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Shunning the Bird's Eye View: General Science in the Schools of Ontario and Quebec

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Abstract This paper considers the adoption of general science courses in two Canadian provinces, Ontario and Quebec, during the 1930s. In Ontario, a few science teachers had followed the early general science movements in the United States and Britain with interest. During the 1930s, several developments made the cross-disciplinary, applied thrust of general science particularly appealing to Ontario educationists. These developments included a new demand for vocational education, renewed reservations about pedagogical rationales based on transfer of training, and a growing professional divide between high school science teachers and university scientists. Around the same time, scientists in the Quebec's French-language universities were engaged in a concerted campaign to expand the place of science in the province's francophone secondary schools. The province's prestigious classical colleges, which were the scientists' principal target for reform, privileged an inductive view of science that had little in common with the applied, cross-disciplinary emphasis of the general science courses gaining support in English-speaking school systems. In 1934, however, a popular American general science textbook was adopted in a workers' cooperative devoted to adult education. Comparing the fate of general science within these two education systems draws attention to the fact that general science made inroads in francophone Quebec but had little influence in public and private schools. In light of the growing support general science enjoyed elsewhere, we are led to explore why general science met with little overt interest by Quebec scientists pushing for school science reform during the 1930s.

1 Separating School Science from Scientists' Science

> While there can be no room for dispute in saying that a knowledge of the "laws" of physics and chemistry give a unity and perspective otherwise impossible, to include youngsters with a few

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> months' training among those who perceive this unity and benefit by this perspective, is to be rather optimistic. Here is a generalization, the reward of a long tedious journey, the endpoint possibly of a considerable amount of accurate quantitative work, generously presented to scientific babes and sucklings still toddling pathetically from chair to chair (Bowers 1936, p. 465).

So wrote Henry Bowers, principal of the normal school in Ottawa, Ontario and author of a new science textbook, *General Science: An Introductory Study of Our Environment* (1938), that would soon be introduced in Ontario high school classrooms. The textbook was created for a new course in general science that was piloted in Ontario's grade 9 classrooms in 1936. General science was by this time a movement with international reach, with proponents in the United States, Britain, and Australia as well as several Canadian provinces. In all these places, general science courses marked a departure from the customary disciplinary organization of high school science program into courses like physics, chemistry, botany and zoology. Instead, general science courses introduced topics that were intended to cut across scientific disciplines. They drew on examples such as municipal water supply, the work of the meteorological service, and "the relationship of plants to man." In doing so, these courses embraced applied science, which was held to be far more suited to students' natural interests than the abstract laws and theorems of the separate disciplines. As Bowers' remarks indicate, the scientific significance of abstract laws was assumed to lie beyond the grasp of young students, mere "scientific babes" that they were. John Rudolph (2005) has observed that this departure from the disciplinary canon of science made general science unique among high school science courses: it was the only science course that did not correspond to an academic field of study (p. 354). While university scientists had been instrumental in shaping the high school physics and chemistry courses of the late nineteenth century, the impetus behind the early American general science movement came from professional educators, not scientists.

General science curriculums attracted support in a variety of locales for distinctive reasons. In the United States, the general science movement emerged in Chicago, where it was closely allied with the work of educational psychologists, in particular John Dewey. It was in part a reaction against the perceived over-regimentation of the laboratory exercises that had become a defining aspect of the science curriculum in the last decades of the nineteenth century (Rudolph 2005, pp. 358–360). In Britain, general science was first advocated in 1916 by the Association of Public School Science Masters (APSSM), which protested the dominance of the classics in the public schools and pushed for mandatory science teaching. Efforts to promote general science reflected an ambition to give science a broader appeal, to make course content more relevant to young pupils, and to increase science's stake on the curriculum. According to Rod Fawns (1998), general science was exported to British colonies in Asia and Africa by Frederick Daniel in the mid 1930s. Daniel was a science master at a prominent British secondary school in Kuala Lumpur and had close ties to British promoters of general science. Here, general science was presented as a way to equip colonial students for careers in agriculture and industry. Daniel envisioned his textbook, *General Science for Colonial Schools* (1940), as "a practical contribution (within the existing fabric of English education) towards the solution of the problem of productive labour" (as quoted in Fawns 1998, p. 287). Daniel's textbook was then adapted to become Australia's first general science textbook (Daniel and Turner 1943).

In the mid 1930s, general science courses were introduced in two Canadian provinces, Quebec and Ontario. Unlike the other papers in this issue, this analysis is not a cross-*national* comparison, but it does highlight the important cultural differences between these two provinces. In Ontario, science educators closely monitored educational writings and practices in the United States and Britain. Over the first few decades of the early twentieth century, English Canadian national identity, particularly in Ontario, shifted from a strong allegiance to imperial Great Britain, which was galvanized by the Boer and First World Wars, to an emerging sense of independence and sovereignty following the Second World War (Buckner and Francis 2006). In matters of curriculum-making and textbook production, however, Ontario had been keenly committed to self-sufficiency since the late nineteenth century and was determined to produce and adopt Canadian rather than British or American textbooks in its public schools. In francophone Quebec, the historical roots of the education system lay with the Jesuit missionaries to New France. Even following the Conquest of 1759, after which France ceded all its Canadian territories to Great Britain, educational ties to France remained strong.

The 1867 British North America Act, Canada's first constitution, established a carefully negotiated division of powers between the federal and provincial governments in an effort to manage the significant cultural differences among the provinces. Education, which played an obvious role in cultural transmission, was placed almost exclusively within the jurisdiction of the provinces. While Ontario moved towards a centralized, non-sectarian public school system over the course of the nineteenth century, Quebec's education system was sharply divided along religious and linguistic lines. Quebec's French-language schools fell under the authority of the Catholic clergy, who fought to keep the provincial government out of the educational sphere. The Church repeatedly warded off efforts to create a provincial Ministry of Education in the late nineteenth century. Education was not turned over to the province until the Quiet Revolution of the 1960s, a period of intense social transformation during which Quebec society underwent rapid secularization.

In the distinct school systems of Ontario and francophone Quebec, educators often measured their own systems against those of other nations, vacillating between self-satisfaction and self-deprecation. When calling for reform, they denounced their schools, curriculums and textbooks as backwards and out of step. When defending the status quo, they portrayed their customs as the envy of other nations. Science educators in particular, who frequently associated science teaching with national economic success and technological superiority, were especially prone to drawing pointed cross-national comparisons. In Ontario, the general science movements in the United States and Britain were conflated and held up against the Ontario curriculum to highlight its "retrograde" emphasis on laws and theorems and its demand for memorization rather than problem-solving. In Quebec, professional scientists pointed to the failings of science education in the province as the source of French Canadians' poor showings in manufacturing and industrial pursuits, which were dominated by the province's anglophone minority.

To the extent that general science found a place in each province, it was allied to vocational education. In Ontario, despite initial advocacy from individual educators, general science found little institutional support until the late 1930s, when it was introduced as a universal science course for grades 9 and 10, explicitly uniting students in both technical and vocational streams. The general science course, designed for broad appeal, was a key ingredient of the harmonization of vocational and academic science education. In Quebec, meanwhile, general science found a minor niche in the mid-1930s in the world of adult vocational education with the publication of a French translation of a popular American textbook by Otis Caldwell and William Eikenberry, key players in the American general science movement. This paper considers the educational ideals that underlay the general science curriculum as it took shape in both Britain and the United States, and how these ideas alternately harmonized and clashed with educational priorities in Ontario and Quebec.

2 General Science in Ontario

2.1 Early Appeals for General Science in Ontario

Ontario educators could read about the ideas of the Chicago reformers in the journal of the Central Association of Science and Mathematics Teachers, *School Science and Mathematics*. The journal's business manager travelled to Toronto in 1905 for the annual meeting of the Ontario Educational Association (OEA), the province's major education conference. The journal earned warm endorsements and an interested readership among Ontario science teachers.[1] American science reformers found occasional sympathizers among Ontario science educators. One member of the OEA's natural sciences section, wielding a 1905 *School Science* article by physics educator John Woodhull, warned his colleagues about the enrolment declines in physics and chemistry signalled by American educators. Canadian teachers could not afford complacency, he urged: the curriculum needed more popular and applied science and less pure science and dry quantitative exercises. In short, it needed to start from the perspective of the student rather than the "science specialist" (Lennox 1905).

While the ideals of the nascent general science movement garnered notice in Ontario, they apparently did not cause much of a stir. The Department of Education certainly had other concerns. With a new provincial government in power, it was cleaning house, amending textbook policies that had long been mired in allegations of cronyism as well as managing the introduction of a new program of studies. If some OEA members harboured hopes for reform, others held up the province's conservatism as a point of pride. One teacher proposed that it was best to wait and choose cautiously. "Science, of all school studies, has been perhaps in most rapid pedagogic development; in Britain and the US this has found expression in outpouring of new texts," he noted. "We have shut ourselves off largely from this by our exclusive texts. Maybe, of course, it is a blessing in disguise. We may have escaped turmoil and confusion and be ready now for a calm conservative adoption of the best product and practice" (McCready 1907, p. 211).

During the second decade of the twentieth century, general science gained prominence in both Britain and the United States. In the United States, two education professors, Otis Caldwell and William Eikenberry, inspired by the ideas of John Dewey, developed a new course in general science that was founded on exercises in problem-solving. In 1914, the new course was published as a textbook, *Elements of General Science*, which would be issued in at least four more editions over the following two decades. In each chapter, students were presented with a problem (e.g., "How does water flow through pipes?") and guided through its solution (which they were presumably only supposed to consult after having attempted to solve it on their own). By the mid 1920s, every American state offered a course in general science, and between 1910 and 1925, more than thirty general science textbooks were published in the United States (Rudolph 2005, p. 386). Caldwell went on to chair the science subcommittee of the Commission on the Reorganization of Secondary Schools, whose 1920 report provided valuable sanction for general science (p. 385–386).

In Britain, meanwhile, the neglect-of-science campaign succeeded in getting the attention of the Prime Minister, who commissioned an enquiry into the state of science education. While this enquiry was underway, a committee of science masters wrote the pamphlet "Science for All" (APSSM 1916/1920), which would provide the framework for the British general science movement well into the 1930s. The report of the Prime

[1] For examples see OEA (1901, p. 20); (1902, p. 18); (1904, p. 25); (1905, p. 22)

Minister's commission, released in 1918, also drew heavily on the ideas articulated in "Science for All" (SMA 1936, pp. 6–9). Much like the American general science movement, the British movement emphasized the importance of responding to the natural interests of the student and taking a cross-disciplinary approach to the curriculum.

Ontario educators, who kept a close eye on educational developments in Britain and the United States, noted the growing attention garnered by general science. When education professor George Cornish issued an appeal for general science in 1921, he pointed to the findings of foreign educational commissions. Quoting extensively from both Caldwell's report and the British Prime Minister's commission, Cornish made a comprehensive case for introducing general science into Ontario high schools. Following the British and American movements, Cornish focused on the importance of cultivating students' natural interests. As he saw it, the disciplinary breakdown of science, central though it was to the identities of professional scientists, held little meaning to beginners:

> To the skilled scientist, the chief interest of a fact is that it affords additional evidence of a fine co-ordination of the facts of that science, but the pupil does not see that beautifully co-ordinated cosmos of facts and is not interested from that standpoint at all (Cornish 1921, p. 494).

Emphasis on the laws and theories of the special sciences should be reduced, he argued. General science operated from the student's perspective, not the lofty "bird's eye view" enjoyed by the accomplished scientist. Moreover, the age for mandatory school attendance would be raised from 14 to 16 in the fall of 1921, he pointed out. General science seemed to have more to offer to the new influx of students who would stay in high school for only a year or two before leaving for industrial jobs. "Does a course in botany, zoology, or even physics properly equip the boy who is going into the factory?" he asked. "For him especially the course in general science is almost a necessity" (p. 495).

2.2 Challenging Scientists' Role as Curriculum-Makers

It is worth noting that the arguments like Cornish's, which emphasized the stark differences between the student's and the scientist's respective standpoints, implied that scientists were not the best candidates for designing a beginners' science course. Indeed, the key figures in the early general science movement in Chicago were not scientists but educationists—people who occupied "an ambiguous position between the science research community and the lay public" (Rudolph 2005, p. 363). In Ontario, the professional divide between high school science teachers and university scientists had widened considerably since the nineteenth century. In 1920, for instance, high school teachers' efforts to have their research recognized by Canada's National Research Council fell flat. Having learned that the NRC was planning to establish a national laboratory in Ottawa, a group of science teachers in the OEA petitioned to be involved as key contributors.[2] They emphasized their qualifications, pointing out that the training of science masters was often "in no wise different from that of those at present engaged in [NRC] work." But their demands evidently met with a lukewarm reception in Ottawa: by the following year's OEA meeting, enthusiasm for this plan had fizzled out. The committee dropped its list of demands and noted that "while appreciating the value of Research Work among teachers…. [involvement will] be left to the initiative of individual members" (OEA 1919, 1920). In 1920, then, many science teachers still saw themselves—in

[2] The establishment of the national laboratory would in fact be delayed until 1932, but at the time it seemed like an imminent prospect (Enros 1991, p. 46).

their moonlighting at least—as independent research scientists. But this vision of their professional identity lacked institutional support and collective momentum. Original research was no longer an assumed part of high school science teachers' occupation.

Significantly, science teachers were expected to be generalists. General science, both in Britain and the United States, was just one manifestation of a pervasive aversion to specialization in secondary schools. In Ontario, likewise, educators continually emphasized that the high schools' mandate was to provide general, liberal education. Some argued that professional scientists, unlike educators, were inevitably specialists—and that the narrowness of their expertise was a handicap when it came to grasping a new learner's needs (e.g., Cornish 1921, p. 494). Queen's University principal William H. Fyfe, a British émigré, went so far as to express nostalgia for the heyday of Victorian science:

> A generation ago there were men who were scientists without being scientific specialists…. As an instrument of education that Victorian type of scientist held an immeasurable advantage over the botanist or biologist or chemist of to-day, whose attention is too often narrowed to one sub-division of one sub-branch of science (Fyfe 1934, p. 658).

Just as teachers were losing their identity as scientists, scientists were being subtly nudged out of the realm of pre-university education.

2.3 Education Research and the Problem of Transfer

While science teachers' professional identities gradually shifted, educational psychologists were steadily gaining influence in matters of pre-university education. The rise of educational research in the United States and its origins in the emerging science of psychology are well documented (e.g., Lagemann 2000). Canada's first department of educational research was founded at the University of Toronto in 1913 by Peter Sandiford, who had earned his PhD under Edward Thorndike at Teachers College Columbia. The Ontario College of Education, established in 1920 and affiliated with the University of Toronto, offered opportunities for graduate studies and doctorates in pedagogy and catered primarily to a clientele of headmasters and normal school principals seeking to advance their careers in the education system.

Henry Bowers, the science teacher cited at the opening of this article, was one example. After spending a few years as principal of a high school in Fergus, Ontario, he enrolled at the OCE in 1925 to earn a doctor of pedagogy degree. Bowers' thesis tackled the pressing question of transfer of training, a topic that interested Sandiford at the time and that Thorndike had repeatedly investigated (Sandiford 1928, pp. 284–300). Educational psychologists had been probing the longstanding dogma of mental discipline since the 1890s, seeking empirical proof that studying any one subject could provide intellectual skills that were transferrable to other fields.

In his doctoral research, Bowers tried to isolate the intellectual effects of individual subjects on Ontario's middle and upper school program (grades 10–13). His particular goal was to determine whether middle or upper school chemistry and physics yielded any discernible transfer of training in students, as determined by students' performance on standardized tests of his own devising. To ascertain this, he compared sets of students who had followed an identical program but for the presence or absence of one subject. By isolating the role of individual subjects, he hoped to determine the effects of studying physics and chemistry, as well as English, algebra, geometry, history, Latin and French, on students' reasoning abilities and observation skills. He sought to confront what he called "a curious lack of scepticism" among educators about the aims of science teaching.

"Assumptions pass unchallenged; unfounded theory becomes vested with authority by usage," he wrote (1927, p. 13).

Although hampered (as he admitted) by participant attrition and the impossibility of controlling for other variables, Bowers' research did not support transfer. "There is no evidence of either transfer or hindrance from Middle or Upper School Physics or Chemistry," he reported (p. 16). Performance differences were equally insignificant for the other school subjects he had examined. Moreover, Bowers assiduously surveyed the extant experimental research on transfer, reaching back to William James' pioneering investigation of memory skills in 1890. Finding fault with nearly all the studies (with the exception of a 1924 study by Thorndike), Bowers concluded that "at present, claims for the existence or non-existence of a *generic* transfer are without basis" (p. 37, emphasis in original).

The qualifier "generic" is significant. While many of the early studies on transfer yielded negligible or weak evidence for its effects, psychologists and educationists had not given up on transfer entirely. Researchers continually questioned and qualified the conditions under which transfer might occur. "Experiments in transfer show that the transfer is greatest when common elements are involved," wrote Sandiford in his 1928 review of the research on the topic (p. 299). The acknowledged limitations of transfer seemed to hold clear implications for curriculum-making and for the disciplinary basis of school subjects in particular. "The more technical a subject, the fewer common elements it provides for thinking to work with," noted John Dewey in the revised 1933 edition of his influential treatise *How We Think* (p. 67). Sandiford (1928) similarly argued that the paltry successes of transfer meant that school subjects could not be justified on disciplinary grounds. "If transfer proves to be a broken reed, then studies whose content is socially useful must be emphasized," he concluded (p. 298). In Britain, the Science Master's Association (SMA) remarked in its 1936 report on general science that appeals to disciplinary value seemed to be unfounded: "The *experimental* evidence has shown quite definitely that the possibilities of transfer of training are much smaller than had formerly been supposed." It was more productive to foster a positive *emotional* experience of science and to ensure that the beginner's first encounter with science was not boring, but stimulating and engaging, the SMA proposed (pp. 13–14).

Naturally, Bowers' research on transference shaped his views of science teaching in Ontario. In a 1936 essay in *The School,* Ontario's leading education journal, he argued that in light of the "pitifully few, and possibly feeble, experimental efforts" showing that science effected any real changes in pupils' attitudes or thought processes, it had become clear that the science program needed revising. Above all, science courses needed to provide students with "valuable information"—content that offered some perceptible application, whether ethical, aesthetic or utilitarian. "Do we not, in a fantastically unreal atmosphere to which custom has dulled our sensibility, teach facts no more useful or ornamental than the incorrect telephone numbers of fictitious citizens?" he asked (p. 463). The "ordinary" physics and chemistry courses were too fact-based, too ambitious in scope and too regimented to foster transference or to provide wider social value. Rather, an effective physics and chemistry course would need to provide "genuine research problems." It would need to reduce its fact-based content and stimulate the independent exercise of reason. Finally, it would need to relinquish its emphasis on laws and the supposed unity of perspective that they offered. In Bowers' view, as we saw at the outset, this was far too idealistic as a pedagogical starting-point. For Bowers, transference—particularly its role in promoting desirable attitudes, like a love of precision and accuracy and an inquisitive spirit—remained a compelling pedagogical goal for the science curriculum, but one that could not be accomplished without a new approach that presented students with compelling, real-life problems.

2.4 Humanizing the Science Curriculum

If one motivation for interdisciplinarity and non-specialization in the science curriculum came from critiques of transfer of training, a second impetus came from concerns for moral education. A central preoccupation within the general science movements both in Ontario and abroad was the need to "humanize" the teaching of science—to broaden science's appeal by, as one educator put it, "[clothing its] lifeless skeleton with living flesh and blood" (Fraser 1943, p. 433). This concern found expression in several ways, but particularly in efforts to integrate the history of science. Scientists of the past were held up as models of noble resolve and selfless diligence. Cornish wrote in 1921 that students should become "hero-worshippers" of scientists like Watt, Faraday, Pasteur and Cavendish and be "filled with enthusiasm to follow in their steps as much as in the steps of great soldiers or statesmen" (p. 449). James Donnelly (2002) has suggested that general science was just one iteration of the time-honoured project to "humanize" the teaching of science, an endeavour that reached back to the nineteenth century (p. 552). Anna Katherina Mayer (1997), meanwhile, has described how the British general science movement, in the wake of World War I, turned to the history of science as a tool to infuse the science curriculum with moral values. British educationists sought to prevent the perceived lapses of German science education, which was thought to have sacrificed morality to efficiency.

Calls to inject human values into the science curriculum revealed the entrenched dichotomies between science and the humanities—dichotomies between objectivity and emotion, utility and aesthetics, materialism and spirituality—that persisted in the public imagination. One Ontario university professor, for instance, declared in 1918 that while science had ushered in great material progress, it had simultaneously inhibited the emergence of a body of great Canadian literature (OEA 1918, p. 42). This duality was reinforced by many educators who assumed that the humanities and the sciences were competing influences on the moral, intellectual and emotional development of students. "The study of 'the humanities' gives sympathy, emotional refinement and a sense of values, but on that diet alone pupils are apt to grow passionate and pale," wrote Fyfe (1934). "They need also the corrective astringent of science" (pp. 659–660). Science students likewise needed the counteractive ministrations of the arts. One high school teacher reported that "A number [of students] told me that the science seemed to them what they described as 'too cold' to make them feel as much at home as in history, poetry, and some other subjects which have more of the 'milk of human kindness' in them." History of science, this teacher believed, was a "magic wand" that could be wielded to give the science course new vitality (Fraser 1943, pp. 434–435).

Yet even as educators turned to the history of science as an antidote to the cold rationalism of science, they regarded the singularly dispassionate nature of scientific thinking as a crucial stabilizing influence in society. In the mid-1930s, Canada, like many other nations, was gripped by economic crisis and growing apprehension toward the steady expansion of fascism in Europe. Sound scientific reasoning, it was hoped, offered protection against suggestibility, bigotry, and credulity. Science was held up as the archetype of critical thinking and cautious judgement. For Fyfe (1934), objective thinking and the uncompromising pursuit of truth, cultivated by the study of science, were sorely needed by a society that was ever more enslaved to advertising and propaganda. "If the eyes of the rising generation are to be cleansed, they must apply themselves properly to science," he wrote (p. 656). Well-trained intelligence was not only an intellectual asset but also a moral virtue:

> The active study of science is the best of all possible antidotes against the prejudice of mass suggestion and the lethargy of ready-made ideas. It breeds a healthy scepticism, a disinterested attitude of mind and an unrelenting passion for truth (Fyfe 1934, p. 659).

Bowers too, hoped that "scientific habits of mind" could be applied to wider society. He developed a keen interest in teaching students how to appraise propaganda and address social problems with clear thinking, particularly after the outbreak of the Second World War. He wrote a textbook for teenagers that dealt with how to critically evaluate propaganda (*Thinking for Yourself*, 1947) and he believed that a course on rational thinking would soon become a staple of the school curriculum (Bowers 1939, p. 97). Both Bowers and Fyfe contended that school science had failed in its mission to teach better thinking. Despite Fyfe's optimism about science's ability to foster objective thinking, he thought the curriculum did not require students to reason things through independently. For both, a general science course offered a way to overcome these problems and fulfill the social promise of school science: to foster sound thinking and to build a more cool-headed, rational society.

2.5 Science for All: General Science in Ontario High Schools

A new general science course was piloted in the 1935–1936 school year and introduced into Ontario high schools in 1937. Significantly, general science was introduced as a common course for all first-year (grade 9) high school students, which represented a significant departure from earlier practice. The Depression had brought an influx of students into the high schools as the need for unskilled labour dropped. The surge in enrolment, in turn, prompted greater attention to the social role of the high school and a new openness to progressive education. By the mid-1930s, Toronto hosted the largest Canadian chapter of the Progressive Education Association (Patterson 1986). "What had seemed somewhat idealistic in the individualism of the 1920s now appeared eminently practical in the depths of the depression," notes Robert Stamp (1982, p. 159). The interwar years saw the rise of composite high schools offering both academic and vocational programs in response to the diversified student body. Even where the two programs were housed in the same buildings, however, they typically had little to do with one another. This changed in 1937, when Deputy Minister of Education Duncan McArthur introduced a plan that called for a new, more flexible grade 9 program. The McArthur plan required all first-year high school students to follow a common curriculum in grade 9 before deciding, the following year, whether to enter the matriculation (university preparation) program, the vocational program, or the commercial program.

The new general science course comprised the first 2 years of high school science. The first year of the course was a staple of the newly integrated grade nine program. The course gave "to all pupils the practical training available formerly only in the technical department," observed one principal who piloted it in a composite high school (Wholton 1936, p. 681). The McArthur plan represented an important shift in the mandate of the high school, making it considerably more open to the "utilitarian" training that had long been anathema to the ideal of a broadly cultural education. According to one high school inspector, the program's goal was to "make our academic schools less academic and our vocational schools less vocational, in other words to provide in all secondary schools a kind of general education which will fit our adolescents for life—as individuals, as citizens and as workers" (quoted in Stamp 1982, pp. 161–162). In McArthur's view, however, the idea was not to steer students towards vocational education but rather to give first-year high school students a taste for school in the hopes of retaining them longer. The general science course, designed to appeal to students' "natural interests" and replete with concrete applications and examples of modern technology, dovetailed perfectly with the broad mission of the McArthur plan.

2.6 Rhetorical Uses of Cross-National Comparisons

Henry Bowers' textbook, *General Science: An Introductory Study of Our Environment* (1938), issued in two parts for grades 9 and 10, was one of two new textbooks written to match the new curriculum guidelines and authorized by the Minister of Education for teaching general science. In the acknowledgments, Bowers thanked George Cornish for his help and encouragement. For Cornish, who had first advocated for general science 17 years prior, the new course was a long-awaited achievement. It represented a pragmatic acknowledgement that most students would never go beyond grade 10 or take another science class. More important, it embraced a proper grasp of adolescent psychology. It recognized that students' minds were not suited to broad generalizations, but tended rather to focus on "very small concrete units of knowledge." It presented problems that would spring up naturally in pupils' minds—problems such as "Why do steel ships float?" or "How did plants and animals get their names?" Finally, it brought Ontario's science curriculum in line with prevailing practice. "We are two decades late entering the field of general science," he wrote.

> Let us not begin where others were a decade ago, but let us launch forth into this promising sea, of which modern educators in every field approve, but unto which only a few have had the courage to plunge. Ontario is too virile to be hanging on to the coat-tails of any man, whether he is the American author of a text-book in general science, or the maker of a British course of study. It is time she was in the van[guard] (Cornish 1938, p. 791).

Even as Bowers' textbook drew interest in other provinces and secured official authorization in New Brunswick, others lamented the inferiority of Canadian general science textbooks. A chagrined reviewer of an American textbook series, writing in *The School*, noted grimly, "A careful study of this set of books covering a three-years' course in general science makes a Canadian teacher almost sick with envy to think what stimulating and attractive books are put into the hands of pupils in the United States" ("Science" 1940, p. 794). Such remarks, however, should be taken with a grain of salt. As W.H. Brock (1990) has pointed out, drawing comparisons with foreign education systems was a ubiquitous strategy among educationists looking to spur change in their own countries. Such comparative arguments were often "relative and rhetorical," he notes (p. 948). As will be shown below, Quebec educators were painting similar comparisons to underscore the urgency for reform in that province.

But while some educators castigated Canada's backwardness, others defended its prudence. In 1938, Peter Sandiford surveyed the new curriculums instituted in several Canadian provinces in the late 1930s and remarked with satisfaction that Canadian educational systems had avoided the pitfalls of American excess. While Teachers College, Columbia had more than 30,000 curriculum revisions on file, Canadians could be "thankful … that we have been spared these frequent upheavals."

> Our neighbours to the south, distracted by the restlessness and continuous change in every department of educational work, envied us our stability. It is a feature of our education that we should cherish (Sandiford 1938, p. 474).

On the force of such cross-national comparisons, educationists like Cornish and Sandiford heralded the school reforms of the late 1930s—including the new general science course—as the culmination of decades of caution and (sometimes plodding) deliberation and the beginning of a new progressive era in Ontario education.

Some science educators in the Ontario Educational Association had followed the development of the general science movement in the United States and Britain since the early 1900s. Given this, it can be tempting to see Ontario's eventual adoption of a general science course as a historical inevitability—a modernization that came "two decades late," as Cornish put it. Certainly, by the 1930s, general science had come to be associated with specific educational outcomes both in Ontario and abroad. It was considered especially well-suited to students headed towards jobs in industry; its emphasis on technological applications was assumed to hold immediate relevance and appeal to young students; and finally, its emphasis on problem-solving promised to develop reasoning skills in students that could help them become rational, judicious citizens. These expectations of general science as a school subject had solidified partly due to the work of Ontario educators like Bowers and Cornish, but also due to the advocacy of educators in Britain (e.g., SMA 1936) and the United States.

In 1930s Ontario, several factors conspired to make the educational goals linked to general science particularly desirable. The Depression placed enrolment pressures on the high schools and prompted increased support for vocational education. A growing scepticism about transfer of training placed a new premium on concrete, "useful" curriculum content. Concerns about mass irrationality, caused in part by the rise of dictatorships in Europe, prompted some educators to look to school science as a training ground in sound thinking. Finally, the changing professional boundaries between high school science teachers and university scientists, compounded by psychological research that differentiated the scientist's perspective from the student's needs as a learner, loosened the ties between school science and the disciplinary organization of science in the universities. Many of these developments were absent in the francophone school system of Quebec in the 1930s. Accordingly, even though a translated version of Caldwell and Eikenberry's general science textbook came on the market in 1934, general science had minimal influence in Quebec's French-language public and private secondary schools during this period.

3 General Science in Quebec

3.1 Education in French Quebec

In Quebec, French and English public schools operated under the jurisdiction of two separate confessional school committees, Catholic and Protestant, which had operated fully independently of one another since the late nineteenth century. The Protestant system was by necessity non-sectarian, and perhaps as a result less overtly religious. In the Catholic system, by contrast, the influence of the clergy pervaded all levels of schooling, both public and private, from the university boardroom, where senior clerics presided over administrative decisions, to the primary school classroom, which was often led by a monk or a nun from a teaching order. The linguistic, religious and administrative dichotomy that defined these two systems had profound consequences for secondary education in the province. The Protestant system, which encompassed the vast majority of English schools, followed the reigning North American model of secondary education by establishing free, uniform, public high schools. The French Catholic secondary school system, for its part, comprised a mix of disparate institutions administered by separate bodies. This comparison focuses exclusively on Quebec's French Catholic schools.

Among Catholic secondary schools, there was a particularly sharp demarcation between the public and private sector. Until the late 1920s, there was little opportunity for students to move from one to the other. Model schools (*écoles modèles*) and academies (*écoles académiques*) came under the public system, and covered the four primary grades along with 2–4 years of *supérieur,* or secondary education. These public schools were not, however, a direct gateway to the universities. The structure of public secondary education was the subject of an ongoing dispute among Catholic educators. Monks in the teaching orders advocated for a system analogous to North American high schools, while the bishops on the Catholic committee of the Council of Public Instruction sought to preserve the élite classical model of secondary education (Charland 2005, pp. 90–91). Over the course of the 1920s, the *modèle* and the *académique* were replaced by a two-year *cours complémentaire* (complementary course) and a three-year *cours primaire supérieur* (advanced primary course) akin to the public secondary courses instituted in France in the 1880s (Troger and Ruano-Borbalan 2005, pp. 16–35).[3] Notably, no mandatory attendance laws were passed in Quebec until 1943. Such measures were proposed several times starting in the late nineteenth century, but were persistently resisted by the clergy as state encroachment into education (Audet 1970, p. 339).

In the private sector, the province's Catholic classical colleges offered an élite secondary education in the form of an eight-year *cours classique* (classical course) rooted in the Jesuit tradition. These colleges were privately run by religious orders, and they represented the standard avenue to the priesthood, the liberal professions, and university studies. Students entered around the age of twelve and graduated at twenty, progressing stepwise through yearlong courses in "Latin elements," Syntax, Method, Versification, Literature, Rhetoric, and Philosophy I and II. The classical course was an exclusively male domain until 1908, when the Congregation of Notre Dame finally got approval to open the first classical college for girls in Montreal.[4] The colleges' program was overseen by the Université Laval and the Université de Montréal, which administered the final examination and conferred its prestigious degree, the *baccalauréat ès arts*.[5] Although Quebec's classical colleges preserved many of the traditional features of French *Ancien Régime* era classical education, they also introduced modern elements such as commercial programs: by 1900, for instance, fifteen of the nineteen extant colleges offered commercial programs (Charland 2005, p. 104). Like the French *lycées*, classical colleges remained highly selective well into the twentieth century.[6] Unlike the secular *lycées*, however, they were

[3] The teaching brothers pressured the Catholic committee by running the *primaire supérieur* course independently until the committee caved and welcomed it under its auspices in 1928.

[4] Even so, by 1953, less than 1 % of French Canadian girls were enrolled in secondary school (Magnuson 1980, p. 97).

[5] One exception was the colleges run by the Compagnie de Jésus, which were independent (Corbo 2004, p. 12).

[6] According to Troger and Ruano-Borbalan (2005), enrolments in French *lycées* represented less than 15 % of age group (chap. 1, pt. VII). In Quebec, in 1946, fewer than 25 % went beyond 8 years of total schooling, and only about 2 % finished secondary school (Corbo 2004, p. 14).

emphatically Catholic institutions: they were fundamentally committed to religious education and remained gateways to the priesthood. Indeed, Quebec's colleges were safeguarded as bastions of Catholic, French-Canadian national identity. Indeed, Charland (2005) suggests that many of the first colleges were established to protect Catholic children from the influence of English schools (p. 103).

3.2 Science Education in Quebec's French-Language Secondary Schools

As gatekeepers of the liberal professions in French Canadian society, the classical colleges were heavily invested in a traditional liberal education. Their professed goal was the provision of *culture générale*, or well-rounded knowledge. Unlike secondary schools in France, where a science program leading to the *baccalauréat ès sciences* had been offered (on and off) since the early nineteenth century, Quebec colleges resisted instituting an alternate baccalaureate until 1953, when the Latin-science option was created (Audet 1971, p. 289). Nevertheless, as of the mid-nineteenth century, the baccalaureate exam typically required some basic knowledge of physics, chemistry, mathematics, chemistry, mineralogy, geology and botany (Chartrand et al. 1987, p. 218). Science courses were usually confined to the Philosophy courses of the final two years. Science teaching remained abstract and theoretical, a complement to the humanities in the college students' general cultural polishing. Science's role within the classical course was not seriously challenged until the 1920s.

Following a pattern previously exhibited in many other places, school science in Quebec came under close scrutiny with the creation of a community of research scientists within the province's universities. The provincial government had proposed setting up a faculty of science at the Université Laval in the 1870s, but the clergy strongly resisted this as unwanted government intrusion into the realm of French-language higher education, which had long been the preserve of the Church.[7] The watershed moment came in 1919, when the Montreal branch of the Université Laval finally managed to gain independence from its Quebec City headquarters, and the Université de Montréal was founded. One of the first orders of business of the new university was to establish a faculty of science. In response to the stimulus of competition, Laval quickly followed suit and established a faculty of chemistry in 1921.

The professors who were appointed to run these science faculties were hired on the basis of their credentials as research scientists. Most had studied abroad in European research universities. These newly appointed scientists emerged as an influential group of activists who took up the cause of promoting science in Quebec. This cause became all the more pressing in the 1930s, when the Depression hit the universities hard. With the survival of science laboratories in jeopardy, Quebec's francophone scientists became convinced of the need to raise popular support for science in the province (Chartrand et al. 1987, p. 260–262).

The scientists decided to focus their promotional efforts on two main targets. The first was secondary education. Indeed, the primary function of the science faculty at Montréal

[7] Université Laval was established in 1852, when the Séminaire de Québec was granted university status by a Royal Charter. It fell under the authority of the Vatican's Congregation for Catholic Education until 1971, when it acquired a new charter and became a fully independent, secular university. The clergy's authority over higher education extended only to the French-language universities. The English, Protestant McGill College (later University), which was English-language and Protestant, was a public institution.

was the training of secondary school teachers, who constituted the bulk of the faculty's enrolment. The reformers were particularly concerned with the teaching of science in the classical colleges. The colleges were the training grounds for the intellectual and social élite of francophone Quebec, and the reformers insisted that the colleges' role should be expanded to include the training of top scientists. The professors launched their campaign in the journal of the province's classical colleges, where they sometimes drew heated rebuttals from defenders of the traditional curriculum who believed that the reformers' attacks opened the door to state education and secularisation (Galarneau 1978, pp. 221–227). The reformers' second major project focused on popularization, including an extremely successful movement known as the *Cercles des jeunes naturalistes* (Young Naturalists' Clubs). The *Cercles des jeunes naturalistes* (CJNs) were clubs for children and teenagers modelled after the Scouts, and their central theme was scientific fieldwork and specimen collection. The tremendous success of the CJNs was widely acclaimed in educational journals, and even led to spinoffs such as the *Cercles des jeunes agriculteurs* (Young Agriculturalists' Clubs).

3.3 School Science and the Advancement of Scientific Disciplines

In Ontario, educationists were the driving force behind science education reform in the 1920s and 1930s, but in Quebec it was professional scientists who led the push for school science reform. In an effort to improve the lot of science both in the classical colleges and the public schools, they emphasized recruitment. Adrien Pouliot, a chemistry professor at Laval, issued an earnest plea for science teaching in a series of six articles (1930–1931) in *L'enseignement secondaire*, the journal of the classical colleges. In his opening piece, he charted the professional occupations of classical college alumni in order to highlight the dearth of students who had chosen scientific careers. For Pouliot, as for many of his colleagues, the welfare of science education in the province was central to the prosperity and self-determination of the French Canadian people. Famously, Pouliot (1930–1931) threatened that unless French Canadians stepped up their participation in industry and commerce, "we will be conquered a second time" (p. 466).

It is not surprising that these reformers, speaking out as professional scientists, maintained strong disciplinary allegiances. They frequently made cases for the specific contributions of their respective fields, publishing essays with such titles as "The place of chemistry in secondary education" and "The teaching of biology and the training of the mind."[8] As they pushed for more science in francophone secondary schools, they were galvanized by a sense that the contents of a revised science program were still undecided. Scientists no doubt had an interest in promoting their own fields, since a steady demand for courses at the secondary level helped ensure the wider institutional success of their discipline.

In this climate of advocacy and campaigning, when the stakes were institutional security, professional prestige, and the promise of national economic success, key aspects of the educational philosophy of general science were unlikely to find much traction. General science proponents abroad had called into question scientists' role in pre-college education and downplayed the disciplinary value of science. In Quebec, scientists were at the helm of education reform, and disciplines were in competition with one another for resources, time, and recognition in the province's schools.

[8] See, for example, Diament 1933; Lortie 1934; Morin 1934; Dalbis 1923; Flahaut 1927.

3.4 General Science and the Classical Course: A Clash of Ideals

Certain elements of the ethos of general science also clashed with the pedagogical principles of Quebec's eight-year classical course. The classical colleges remained rooted in a highly structured, stepwise progression through the 8 years of the course. A methodical, Baconian understanding of science underpinned the student's progress through the eight-year program. Science learning was conceived as a strictly inductive process, guiding the student from object lessons in the program's early years, to "philosophy" (i.e., generalizations and laws) at its culmination. For instance, Léon Lortie (1934), a professor of chemistry at the Université de Montréal, argued that chemistry contributed to general knowledge "only insofar as it follows the logical method":

> observing, learning and collecting facts; comparing them, grasping the relationships between them and classifying them. Then, by means of analysis and reasoning moving from the known to the unknown, generalizing…; becoming initiated to scientific induction in order to establish for oneself the laws of nature; passing thereby from the concrete to the abstract, drawing conclusions from premises based on experience; synthesizing all this knowledge in a harmonious whole (Lortie 1934, p. 256).

The student's gradual advance from empirical facts to laws and structures demonstrates a deliberate emphasis on laws and theories—an emphasis that general science had jettisoned. Likewise, Université de Montréal geology professor Léo Morin (1934) would argue in *L'enseignement secondaire* that the practice of science, which drew on skills of observation, classification, comparison and synthesis, represented "the complete cycle of human thought" (p. 376). Morin further argued that science should not be taught by considering each branch in isolation, but rather by emphasizing the connections among its branches. Despite their distinctive techniques and methods, the various fields of science culminated in a common end-point, namely, the general principles of physics and chemistry (p. 377).

Morin's reflections on the reductionist unity of science highlight just how far removed the reformers' aspirations for secondary science education in Quebec were from the educational philosophy of the general science movement as it found expression in Ontario. Cornish had stressed that students' minds thrived on small bits of concrete knowledge and that the laws of science were too remote to be a relevant pedagogical endpoint. In the United States, the general science movement had embraced Dewey's account of a "complete act of thought" in *How We Think* (1910, rev. ed. 1933). For Dewey, thinking was fundamentally a process of problem solving, and the steps of thought included identifying the problem, proposing solutions, testing them, and drawing conclusions. Dewey did not intend this to be understood as a strictly inductive process. Morin's pedagogical arguments, rooted as they were in interdisciplinarity and the unity of science, were therefore put to a very different purpose than similar arguments raised by general science proponents. For Morin, the connections among the branches of science pointed to a fundamentally reductive understanding of science. This bird's eye view of science's disciplinary structure, gleaned from the vantage point of the mature scientist, was just what the general science movement held to be largely irrelevant to the young pupil.

3.5 An American Textbook in Quebec

Despite these pedagogical differences, general science nevertheless made one notable appearance in Quebec. In 1934, a French translation of Caldwell and Eikenberry's *Elements of General Science*, the iconic American general science textbook first published in 1914, was issued by the Quebec publishing house Garden City Press (Caldwell and Eikenberry

1934). The press was owned by James John Harpell, an enterprising businessman who was strongly influenced by the workers' cooperative movement. The translation and adaptations were done by Louis Even, an employee of the press, and W.L. Goodwin, former Dean of the Faculty of Applied Sciences at Queen's University in Kingston. Revisions were overseen by two Trappist monks at the Institut Agricole d'Oka, Brother Léopold (Ortiz), the director of the Oka school, and Father Louis-Marie, author of a celebrated Quebec flora.

The translation project was likely undertaken first and foremost for the benefit of the press's own employees. Harpell was an autodidact and a firm supporter of adult education. He had expanded his Kingston-based publishing business to the small francophone community of Ste.-Anne-de-Bellevue, near Montreal, in 1918. Inspired by Sir Ebenezer Howard's garden city movement in Britain, Harpell decided to create a workers' community, which he named Gardenvale, where his employees could live and take night classes. One of Harpell's guiding purposes as a businessman was to promote workers' education through "self-study." In 1922, he established the Institute of Industrial Arts as the educational wing of Garden City Press. Employees were strongly encouraged to take courses and were given a raise for every course they completed. "Learn More, Earn More," was the motto printed on the cover of every course (Quarter 2000; Vincent 1996). Goodwin and Even, the translation-adaptation team for the general science textbook, were both instructors for night classes at Garden City Press.

Whatever his primary motivations for commissioning the textbook's translation, Harpell would have wanted to turn a profit with the initiative. This would plausibly explain why he sought the endorsement of the monks at the Institut Agricole d'Oka, whose only tangible contribution seems to have been writing the book's preface. In the preface, Léopold (1934) positions the textbook within the recent popularisation movement initiated by French Canadian scientists:

> The publication of this book… brings timely encouragement and support to the wonderful movement launched here a few years ago for the study of the natural sciences—for the study of the laws of nature. The creation of the *Cercles de Jeunes Naturalistes*, whose numbers continue to grow from year to year, was inspired by the innate fondness of young people for the things of nature (Léopold 1934, p. iii, my translation).

Léopold makes no mention of the textbook's fundamentally interdisciplinary approach, except to note that the student of nature required at least a smattering of knowledge from various scientific disciplines:

> [T]he study of nature itself cannot go far without at least introducing the most elementary notions of physics, chemistry and mechanics. This book will initiate the student who has not had the advantage during his school years of broaching these subjects, whose applications turn up frequently in daily life (Léopold 1934, p. iv, my translation).

In Léopold's view, the new textbook was particularly well suited to the self-taught learner. He notes that the material is presented simply enough that anyone able to read could make progress, if they were willing to sacrifice a little leisure time to study. Clearly, Léopold assumed the book's niche was for autodidact adults who had had little exposure to science during their formal schooling.

There is no apparent evidence that the new textbook was used in any classes at the Institut Agricole d'Oka, nor even that it was acquired by their library. Nevertheless, Léopold and Louis-Marie's commendation may have helped the textbook's bid for authorization by the Catholic committee of the Council of Public Instruction. In 1935, the translated textbook was approved for used in primary schools—not for student use, but rather as a teachers' manual and as a reference book for school libraries ("Documents officiels" 1935). Marketed as a primer, it remained unlikely to find a foothold within the private classical colleges, where science courses were still confined to years 7 and 8, Philosophy I & II, and heavily focused on laws and synthesis.

The official sanction of an American textbook in translation was the exception rather than the rule in Quebec's francophone schools. Paul Aubin (2007) notes that less than 5 % of Quebec textbooks were imported or translated. The vast majority of these imported books came from France (p. 238). Indeed, the Caldwell and Eikenberry textbook appears to be the only American textbook to be approved by the Catholic Committee of the Council of Public Instruction. Textbooks were a lucrative industry in francophone Quebec. Home-grown textbooks were also an important symbol of self-sufficiency in matters of education, as they were in Ontario. The burgeoning francophone research community in the 1920s and 30s celebrated the publication of new science textbooks that could replace imported French ones, and they chronicled the history of science in Quebec by publicizing the legacies of influential scientists of the past (e.g., Lortie 1937). Yet the impact of "attractive" American general science textbooks—which was lamented by the Ontario reviewer quoted above—had been felt as far away as Australia (Fawns 1985, p. 173). This was apparently just as true in Quebec. Andrée Dufour (2007) has observed that the French edition of *Elements of General Science* featured layout and content that were noticeably more modern than those of contemporary Quebec science textbooks.

In Quebec, where educators were increasingly making allegations about Quebec's deficiencies in comparison to other places and looking outwards in order to modernize school programs, general science was granted limited approbation, but only insofar as it matched the prevailing purposes of Quebec's educational traditions. Divorced from its original mandate and subsumed instead within vocational education and the pressing efforts of popularization, general science in Quebec served as an instrument of science reform in a way that its creators, the original Chicago reformers, would not have envisioned.

4 Conclusion

Ontario and Quebec educators were influenced by their cultural ties to Britain and the United States, on the one hand, and France, on the other—but also by their desire for self-sufficiency and self-determination. The strong networks of communication between the educational communities in Ontario and the United States, via educational journals and other published materials, meant that Ontario educators were keenly aware of the incipient general science movement emerging from Chicago. While a few expressed admiration for the American reforms, this was not sufficient impetus for adopting general science wholesale in a strongly centralized school system where caution and conservatism were cherished values. Rather, several concurrent developments combined to prompt its adoption. A growing skepticism about the extent of transfer of training meant that educators were ready to relinquish the idea that studying science necessarily conferred general intellectual skills. If transferrable mental competencies were not a viable pedagogical goal, it became more imperative that content of science courses be directly applicable to students' lives. General science, which was rooted in practical problem solving and concrete applications from everyday life, seemed to offer a promising way forward. Its approach was all the more appealing given the efforts during the late 1930s to harmonize vocational and academic science education in the early years of high school.

Francophone Quebec had few ties with American or British educators. Rather, it looked to France, albeit often critically. Quebec educators compared their classical course to France's secondary programs to underscore the need for an expanded science curriculum. In the 1920s and 30s, Quebec scientists fought for cultural and institutional support for science by arguing that scientific excellence was essential for French Canadian society to compete in a global economy. In fact, many of the scientists who spearheaded this movement would later become involved in nationalist politics. Galvanized by the possibilities of an expanded science curriculum, scientists were keen to promote their own disciplines, so the interdisciplinary nature of general science would have held little appeal. Where general science was adopted, it was by an anglophone business owner concerned with the vocational education of his employees. There is little evidence that French Canadian educators engaged with the general science movements in English-speaking countries. Their attentions lay elsewhere.

As we have seen, examining the ways in which educators in Ontario and Quebec interacted with the ideals of general science brings into relief the different priorities that were at play in their respective social contexts. In drawing such comparisons, apparent indifference can be as revealing as direct responses. Comparative analysis can make silences conspicuous where they might otherwise seem unremarkable. The absence of a general science movement in Quebec becomes noticeable only when science education in the province is contrasted with that in the neighboring province of Ontario. In the historiography of Quebec science education, it has not previously been asked why Quebec did not interact with the general science movement. Such a question remains invisible to those pursuing internal histories. By searching for general science in Quebec, our attention is drawn away from the established historical narratives of science education to a seemingly minor incident on the margins, the publication of Harpell's translated textbook. The production of this textbook, which ended up being approved for use in public schools, indicates that general science was a genuine alternative for Quebec educators and not a moot point. Cross-national comparisons bring into evidence a range of historical contingencies that would otherwise escape our notice.

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