects, questions, quizzes, records, role-play activities, rubrics, self-assessments, tests, observations, and wikis.[24]

In Canada, assessment may be conceptualized as **for** learning, **as** learning, and **of** learning.[25] Assessment **for** learning is diagnostic in nature: It is meant to provide an opportunity to measure student learning in order to formulate more appropriate future learning and teaching. Assessment **as** learning is formative in nature, as it provides students the chance to assess their own progress, as well as that of their peers. Finally, assessment **of** learning is summative and is typically used to measure a student's cumulative knowledge.[26]

Special Initiatives in Mathematics and Science Education

The federal government continues to earmark funds in federal budget proposals for fostering growth in the science, technology, mathematics, and engineering (STEM) field. These funds support programming targeting students from elementary to postsecondary levels. For example, since 2017, a federally funded program called CanCode has helped to prepare youth for further studies in STEM, equipping them with digital skills such as coding concepts, data analytics, computational thinking, and digital content development. CanCode focuses on targeting traditionally underrepresented students in STEM, such as girls and Indigenous students. Students and teachers from kindergarten to Grade 12 have the opportunity to access different programs under CanCode. In the 2021–2022 budget, the federal government committed to extend the CanCode project by dedicating an additional $80 million over 3 years.

Provinces and territories may individually or collaboratively decide upon and implement policies and programs to support learning opportunities in mathematics and science. For instance, Newfoundland and Labrador, along with the other Atlantic provinces, have partnered with the Atlantic Canadian charity Brilliant Labs to promote coding and digital skills in youth.

Suggested Reading

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