Chapter 9
Science Education in Nova Scotia: Building on the Past, Facing the Future

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Abstract Nova Scotia has a small, and declining, student base as its general population both decreases and ages. Schools are being closed or amalgamated, which causes disruption within the school system, between the system and parents, and within teacher education programs. Secondary school programs are particularly affected because there may be too few students to offer a wide variety of science courses. Current provincial curriculum directions arise from public consultations undertaken by the province in 2015. The government has committed to continuing with those directives. Historically science programs in NS have been based on an innovative curriculum developed by the Atlantic Science Curriculum Project in the 1980s. However, the current science curriculum has mostly been derived from the 1997 Pan-Canadian Common Framework and has been minimally updated. Recently, the province has begun modifying the elementary science curriculum and has provided various information and communication technology resources (e.g., probeware, robots, programming tools) to schools. The expectation is that teachers will take a more integrated approach to teaching science across multiple subject areas. Nova Scotia science education faces challenges related to setting entry requirements for BEd programs, providing meaningful professional development opportunities, and including Indigenous perspectives.

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9.1 Introduction

Located on the eastern Atlantic coast of Canada, Nova Scotia is one of the smallest provinces in the country, with an area of approximately 53,000 km^2, a population of just under 1 million people, and the third highest rural population at 43% (Statistics Canada, 2011). Although Nova Scotia's overall population is increasing, that increase is due to growth in its capital city of Halifax; 42% of the province's population resides in Halifax Regional Municipality, the only large city in Nova Scotia (Fig. 9.1). From 2010 to 2014, 10 of 18 counties' population were stable or showed slow decline (0–4.9%), and six counties showed rapid decline (5–9.9%); only Halifax and one of its neighbouring counties showed growth (Nova Scotia Finance & Treasury Board, 2015). The median age of Nova Scotia's population has been steadily trending upward from 25.4 years in 1971 to 43.7 years in 2011 (Statistics Canada, 2011). From 2006 to 2011, the 65+ age group increased by 11%, the 15–64 age group increased by 0.2%, and the 0–14 age group declined by 5.6%. The rural to urban shift, combined with an aging population, has resulted in school closures across much of the province.

Fig. 9.1 Map of Nova Scotia

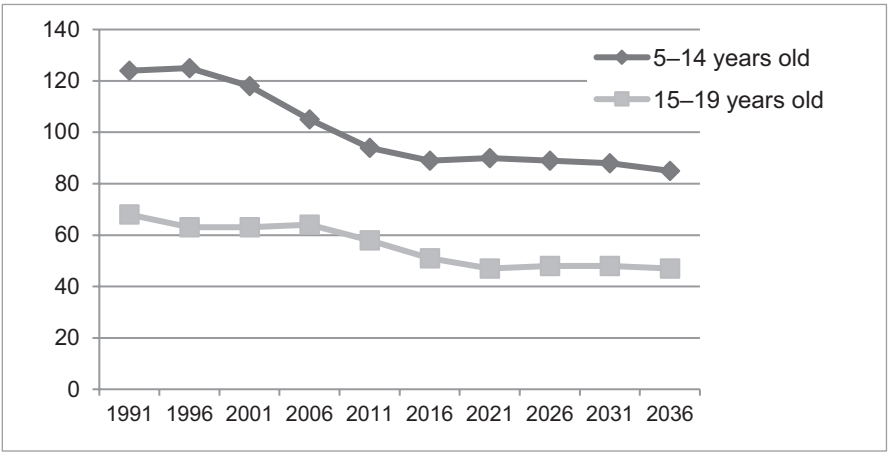

Fig. 9.2 Student enrolment in Nova Scotia, in thousands (Statistics Canada, 2015)

In fact, the student population has been declining for well over 20 years (Fig. 9.2), although it is now gradually reaching a plateau (Statistics Canada, 2015). This student decline has not been accompanied by an associated decline in the number of educators; between 2001 and 2011, student populations declined by 24.5%, whereas the number of educators declined much less at 3.8%—from 9,594 to 9,231—between 2002 and 2013 (Statistics Canada, 2016). This imbalance in student-educator populations has implications for new teachers for whom it is more difficult to find employment. An obvious solution would appear to be reducing the number of student teachers admitted to faculties of education; however, unpublished studies suggest that students who are not admitted at provincial universities attend universities in the US state of Maine and then return to be licensed in the province (R. Berard, personal communication, June 1, 2016), thus not reducing the number of certified teachers.

Schools in Nova Scotia start at Primary (P) rather than Kindergarten (K), registering students who turn 5 years old by December 31 of the school year. Schools are organized in several different grade configurations. Recently, Nova Scotia has started pre-primary programs in schools (for students who are 4 years old by December 31) on a limited basis across the province, a program that is now being expanded. In 2016, the Nova Scotia Department of Education and Early Childhood Development (NSDE, 2017a) reported that there were:

- 210 elementary schools (P–2, P–4, P–5, P–6, 3–5, 3–6, 4–6)
- 52 elementary/junior schools (P–7, P–8, P–9, 5–7, 5–8, 6–8, 6–9)
- 33 elementary/junior/senior high schools (P–12, 5–12, 6–12)
- 25 junior high schools (7–8, 7–9, 8–9)
- 40 junior/senior high schools (7–12, 9–12)
- 18 senior high schools (10–12)

Those schools with Grade 7 and up are more likely than elementary schools to have science specialist teachers. In many areas of the province, schools seem to be transitioning to a P–8/9–12 or P–12 structure in response to the changing demographics of their school-age population. If there are sufficient students, then P–8 and 9–12 schools are being built; in smaller catchment areas, P–12 schools are being built, such as in Bridgetown (a former town of 900, now part of a municipal region) where a new P–12 school is slated for opening in the fall of 2017.

Until recently there were seven English language school boards and one province-wide French language (Acadian) school board with a combination elected/appointed governance structure. In 2018 the Nova Scotia government eliminated elected school boards, redesignated the Regional Centres for Education, and had them all managed by a single appointed advisor council. Areas included in each Regional Centre conform to county boundaries, with individual Centres being comprised of one to three counties (see http://ns-schools.ednet.ns.ca/). There are also 14 band-operated schools—federally-funded schools operated by First Nations education authorities for K–12 students who live on reserves; the Mi'kmaq Services division of NSDE acts as a liaison between the department, these schools, and the Council on Mi'kmaq Education (NSDE, 2017b). There are also approximately 24 private schools in the province.

9.2 History of Nova Scotia's Science Curriculum

From the mid-1980s to the late 1990s, the Nova Scotia junior high school science curriculum was guided by the Atlantic Science Curriculum Project (ASCP) and the *SciencePlus* series of textbooks (ASCP, 1986, 1987, 1988). ASCP was an initiative headed by two professors of science education: Charles McFadden and John Haysom, University of New Brunswick and Saint Mary's University, respectively. The ASCP curriculum was developed with teams of teachers and science education consultants and academics, field tested in schools, and revised as necessary to reach the desired learning outcomes. Detailed teacher manuals were produced, and extensive professional development (Pro-D) workshops were offered to teachers about how to teach science using a hands-on inquiry investigation approach. This curriculum was very forward-looking for its time, reflecting many of the approaches for science classrooms that are currently advocated such as hands-on investigation activities, inquiry investigations, depictions of gender and ethnic diversity of individuals doing science, and authentic science. The curriculum was subsequently adopted in other jurisdictions (including various boards in Ontario and the US state of California). In the late 1990s, the Education Ministers of Atlantic Canada adopted the *Common Framework of Science Learning Outcomes, K–12* (Council of Ministers of Education, Canada [CMEC], 1997) as the basis of science education. Implementation of the *Common Framework* in Nova Scotia began in 2000, with specific workshops and resources being developed for teachers.

Table 9.1 Topics in primary through Grade 10 science in Nova Scotia

Grade	Earth/space science	Life science	Physical science
P	Explore sand and water	Explore living things	Chemistry Explore objects
1	Daily and seasonal changes	Needs and characteristics of living things	Materials and their properties Constructing objects
2	Air and water in the environment	Animal growth and changes	Chemistry—liquids and solids Motion
3	Exploring soils	Plant growth and changes	Materials and structures Invisible forces
4	Rocks, minerals, and erosion	Habitats	Light Sound
5	Weather	Healthy body	Forces and simple machines Chemical and physical properties of matter
6	Space	Diversity of life	Electricity Flight
7	Earth's crust	Interactions within ecosystems	Mixtures and solutions Heat
8	Water systems	Cells	Fluids Optics
9	Space	Reproduction	Atoms and elements Electricity
10	Weather	Sustainability of ecosystems	Chemical reactions Motion

The P–3 science curricula were revised in 2015 and the Grades 4–6 curricula in 2016. NSDE officials have said that the Grades 7–8 curricula will be revised next, in accordance with Nova Scotia's *Action Plan for Education* (NSDE, 2015). Topics currently included in the P–10 science curricula are shown in Table 9.1. Details of the specific science knowledge, skills, and attitudes required for each grade level can be found in the document *Foundation for the Atlantic Canada Science Curriculum* (Atlantic Provinces Education Foundation, 1998). Whereas the Grades 11–12 science curricula have not been updated since their implementation in 2000, the Grade 10 curriculum was updated in 2012.

Revision was called for in part because, according to teachers, there was *too much curriculum*; the revised curriculum has been streamlined in terms of content and the number of listed outcomes. For many teachers, this change was welcomed as it tended to simplify the science curriculum, making it easier to connect lessons with outcomes. However, the time allocated for teaching science was also adjusted. At the P–3 level, rather than having a designated block of time for science, as is the case for language arts (615–790 min/week), mathematics (375–450 min/week), music (60 min/week), and physical education (100–150 min/week), science was included in a block of courses (along with social studies, health, information and

communication technology, and visual arts) that has no specifically allocated teaching time. The expectation and hope was that teachers would integrate science (and the other subjects) as part of the English language arts and mathematics curricula that dominate the weekly timetable (Ministry official, personal communication, June 15, 2016). However, the message heard by teachers seems to have been that they were only to teach science when it supported the mathematics and literacy curricula. The outcomes of this approach to science education are likely at best to be mixed; it is quite possible that overall science instruction in those grades will decline as a result. On the other hand, if the integrated approach to curriculum takes hold, then the science that is taught might be better embedded in a broader range of knowledge outcomes for the students, such as being able to relate a science concept to an applied example from a historical social studies event.

Similarly, the Grades 4–6 curricula were streamlined and times reallocated, with 450–500 minutes/week designated for mathematics and English language arts and 40 minutes/week each for other subjects such as science, social studies, and computer coding. Again, there is a danger that many teachers will include little or no science in their classrooms as they emphasize helping students achieve learning outcomes in literacy and mathematics over achieving outcomes in science. Several elementary teachers have told the authors that they believe the removal of science as a distinct area with allocated time from the weekly timetable to be an unfortunate change. However, NSDE clearly expects cross-curricular learning activities to be developed.

NSDE's expectations for cross-curricular implementation highlight the importance of helping preservice and inservice teachers understand how science can be effectively integrated with other subjects, particularly language arts and mathematics. To support preservice teachers in cross-curricular approaches, faculties and schools of education at some Nova Scotia institutions are developing methods courses that use an integrated approach to subjects. For instance, during their second science methods course, elementary education students at Mount Saint Vincent University develop integrated, cross-curricular lesson plans that include the use of a technology tool. The integration of science with other subjects is more likely to occur in Grades 5 and 6, perhaps because the science curriculum for these grades has a strong focus on data literacy, including collection and analysis of data and drawing conclusions, which is consistent with aspects of the mathematics curriculum.

The Grades 9–12 science curriculum documents, with the exception of Grade 10, were last revised between 2000 and 2003 and were based on the *Common Framework* (CMEC, 1997). There are currently no publicized plans to update the remaining documents, but given the recent revision of the P–6 documents, the impending revision of the Grades 7 and 8 documents, and the age of the Grades 9, 11, and 12 documents, it is likely that these last three documents will be revised to address aspects of the *Action Plan for Education* (NSDE, 2015), such as including computer coding across the curriculum.

High school courses generally have 120 contact hours over either a semester or school year. Apart from typical science courses in general science, chemistry,

physics, and biology, Nova Scotia offers Agriculture/AgriFood 11, Oceans 11, Geology 12, and Food Science 12. There are also options for locally-developed science courses to accommodate local needs. Students require two science courses for graduation: one of biology, chemistry, Science 10, or physics, and any other approved science course.

In addition to the provincially-designed curriculum, each school board has at least one International Baccalaureate (IB) program (http://www.ibo.org/) with its associated science courses; there are 13 IB programs across the province. As well, several high schools offer the Advanced Placement (AP) program (https://apcanada.collegeboard.org/) with its associated science courses. Both the IB and AP programs have standardized curricula and final examinations, and both offer additional opportunities for students interested in science. The presence of IB/AP programs guarantees that school boards provide adequate materials for teaching science in the schools that offer those programs. Anecdotally, these programs are popular, with more students wanting to register than can be accommodated.

9.3 Assessment

Nova Scotia regularly participates in international and national assessments of student science achievement, specifically, the Programme for International Student Assessment (PISA) and the Pan-Canadian Assessment Program (PCAP), both of which assess science knowledge as well as other subjects. However, while the academic performance of Nova Scotia students has remained fairly consistent in these assessments, the average performance in mathematics, science, and reading is "significantly below the performance of students living elsewhere in Canada" (Minister's Panel on Education, 2014, p. 9).

Until 2002, Nova Scotia had provincially mandated the final examinations in Grade 12 Chemistry and Physics that counted as part of the final grade. In 2013, Grade 12 provincial examinations in Mathematics and English were halted although there have been arguments against their elimination (Bennett, 2017). However, as of 2015, the province instead requires Grade 10 examinations in Mathematics and English that count for 20% of the final grade.

9.4 Bachelor of Education Programs

Nova Scotia has five postsecondary institutions that have Bachelor of Education (BEd) programs: Acadia University (Acadia), Cape Breton University (CBU), Mount Saint Vincent University (MSVU), St. Francis Xavier University (StFx), and Université Sainte-Anne. A sixth institution, Saint Mary's University (SMU), has a BEd program in their calendar but is currently not allocated any BEd students by the provincial government, which means if they did accept students they would not receive any

funding. Twenty-five years ago, undergraduate elementary/secondary education programs at both SMU and Dalhousie University had their student allocations reduced to zero, resulting in Dalhousie closing its program and SMU essentially putting its program in stasis by maintaining it *on the books* with an assigned dean but no students. Closing the Dalhousie program means that Nova Scotia is the only province without a faculty of education in one of its keystone institutions, which—one might argue—has implications for faculty recruitment, retention, and research.

At that same time, the MSVU BEd program had its student allocation increased and subsequently developed its secondary education program. Some Dalhousie and SMU faculty members moved to MSVU, while others retired. Dalhousie's graduate programs in education were closed as was SMU's master's program; enrolled students were allowed to finish their degree program. MSVU started its own graduate program—initially a master's program that has since expanded to become a joint doctoral program (PhD) in education with Acadia and StFx—mostly along the lines of the programs that had been offered at Dalhousie. The shared PhD program did not begin until 2011, and it remains the only one in the province. SMU currently offers some upgrading and graduate courses in education, including upgrading for science teachers who do not have appropriate certification for teaching elementary science to meet provincial requirements.

With the exception of Université Sainte-Anne, all BEd programs in the province are post-baccalaureate, or consecutive, programs and typically consist of four semesters (totalling 45 credit hours, with a 3-credit hour course usually one semester in length) and a minimum of 15 weeks of practicum experience (worth 15 credit hours but taking substantially more time per credit hour). Some programs include longer placements; MSVU and StFx, for instance, have 22 weeks of practicum over 2 years. Three universities (i.e., Acadia, StFx, and MSVU) have tenured/tenure-track professors who are science methods instructors, and each institution can accept up to 125 BEd students per year into its program (across both secondary and elementary education) with typically 15 to 20 students having a high school science as a major or minor teachable (certified teaching area) at each university. CBU can accept a total of 40 students per year into their BEd program. Along with their regular 2-year program, Acadia offers an accelerated option with students being able to complete essentially the same requirements within a 16-month period (starting in September 1 year and finishing at the end of the following December). Université Sainte-Anne offers a program where the BEd can be integrated with a Bachelor of Arts or a Bachelor of Science, which meets the provincial minimum of 90 credit hours of approved undergraduate studies and 60 credit hours of approved professional studies (including practicum).

9.4.1 Admission Requirements

The province sets minimum standards for university admission, but institutions typically set their own higher requirements. Individual BEd programs at different institutions may have minimum mark, course level, and laboratory course

requirements for admission, but there is no consistency across programs. There are no provincial stipulations regarding the level (first to fourth year of university) of the required subject-specific courses or minimum grade requirements for admission to the BEd. Thus, students might be accepted with fewer than the required (for licensure) number of undergraduate courses in the teachable areas; however, these students must complete those courses before graduation through summer or online courses.

Admission requirements to Nova Scotia's BEd programs include prerequisites that pertain specifically to science education. Those applicants who wish to teach at an elementary level require 6 credit hours of science coursework at the undergraduate level, which may be a course from a science faculty/department or a foundations of science type of course offered through an education department/faculty specifically for prospective elementary teachers. Although the province does not require it, some institutions have a laboratory prerequisite. In the past, it was generally expected that people entering a BEd program would have these requirements before they began the program, thus providing some science background for their methods instruction on how to teach science. However, some institutions admit students to BEd programs with only 3 credit hours of undergraduate science coursework, with the stipulation that the remaining 3 credit hours be completed before graduation. Therefore, it is possible that a student could complete all required science methods courses without the science content needed to inform their developing understanding of science pedagogy.

Secondary science teacher candidates have more stringent requirements to meet than elementary teacher candidates. Secondary teacher candidates must have at least two teachable subject areas. At some institutions (e.g., MSVU), one teachable would be science and the other a non-science subject, such as mathematics, social studies, or art. At other institutions (e.g., StFx), it is possible to graduate with science as both a major and a minor teaching area. Secondary teacher candidates require 30 university credit hours of coursework (i.e., five full-year courses or 10 half-year courses or a combination thereof) in their major teachable subject area and 18 credit hours of coursework (i.e., three full-year courses or six half-year courses or combination thereof) in their minor teachable subject area. According to provincial rules, one full-year course (or equivalent) for each teachable may come from a cognate or related area; for instance, someone might receive equivalent-to-science credit for completing a biostatistics course. The designation of major and minor teachable areas has implications for the content knowledge of science teachers, which is discussed later in this chapter.

9.4.2 Education Programs

Both elementary and secondary programs may have general methods courses with a few subject-specific courses, or they may have a series of subject-specific methods courses. The provincial expectation is that students in elementary education take a minimum of one 3-credit hour science-specific methods course. At CBU, Acadia,

and StFx, elementary teacher candidates are required to take one 3-credit hour science methods course and might have the opportunity to take another as an elective. At MSVU, elementary teacher candidates take two science methods courses—one with a science focus and the other with a science, technology, engineering, and mathematics (STEM) focus—where they learn to develop cross-curricular lessons in line with NSDE revisions of the P–6 curriculum.

Students in secondary science education are required to complete a minimum of two 3-credit hour science methods courses for a major teachable and one 3-credit hour course for a minor teachable although variations occur. MSVU requires a third science methods course for those students who have science as a major teachable; at some institutions, students have the option of taking up to two additional science methods-oriented electives. Some institutions (e.g., StFx) offer other science pedagogy courses on a rotating basis (e.g., environmental or middle school science) and encourage their secondary science teacher candidates to take more than 6 credit hours in their major teaching area and 3 credit hours in their minor teaching area. There are currently no teacher education institutions in Nova Scotia that offer separate science methods courses focused on distinct disciplines such as biology, chemistry, physics, or earth science. The dominant perspective is that science is a generic area and that one or two science methods courses will be sufficient to meet the needs of teachers who will teach in these separate areas of science. The net effect is that many new secondary science teachers have a limited and somewhat generic experience in science pedagogy and curriculum.

9.4.3 Teacher Certification and Progress Through the Ranks

"To be granted a teacher's certificate in Nova Scotia, an applicant must have completed an 'Approved Program of Professional Studies' as part of the broader certification requirements" (Nova Scotia Office of Teacher Certification [NSOTC], 2017a). Graduates of these programs would be expected to have completed courses that explore The Context of Public Education, Human Development and the Learning Process, The Act of Teaching, and The Professional Context (NSOTC, 2017b). There are, however, no provincial stipulations with respect to the number of required courses in specific subject areas such as science. Although in general The Act of Teaching courses may include science-teaching-methods-specific courses, the number of these courses varies by institution. Other required courses in the BEd program—for elementary and secondary teachers—conform to the description of an approved program of professional studies that can be implemented as individual institutions might wish "in a variety of ways including, but not limited to, formal courses, professional workshops and a supervised practicum of at least 15 weeks" (NSOTC, 2017b, p. 1). It should be noted that the province is currently discussing a revision of the BEd programs with the Faculties of Education, but as of yet no firm direction for change has been decided upon.

The licence that every Nova Scotia secondary teacher receives includes a major and minor endorsation. Teachers can have more teachable endorsations added to their licence if they have the requisite number of approved courses in the subject area along with at least one methods course in that subject area. In the case where a teacher candidate wishes to be licensed with science as both a major and a minor teachable area because they have sufficient undergraduate credit hours in two different science disciplines, the province allows teacher candidates to *double dip* in the sense that they can use their two required courses in science curriculum and pedagogy for both science subject licence certifications.

Following certification, a teacher is placed on a salary grid in a category related to education and at a level related to length of teaching experience. Years of teaching experience result in upward movement within the category until a maximum salary is reached. For instance, a beginning teacher with a 4-year university degree and a 2-year BEd would start at teacher certification (TC) 5 with a salary of approximately $53,276 (Nova Scotia Teachers Union [NSTU], 2019), while a teacher with the same education and 11 years' experience would earn approximately $76,038. Teachers can progress from TC 5 to another category (e.g., TC 6, 7, and 8) by completing either a certificate course or an administrative program or by completing a graduate degree (for details, see § 24–28 and 30D–G of the Government of Nova Scotia (2015) Order in Council). A graduate degree in education is by far the most common choice, and a large number of teachers in Nova Scotia have two or three graduate degrees. Universities offer Masters of Education, Masters of Arts, and Research Masters of Arts in addition to the joint PhD program. It should be noted that (a) none of these graduate programs is science education-specific; (b) there are some graduate courses in science education, but they reportedly are rarely, if ever, taught; and (c) the number of thesis students studying science education issues appears low; therefore, there is some question as to exactly how much graduate-level science education actually occurs in the province.

9.5 Challenges and Opportunities

Every educational system has things it does well, while having with room for improvement in others, and Nova Scotia is no exception. Challenges discussed in this section include current entry requirements for BEd programs, the effect of minimal contractual obligations for Pro-D on attendance at opportunities offered by the province, and the limited updates to science curriculum in the past two decades. Opportunities for enhancing science education in the province include summer science camps, science fairs, robotics competitions, and the new provincial coding initiative.

9.5.1 Secondary Science Teacher Quality

There are several factors that impact the quality of secondary science teachers in the province, including small cohorts of science teacher candidates and a lack of stringent admission requirements. The small number of preservice secondary science teachers in each BEd program means that methods courses for specific science disciplines are not widely offered. The comparatively small size of BEd programs in Nova Scotia means that it is often not feasible to offer major and minor teachables in two different science disciplines. As a result, preservice secondary science teachers typically have a major teachable in science and a minor teachable in another subject area (or the reverse), which means that the content background of certified science teachers may be limited in comparison with teachers in other provincial/territorial jurisdictions. The small program size also means that science methods courses tend to be generic rather than discipline specific, resulting in fewer opportunities to develop pedagogical content knowledge. The province's lack of rigorous admission requirements further negatively impacts the academic depth and breadth of science teacher content knowledge. When standards for entry into BEd programs are reduced and/or the number of applications decline, as is currently the case, there are likely to be fewer elective courses offered, including elective science methods courses. These aspects will undoubtedly have a negative impact upon secondary science teacher quality.

9.5.2 Professional Development

Professional development (Pro-D) opportunities are provided by NSDE, individual school boards, and NSTU. Although there are no Pro-D requirements associated with teacher certification in terms of salary level, category upgrades, or pay increases, according to government regulations (Government of Nova Scotia, 2015), teachers are required to submit annually a Pro-D profile that documents 100 completed hours of Pro-D every 5 years. There is no contractual obligation to attend Pro-D events held by NSDE or school boards during the summer or on weekends. There are provincial and local grants as well as funding from school boards to support teachers who want to attend various out-of-province science education conferences. For instance, every year a number of teachers from Nova Scotia attend the annual national conference of the National Science Teachers Association (http://www.NSTA.org) in the United States.

When a NSDE initiative or update requires teacher inservice sessions, arrangements are made at the board or school level, and teachers are typically pulled from regular classroom duties and replaced with a substitute teacher (Ministry official, personal communication, June 15, 2017). For example, NSDE recently provided a 1-day workshop on the streamlined Grades 4–6 curricula. NSDE has also offered weeklong, science-focused summer institutes at different locations around the prov-

ince. However, these institutes were often poorly attended despite providing opportunities to also acquire new classroom resources such as microscopes, thermometers, balances, and laboratory coats. This low attendance likely reflects the lack of contractual obligation to participate in Pro-D outside the school year, and currently these institutes are no longer being held.

During a regular school year, each school board schedules 5 or 6 Pro-D days—called PD days—with timing and topics determined by the individual boards. PD days are those days over and above the required number of school days where teachers are directly involved in teaching students. The number of contact, or teaching, days is set out in the Education Act, while the number of PD days is not (P. Hayden, personal communication, June 15, 2017). These PD days are typically noninstructional days and usually involve the entire teaching staff, with the school being closed to students. There is variation among school boards around how PD time is managed, whether it will be scheduled as full days, half days, or through flex time arrangements, and reportedly does not often deal with subject-specific topics.

NSTU has 22 Professional Associations, including the Association of Science Teachers (AST). On one noninstructional day every fall, NSTU sponsors Professional Association Conferences and, although attendance is optional, there is an expectation that teachers will engage in some form of Pro-D on that day. The annual conference organized by the AST consists of workshops on a variety of science education topics such as conducting laboratory activities, inquiry investigations, and data analysis. These workshops are facilitated by teachers, college and university educators, and not-for-profit groups such as Project WILD (http://cwf-fcf.org/en/explore-our-work/education/for-educators/project-wild.html). The diverse range of topics is generally applicable to the classroom, and this Pro-D event typically attracts hundreds of teachers of science from Primary through Grade 12.

9.5.3 Initiatives Related to Science Education

There are currently a number of initiatives and activities in the province that relate to science education. Apart from the typical summer science/engineering camps offered at universities by various science/engineering departments, there are science fairs that are coordinated by the nonprofit Nova Scotia Youth Experiences in Science! (NS YES!) organization, robotics competitions, and the provincial coding initiative that involves the not-for-profit organization Brilliant Labs (https://www.brilliantlabs.ca/).

9.5.3.1 Summer Camps

Most science-related summer camps focus on a selection of *entertaining* activities from science, engineering, and robotics. Some of the opportunities available to Nova Scotia children include:

- Science camps (http://maritimes.madscience.org/summercamps.aspx)
- STEM-focused camps (http://www.supernova.dal.ca/about/)
- Camps for girls (http://www.wiseatlantic.ca/)
- More formal marine research activities (http://www.smu.ca/academics/science-marine-mammal-summer-camp.html)
- STEM and architecture activities with LEGO® (http://www.bricks4kidz.com/canada-novascotia-halifax/)

9.5.3.2 Science Fairs

Properly done, a science fair project gives students a chance to pick a topic and design an experiment, followed by visual, oral, and written reporting; thus, science fair investigations often reflect *authentic science* better than classroom instruction (C. Coveyduc, personal communication, June 23, 2016). Regional science fairs are usually held in each of the Regional Centres for Education and among First Nations schools. Funding to support science fairs usually occurs at the Regional Centre for Education level with no direct funding from NSDE.

NS YES! was conceived in 1998 as a representative vehicle at the national, provincial, and board level; it opened doors to funding support from private groups and the provincial government. As a result of the efforts of NS YES!, the maximum number of participants that could be sent to the national science fair was quickly reached, a success level that continues to date (C. Coveyduc, personal communication, June 23, 2016). Nova Scotia typically sends 40 regional science fair winners to the national Canada-Wide Science Fair (CWSF). NS YES! hosts a yearly showcase of winning projects that includes dinner with scientists, a public presentation of the projects, educational workshops, and tours of actual science research facilities, which many students in this very rural province have never before seen. The annual Provincial Showcase has become an amazing display of the creative talent, ability, and determination of Nova Scotia's young people (C. Coveyduc, personal communication, June 23, 2016). Current funding difficulties make it difficult to predict if the showcase will continue.

9.5.3.3 Robotics Competitions

Students in Nova Scotia have the opportunity to participate in a provincially-funded robotics competition hosted and run by Acadia University's Joudrey School of Computer Science. Started in 2005 with 12 teams from eight high schools, the competition recently had 17 high school Robofest® teams and 29 middle school *FIRST* LEGO League (FLL) teams from across the province selected from the 63 registered teams that went through a qualifying round. These two competitions offer opportunities for students to design and implement hardware and software. The Robofest competition (http://robots.acadiau.ca/robofest.html) provides students with a programming challenge that they solve by structuring algorithms. The FLL

competition requires teams to build robots out of LEGO and to research a yearly theme; a recent theme was Trash Trek. Although robotics competitions are consistent with the newly developed information and communication technologies and coding curricula described earlier, there is currently little explicit integration with the science or mathematics curricula.

9.5.3.4 Provincial Coding Initiative

NSDE recently introduced a curriculum focus on computer coding that is now required across all grades from Primary through Grade 12. Coding is meant to be integrated with other subjects; for example, some resources that were recently provided to elementary schools (P–6) for science and mathematics (notably Chromebooks, iPads, Sphero SPRK, Makey Makey kits, and PASCO probes and software) also require coding. Apart from these resources, school boards are introducing coding tools such as Kodable, Tynker, LightBot, and Scratch. These technology tools are intended to provide teachers a focal point for creating lessons that integrate subject areas (e.g., an activity combining mathematics, science, and English language arts using one of the technology tools). A federally funded initiative has resulted in class sets of the BBC Micro:bit being distributed to dozens of schools in Nova Scotia to support teaching senior elementary and middle school student coding.

To further support these coding initiatives, NSDE has contracted a private organization, Brilliant Labs, to create a makerspace for each school board that will contain 3D printers, robotics equipment, and video production equipment. Along with these technology centres, schools will be provided with makercarts. Some boards have been buying additional supplies for their schools so more students can have access to these types of technologies. Individual teachers have access to a fund to buy additional technological equipment to support their teaching. This funding support and availability of technological supplies has led to changes in how science is taught in Nova Scotia schools. An example of an early supporter of the move to integrate technology into science classrooms who changed his teaching of physics to incorporate Arduino and programming can be seen at https://www.youtube.com/watch?v=-b2Hgf5KrMc. In addition, NSDE has been encouraging teachers to have students participate in Hour of Code events to learn the basics of computer coding.

9.5.3.5 Indigenous Perspectives on Science

There are many reasons for having Indigenous perspectives included in the school curriculum from both a social justice perspective so as to more accurately reflect history and to provide a grounding in the curriculum for Indigenous students (see Chap. 6, Ontario, this volume, for a more extended discussion of this topic). Despite Indigenous issues becoming more prevalent in the cultural zeitgeist in the last several years, Nova Scotia science education documents do not presently reflect this

change and do not deal with indigeneity. However, this does not mean that the NSDE does not expect Indigenous perspectives to be incorporated into curriculum activities. In a June 15, 2016, workshop attended by various stakeholder groups, which was the same workshop provided P–6 teachers that year about the new technology and changed curricula, the main example of how to enact the integrated curricular approach drew on Indigenous perspectives in relation to the science of sound (in an integrated social studies, Indigenous music and poetry, and the science of sound activity). NSDE officials made it clear in their discussion that Indigenous perspectives were to be incorporated into the integrated curriculum lessons. However, the middle and high school science documents currently reflect minimal Indigenous perspectives—with the last update done more than 20 years ago, this is unsurprising. It remains unclear how the NSDE specifically expects Indigenous perspectives to be incorporated into middle and high school science activities at this juncture.

9.6 Concluding Remarks

Nova Scotia's current science curriculum was derived from a 20-year-old document, the *Common Framework* (CMEC, 1997); even the recently revised Primary through Grade 6 curricula still reflect the pedagogies expressed in it. However, the recent attempt to revise Nova Scotia's science curriculum, including the coding initiative, may have been halted in its tracks. With some resistance from teachers arising from a recent contract dispute (NSDE staff, personal communications, December 20, 2016), the provincial government appears to have paused curriculum development and revision. This hiatus is not necessarily a bad thing as the revision process was reportedly being conducted both quite quickly and without review external to the NSDE. The revision of the P–3 and Grades 4–6 science documents is rumoured to have been completed in less than a week by a team of three persons, none of whom had science expertise. This lack of external involvement in the process of curriculum design or evaluation is unusual, particularly when compared with science curriculum development in other provinces.

Recently, the province's five faculties of education have had undersubscribed BEd programs, some quite considerably, although there are reports that numbers have been higher in the last two years at some institutions. In addition, there are areas of the teacher preparation system that are problematic. These conditions seem to warrant a comprehensive re-examination of teacher education in general. Such a re-examination would, of course, include aspects of science teacher education raised in this chapter. It should not be surprising that this chapter concludes by calling for a thorough and critical examination of the science topics, and the sequencing of those topics, that are taught in Nova Scotia.

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