Soil 4 Youth: Charting New Territory in Canadian High School Soil Science Education

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ABSTRACT  As global issues continue to place increasing demands on soil resources, the need to provide soil science education to the next generation of soil scientists and the general public is becoming more imminent. In many countries around the world, including Canada, soil is either not included in the high school curriculum or it is not covered in depth. To address this need for better integration of soil science into high school programs in Canada, a national collaborative program entitled Soil 4 Youth (soilweb.landfood.ubc.ca/youth/), was established in 2009. The goals of the Soil 4 Youth program are to: (1) promote the discipline of soil science to high school students and teachers, (2) create open access soil education resources that can be directly implemented in high school curricula in Canada, and (3) raise awareness about the importance of soil. During the initial 4 years of the Soil 4 Youth program, we developed a variety of soil education resources, struck collaboration with several provincial high school teachers’ associations and not-for-profit organizations focused on promotion of science, and focused our efforts toward reaching a broader group of high school teachers and students. Our initial efforts of building the Soil 4 Youth program indicate that it is a viable platform through which collaboration among Canadian soil scientists and high school teachers can take place to ensure that high school students are better informed about the importance of soil.

Impact Statement  The Canadian collaborative program, Soil 4 Youth, was established to promote the discipline of soil science to high school students and teachers. The program provides a platform for collaboration among soil scientists and high school teachers to ensure that high school students are better informed about the importance of soil. This article describes the development of the Soil 4 Youth program, offering insights into the challenges and potential solutions to advance soil science education for youth.

Soil is one of Earth’s key natural resources. As a foundation for all terrestrial vegetation, soil supplies human civilization with food, fiber, and fuel. Soil also plays essential roles in filtering water, supporting biodiversity, and moderating global climate change. Soils around the world are being degraded at an unprecedented rate through pollution, wind and water erosion, compaction, or loss of organic matter, and taken out of production due to urbanization and industrial development (Janzen et al., 2011). These stressors threaten our ability to feed the Earth’s growing population, projected to grow to 9 billion by 2050 (United Nations, 2011). At the same time, the increasingly more urbanized general public has a very limited understanding of the important roles of soil and the need to sustain it against these numerous threats. There is an increasing disconnect between the urban population and the land because most urbanites are not aware of the vast distances their food and fiber travel from where they are produced (Brown, 2009). Most soils in urban environments are hidden under roads, sidewalks, and grass lawns, and they are not a central focus of city dwellers’ daily lives. This disconnect is even further exacerbated by the almost complete lack of soil science in the curricula of elementary, middle, and high school programs of many countries around the world (Geyer et al., 2004; Landa, 2004).

Beyond a lack of awareness about the importance of soil among the general public, the majority of students in colleges and universities also miss training opportunities on this important subject. At the postsecondary level, soil...
science is generally taught as part of agricultural sciences and forestry programs, which are also shrinking and/or disappearing, and less commonly in earth and environmental sciences (Baveye et al., 2006; Sharik et al., 2012). Soil science curricula often focus on the importance of soil for plant growth, and less attention is given to soil’s role in maintaining other environmental services (e.g., carbon sequestration, water filtration and storage, biodiversity). As a result, natural resources management and policy decisions are left to decision-makers who do not fundamentally understand soil processes and roles of soils in the broader environmental context. The need for the enhancement of soil science education and provision of adequate soil information has been highlighted by various international organizations, including the United Nations (UN Millennium Project, 2005; UN Development Programme, 2007) and Intergovernmental Panel on Climate Change (Hartemink, 2008).

**Need for Soil Science Education in High School Programs**

The integration of soil science into the high school curriculum is important because it addresses the broad issue of the lack of public knowledge about the importance of soils in a global context, which in turn will enhance overall scientific literacy of the general public (Ayala, 2004). Exposing secondary students to soil science will also spur more advanced training in this field.

Hayhoe (2013) recently reviewed Canadian and international elementary, middle, and high school programs with regard to soil science topics and found that soil science is explicitly mentioned in high school curriculum documents of several Canadian provinces, various states in the United States, and in South Africa, but not as frequently as other sciences such as geology and astronomy. One of the few encouraging examples of initial integration of soil science into the high school curriculum in Canada is from Ontario, where soil science components have been incorporated to increase understanding of the fundamental concepts of ecosystems and sustainability (Ontario Ministry of Education, 2007). Courses including Science 9, Biology 11, Chemistry 11, Environmental Science 11, and Earth and Space Science 12 all have specific expectations related to knowledge of soil properties and processes. In many cases, however, the depth to which the subject area is explored depends on the teacher’s interest and experience. Education programs with a soils emphasis outside of secondary school curricula, such as Envirothon Canada (Envirothon Canada, 2013) and Ontario Envirothon (Ontario Envirothon, 2013) have been initiated by interested and enthusiastic teachers, but those programs only reach a small proportion of high school students Hayhoe (2013).

Another Canadian example of soils education in secondary curricula is from British Columbia, where although principles of soil science are not explicitly incorporated into any of the learning outcomes for high school courses, they are indirectly implied through broader, upper-level courses such as Sustainable Resources 11/12 and Earth Science 11 (BC Ministry of Education, 2013). As an example, one Prescribed Learning Outcome (PLO) in Sustainable Resources 11/12 under the “Agriculture” unit is “It is expected that students will: assess current practices related to sustainable management of agricultural resources in British Columbia” (BC Ministry of Education, 2008). A key facet of sustainable management of agricultural resources is proper soil management, whereby soil science principles can be taught in this context. In Saskatchewan, soils are implicitly included in discussions of nutrient cycling (carbon, nitrogen, and oxygen) in Science 10 (Saskatchewan Curriculum, 2005) and are slated for increased coverage in a grade 11 course, Environmental Science 20, which is currently being developed (Saskatchewan Ministry of Education, 2012). The latter will address the role of soils in the context of terrestrial ecosystems, including linkages to agriculture and food production, but once again, soils will be just one component of a much broader course.

Despite these initial sporadic examples of bringing aspects of soil science into high school programs in Canada, there is a need to improve soil science exposure to high school students. Hayhoe (2013) summarized several studies of high school students’ knowledge of soil science and found a wide variability among students in terms of their understanding. In one example, students thought the depth of soil was between a few centimeters and 100 meters (both generally extreme). When given a chance to learn about soil, high school students were generally keen to engage with the subject matter. A study by Moebius-Clune et al. (2011) involved 48 secondary school students in the state of New York using hands-on-field-based enquiry lessons on water infiltration and runoff and showed that students enjoyed the lessons. Students also stated that they overwhelmingly preferred that type of learning to typical secondary school laboratory experiments as they learned how to work in a team as research scientists do. The initiative to bring soil science into the high school curricula cannot solely be left to secondary school teachers, who often lack knowledge about the discipline (Landa, 2004), but also requires active involvement of professional soil scientists. It is imperative that soil scientists become involved in communicating the relevance and excitement of working in this field to youth (both at high school and university levels), especially since knowledge about soil resources is more vital today than ever before, due to ongoing pressures brought about by climate change, growing populations, and a shrinking available land base.

To address the need for better integration of soil science into high school (grade 8–12) programs in Canada, we established a national collaborative program entitled Soil 4 Youth in 2009. The goals of the Soil 4 Youth program are to: (1) promote the discipline of soil science to high school students and teachers, (2) create open access soil science educational resources that can be directly implemented in high school curricula in Canada, and (3) raise awareness among high school students about the importance of soil in the context of global issues. This article describes the development of the Soil 4 Youth program in Canada, offering insights into the challenges and potential solutions to advance soil science education platforms for youth.

**DEVELOPMENT OF THE SOIL 4 YOUTH PROGRAM**

During the mid-2000s at annual general meetings of the Canadian Society of Soil Science, action on the revitalization of soil science in Canada was identified as a priority. One outcome was the establishment of a core group that focused on the exploration of possibilities of enhancing soil science education in Canadian high schools (Table 1). The Soil 4 Youth program development team consists of university and government scientists, graduate
students, soil science practitioners, multimedia/information technology specialists, instructional designers, and educators from six Canadian universities (The University of British Columbia, Vancouver; University of Saskatchewan, Saskatoon; University of Toronto, Mississauga; Laurentian University, Sudbury; Carleton University, Ottawa; and Dalhousie University, Halifax) and a federal research organization (Natural Resources Canada–Canadian Forest Service, Sault Ste. Marie, ON). Establishment of the Soil 4 Youth program and development of the online educational resources were supported by the Canadian Society of Soil Science. The timeline of the key events during development and initial delivery of the Soil 4 Youth program is shown in Table 1.

The initial idea quickly garnered interest among other scientists and graduate students. In 2010, the group obtained funding for 3 years from the Natural Sciences and Engineering Research Council of Canada's PromoScience Program, which provides financial support for organizations working with young Canadians to promote an understanding of science and engineering, and the Soil 4 Youth program formally commenced.

The Soil 4 Youth program team built extensively on the experience of team members who had been engaged in developing online soil science educational resources for the post-secondary level through their involvement with the Virtual Soil Science Learning Resources Consortium (Virtual Soil Science Learning Resources, 2013) and other programs and initiatives. The Soil 4 Youth program is delivered through an open access website (soilweb.landfood.ubc.ca/youth/, accessed 24 Apr. 2014), which serves as the main hub of educational resources for high school students and teachers and facilitates interaction among the team members. Material developed in the initial year of the Soil 4 Youth program focused on communicating the soil science research projects of the team members to a high school audience. This approach allowed soil scientists on the team to begin creating content on topics they were familiar and comfortable with developing. In the following years, additional information and resources were added, particularly lesson plans and activities that could be directly implemented in high school classrooms. This was accompanied by ongoing refinement of the material and the website based on feedback gathered from high school teachers and students, as well as undergraduate and graduate students and university recruiters. In addition, we are also making refinements of the Soil 4 Youth program’s website using online website evaluation tools (Business Development Canada, 2014).

Once material was posted on the website, the focus shifted to reaching a broader community of high school teachers, as they are the key avenue to bring the topic of soil science and Soil 4 Youth program resources to secondary students. By the Soil 4 Youth program’s 4th year we had connected with several provincial science teachers’ associations in Canada (e.g., BC Sciences Teachers Association, Saskatchewan Science Teachers Society), one not-for-profit organization focused on promotion of science and technology to the general public (Science World in Vancouver, BC), and organizing committees of the British Columbia and Ontario Envirothon, environmental education programs that strive to help secondary students go from environmental awareness to active stewardship (BC Ministry of Education, 2013; Ontario Envirothon, 2013).

Table 1. Key events in development and delivery of the Soil 4 Youth program in Canada.

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<th>Year</th>
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| Mid-2000s | • Revitalization of the discipline of soil science in Canada was identified as one of the priorities for the Canadian Society of Soil Science (CSSS).  
• One of the directions for the revitalization process identified as enhancement of soil science in high school curriculum. |
| 2008      | • Core group of soil scientists established within the CSSS.           |
| 2009      | • Potential funding source identified (i.e., PromoScience Program within the Natural Sciences and Engineering Research Council (NSERC) of Canada.  
• Soil 4 Youth program goals were developed and proposal was submitted to PromoScience. |
| 2010      | • Three-year funding approved.                                          
• The Soil 4 Youth program was initiated.  
• Development of Soil 4 Youth program’s website and educational material, focused mainly on soil science research projects.  
• Initial informal feedback gathered from soil science colleagues both in Canada and the United States. |
| 2011      | • Continued with material development (e.g., added lesson plans and activities on topics related to the research projects featured on the website).  
• Website refinements.  
• Ongoing discussion among the team members on directions for the Soil 4 Youth program.  
• Recruited additional team members.  
• Gathered initial feedback from high school teachers and university recruiters about the Soil 4 Youth program. |
| 2012      | • Continued with material development (e.g., added information on career options in soil science).  
• Explored ways to reach a broader group of high school teachers.  
• Gathered initial feedback from selected group of high school teachers.  
• Website and material refinements. |
| 2013      | • Established connections with provincial associations of science teachers and local organizations focused on promotion of science to the general public.  
• Got involved with several ongoing initiatives that promote soil science and soil science related themes (e.g., Ontario Envirothon, Delta Wildlife & Farm Trust field day).  
• Gave a presentation at the "Catalyst" conference organized by the BC Science Teachers Association, Richmond, BC.  
• Developed Soil 4 Youth program’s promotional material (e.g., bookmarks, posters).  
• Ongoing planning of future directions for Soil 4 Youth program. |

Soil 4 Youth Program Online Components

Since the Soil 4 Youth program has two target audiences (high school students and teachers), an attempt was made to address the needs and expectations of both groups. The Soil 4 Youth program website includes five components: (1) real-life soil science Research Projects from Canadian
universities with related classroom activities, (2) Resources for Teachers, including hands-on activities and lesson plans, (3) Resources for Students, including higher education, career options, community involvement pages, and examples of professionals in soil science related careers, (4) Ask a Scientist, a question-and-answer platform involving a university professor in soil science, and (5) Events and News page featuring the Soil 4 Youth program’s involvement in the community and also links to the latest online articles focused on soils and their importance in global issues.

Homepage
To attract and engage high school students, the overall presentation and organization of the Soil 4 Youth program website includes several unique elements. The homepage scene (Fig. 1) is one that is familiar to many learners, with an illustration of a science laboratory containing a lab bench with glassware, a bookshelf, a computer, and field equipment. This brings relevance to teachers and students, as they regularly come across some of these components in a school setting. To engage users further, three cartoon characters were created by a professional illustrator to act as hosts of the Soil 4 Youth program website. After several trials, these three characters were agreed upon by the development team to represent a realistic approximation of the Canadian soil science and education community. The character biographies incorporate their interest in soils (excerpts below):

- Ms. Sandy: I am a high school teacher who lives in British Columbia’s Fraser Valley, a region known as the province’s bread basket because of its nutrient-rich soil. I grew up surrounded by the rich red soil of Prince Edward Island and was fascinated by the story that can be told by only knowing its colour!

- Clay: I am a grade 11 student in Ms. Sandy’s chemistry class. I never thought soil was all that interesting—I figured it was just dirt! But I have learned a lot about it in Ms. Sandy’s class and am now thinking about becoming a soil scientist. Learning about chemistry and biology is a lot more fun when we can get outside and get our hands dirty.

- Dr. Terry Firma: I am a professor of soil science at Earth University. I grew up on a small farm and ever since I was a kid, I had my hands in the soil. I studied chemistry in university and now I am a soil scientist. I research how different types of fertilizers help plants to grow, and how this depends upon the soil type. I have had the opportunity to travel all over the world to see how different farmers grow food for us to eat!

Ms. Sandy and Clay can also introduce themselves to the user via an audio clip that is activated by a mouse-click on the respective character. To help navigate the Soil 4 Youth program website, the homepage also includes an audio introduction by Dr. Terry Firma directing the user to the different sub-pages of the website.

Research Projects
Currently, there are four soil science research projects that are featured at the Soil Research Projects page (http://soilweb.landfood.ubc.ca/youth/research-projects). These provide a few illustrative examples to keep the users’ interest and bring tangible relevance to the broader study of soil science. These projects include: “Maximum Soil Squishiness,” “The Arctic Has Gas,” “Critters Beneath our Feet,” and “It’s Cold Down Here!” and cover a range of different topics and ecosystems linking soil science research to physics, chemistry, and biology.
There are four major components that the user can look through to learn more about each of the projects. "The Story" provides the background on the research question and features a visually appealing carousel of images, graphs, or maps related to the research topic. The "Research Summary" puts the research into a real-world context by providing information about the impacts of their research, such as how the "Maximum Soil Squishiness" results can be useful to forest management and sustainability. This helps the user (student or teacher) to understand how scientific research fits into the scope of land management practices and can also inform policy. "Student Activities" are presented to illustrate that concepts can be adapted for the high school classroom and are simple to implement and fun. As recommended by Field et al. (2011), lab and field activities are included, which aligns with the soil science teaching principles in post-secondary education. The field activities require the students to go outdoors and observe the soil in their own schoolyard or home backyard, which helps connect some of the more abstract concepts in soil science (such as soil texture or infiltration rates) to a real place.

The "Student Activities" also include Prescribed Learning Outcomes (PLOs), based on British Columbia's learning standards for the provincial K–12 education system, to guide teachers to incorporate a specific activity into the curriculum. Prescribed Learning Outcomes are the legally required content standards for the provincial education system (BC Ministry of Education, 2013). They are statements of what students are expected to know and be able to accomplish by the end of the course (BC Ministry of Education, 2013). Including PLOs helps teachers seamlessly incorporate the Soil 4 Youth program resources into their curricula. "Ms. Sandy’s Notes" are additional resources providing teachers a more detailed background on each of the research projects including learning objectives and definitions of key soil science terms specifically related to a particular research project.

Classroom activities modeled on real research projects can be a mechanism by which teachers provide a valuable introduction to scientific inquiry, which is a key facet of science and research (American Association for the Advancement of Science, 1989). Moebius-Cline et al. (2011) demonstrated that an intensive soil science inquiry unit in three earth science secondary school classes provided students with a valuable understanding of what science is and how it is conducted through observation, developing a research question and hypothesis, experimenting, collecting data and data analysis, and reporting results. These skills are essential for anyone interested in pursuing a career in soil science, and they are further honed at the university level (Strivelli et al., 2011). If we are to advance scientific literacy of the general public, they must be able to accomplish by the end of the course (BC Ministry of Education, 2013). Including PLOs helps teachers seamlessly incorporate the Soil 4 Youth program resources into their curricula. "Ms. Sandy’s Notes" are additional resources providing teachers a more detailed background on each of the research projects including learning objectives and definitions of key soil science terms specifically related to a particular research project.

Resources for Teachers

The Resources for Teachers (http://soilweb.landfood.ubc.ca/youth/resources) tab is highlighted on the homepage of the Soil 4 Youth program website as an easy entry point for teachers who want to navigate directly to classroom activities and lesson plans. This page features a variety of lesson plans for hands-on soil science activities covering a range of topics (from soil hand texturing to creating an earthworm farm), learning objectives, materials needed, and printable handouts. These are user-friendly, interactive resources that bring relevance to soil science principles. In addition, an inventory of outside educational resources developed by other programs and initiatives (e.g., K–12 Soil Science Teacher Resources created by the Soil Science Society of America) is also included. Many additional innovative resources (e.g., complete equipment kits, course manuals, teacher resource manuals) for teaching soils at the K–12 levels are being developed around the world. For example, inventories of online educational resources can be found at the European Soil Data Centre (http://eusoils.jrc.ec.europa.eu/Awareness/Inventory.cfm, accessed 25 Apr. 2014), the U.S. Department of Agriculture website for Soil Education (http://soils.usda.gov/education/, accessed 24 Apr. 2014), and "Discover Soils" page of the Soil Science Society of America website (https://www.soils.org/discover-soils, accessed 24 Apr. 2014).

Resources for Students

Career prospects are a major factor that influences high school students in the decision about post-secondary degree selection (McCallister et al., 2005; Baveye et al., 2006; Collins, 2008). Furthermore, prospective university students (and their parents) noted in a survey conducted at the University of Florida that they knew very little about the career opportunities an educational background in soil science could provide (Collins, 2008). Consequently, the Soil 4 Youth Resources for Students page (http://soilweb.landfood.ubc.ca/youth/career-path) features a variety of information for students to learn more about education and careers related to soil science, and community organizations that engage in projects associated with soils. Students can find information on: (1) "Post Secondary Education" with links to Canadian universities that offer undergraduate and graduate degrees in soil science or related natural science with a soil science emphasis, (2) "Career Options" with examples of careers for people with degrees in soil science or related natural science, (3) "Meet the Pros" with testimonials of real Canadians about the relevance of soil science to their profession, and (4) "Get Involved" with examples of how students can connect with community organizations on topics such as composting, where food comes from, and professional soil science organizations.

There are numerous natural resources careers that include soil science as an integral component and examples of different career paths are presented with a job title, description, average salary and employment requirements. Job titles including forestry professionals, biologists, environmental specialists, and land use planners are presented with links to detailed descriptions provided by Human Resources and Skills Development Canada (Human Resources and Skills Development Canada, 2013). The "Soil Pros" (both women and men from a range of ages) can be a source of inspiration for high school students, allowing them to see what future careers might hold in store.

A long-term goal of the Soil 4 Youth program is to motivate students to learn about soil and to take action to protect this important, yet often overlooked and underappreciated natural resource. To inform students about on-going initiatives carried out around soil conservation and sustainable management practices,
the “Get Involved!” page provides links to scientific and professional societies, soil science programs at post-secondary institutions, and action ideas for promoting soil conservation through changes in personal behaviour. By providing these links, the Soil 4 Youth program engages students to deepen their in-school learning and continue exploring the opportunities for extra-curricular learning.

**Events and News**

To keep users of the Soil 4 Youth program connected with the team, the Soil 4 Youth program posts educational outreach events that it is participating in on the Events and News page (http://soilweb.landfood.ubc.ca/youth/events-news). These events are featured chronologically with links. Soil scientists are making important discoveries around the world, so online articles featuring “Soil in the News” are also presented as a way to link soil science to global environmental issues.

**Ask a Scientist**

The Ask a Scientist page (http://soilweb.landfood.ubc.ca/youth/ask-a-soil-scientist) adds an interactive element to the website where interested students can pose questions (relating to a Soil 4 Youth program activity, or broader concepts) to a soil science professor, Dr. Terry Firma (pictured on the homepage). Although the questions are posed to a fictional character, the answers are provided by University of British Columbia soil science professor, Dr. Maja Krzic. There are a series of sample questions and answers that cover a range of topics including soil nutrients, glacial erratics, and chemical conditions that lead to red soil color. Through collaborations with high school teachers, the forum can provide a key first-hand resource for students engaged in classroom activities or exercises related to soils.

**GROWTH AND FUTURE DIRECTIONS FOR THE SOIL 4 YOUTH PROGRAM**

With the Soil 4 Youth program’s online platform established and its initial key features developed, it is important to ensure that the target audiences are aware of the Soil 4 Youth program’s value, so they both utilize the resource and contribute to its fine-tuning. Soil 4 Youth program team members continue to participate in various events related to education and outreach. For the successful continuation of the Soil 4 Youth program, it is also important that it continues to grow, since new team members will expand the outreach of the Soil 4 Youth program into their local communities. The main avenues to recruit new Soil 4 Youth program members are the Canadian Society of Soil Science and graduate and undergraduate soil science (and/or soil science related) programs, including some provincial organizations such as the Pacific Regional Society of Soil Science and the Manitoba Soil Science Society.

**Collaboration with High School Teachers**

The Soil 4 Youth program continues to collaborate with high school teachers in several community-based extracurricular educational programs that focus on natural resources education (e.g., Ontario and BC Envirothon programs). In northern Ontario, the Algoma Envirothon format consists of several activity days throughout the school year culminating with a 2-day competition in the spring. High school students are brought out of the classroom, into the field to experience hands-on soil lessons and then a practical soils test facilitated by a soil science professional. These types of programs provide the Soil 4 Youth program opportunities to pilot new activities and to gather teacher and student feedback. In some cases this exposure to soils, using Soil 4 Youth program resources, leads to teacher requests for similar presentations during regular high school science classes. In other instances the approach and resources are taken back to the classroom by enthusiastic teachers to enhance student learning. In both scenarios, awareness of soils and their importance is being heightened within high schools.

To better inform teachers about the Soil 4 Youth program, the team is exploring avenues to strengthen connections to regional and provincial high school teachers’ associations and with provincial Ministries of Education. Soil science can be framed under several existing high school subject areas, including earth science and geology, sustainable resources, natural resource management, food production and agriculture, biology, and geography, and with the help of the respective Education Ministries across Canada, there should be ways to modify existing programs to include principles of soil science.

University recruiters are starting to use the Soil 4 Youth program’s online educational resources to actively promote degree programs offered by their post-secondary institutions to high school students, teachers, and principals. Each year, university recruiters go to numerous local, regional, and international recruiting events and are always in need of specific, informative, and visually attractive promotional material. In that regard, the Soil 4 Youth program team has developed several promotional items (e.g., bookmarks, pamphlets, postcards) featuring website hosts Ms. Sandy, Clay, and Dr. Terry Firma.

**Collaboration with Not-for-Profit Organizations**

To reach a broader audience within the two target groups (high school students and teachers), we have started collaboration with the Community Scientist Initiative (CSI) program at Science World in Vancouver, BC. The goal of the CSI program is to train scientists and science-based professionals to be science communicators and ambassadors who will engage British Columbians in science and inspire future science and technology leadership. The CSI program also offers skills training to effectively engage public audiences and to develop and deliver activities and experiences that provide connections to real and regionally-relevant science and technology (Science World, 2013). This collaboration is an excellent opportunity for members of the Soil 4 Youth program to improve their outreach skills. It also provides a forum to include soil science related activities in ongoing displays featured by Science World, a not-for-profit organization visited by more than 600,000 people each year (Science World, 2013).

**Contributions of Soil Science Students**

Involving current soil science students to develop the Soil 4 Youth program has been one of the most rewarding experiences during this process. Students bring enthusiasm and amble fresh ideas on how to pursue this initiative and reach the new generation of students from high schools. Student members are also excellent promoters of the Soil 4 Youth program and the discipline of soil science. In one example, graduate students showcased the importance of
soil for a variety of land-uses to the general public through hands-on activities (Fig. 2) during the Think & Eat Green @ School Summer Institute, organized at The University of British Columbia, Vancouver, in July 2013. As a result of this event, the Soil 4 Youth program was invited to become a permanent lesson unit to teach students how to run hands-on soil activities for other classroom settings within The University of British Columbia’s undergraduate course entitled Land, Food, and Community.

To ensure that new hands-on activities are added each year, the Soil 4 Youth program, in collaboration with Canadian Society of Soil Science, is planning a competition for graduate soil science students to develop inquiry-based educational activities for the high school curriculum. Inclusion of the inquiry-based teaching approach in high school science classes helps foster critical and independent thinking, scientific reasoning, creativity, and in the long-term contributes to more scientifically literate citizens (Ontario Ministry of Education, 2007). By broadening the resources available to teachers, the Soil 4 Youth program will enhance teaching and learning about soil at the high school level and hopefully motivate students to pursue soil science as a future career path.

CONCLUSIONS

Despite some initial positive examples of the inclusion of soil science topics into high school programs of several Canadian provinces, in most cases soil is still not covered in depth. Ensuring that soil science is adequately included into the high school curriculum is a tremendous task. Activities carried out to date by the Soil 4 Youth program represent initial efforts toward the inclusion of soil science into Canadian high school programs.

The Soil 4 Youth program provides an engaging, research-based, online educational platform for students to learn about soil. It offers a range of activities and hands-on resources for teachers to incorporate the principles of scientific inquiry and soil science into the classroom. Traditionally, soil scientists are not actively involved in teaching at the high school level and often they are not aware of how they can get involved. On the other hand, high school teachers do not have many opportunities to connect with scientists who can help them to develop specialized lessons. The Soil 4 Youth program has strong potential to facilitate these connections and to serve as a platform through which Canadian soil scientists and high school teachers will collaborate to bring soil science into high school programs. As an initial step, the Soil 4 Youth program team has created a variety of online activities and lesson plans. To make these resources directly applicable for the high school curricula, PLOs (BC High School Curricula) have been provided for each Soil 4 Youth program online activity. In addition, through growing connections with provincial teachers associations the Soil 4 Youth program is promoting its educational resources and initiatives.

To raise awareness about soil science among high school students, the Soil 4 Youth program outlined a variety of career options and pathways of real-life soil scientists employed in a range of positions in private and government sectors. The Soil 4 Youth program’s expanding collaboration with university recruiters and not-for-profit organizations focused on promotion of science to the general public will further widen the outreach of our program in years to come.

The growing interest in climate change, food security, and the ongoing need to sustainably supply food, fiber, and fuel to an ever-increasing global population have brought soils back onto the global research agenda as well as the public policy arena. The soil science community has a vitally important role to educate the next generation of soil scientists and increase public awareness about the importance of soil and soil management in the global environment. The soil science community in Canada (and elsewhere) needs to ensure that soil science finds a permanent place in the national science curriculum at the high school level and that teachers are given adequate training, resources, and support through initiatives such as the Soil 4 Youth program.

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REFERENCES


Fig. 2. Participants at the Think & Eat Green @ School Summer Institute at The University of British Columbia, Vancouver, show their “Great Wall of Soil,” created as part of a Soil 4 Youth program activity in July 2013 (photo credit: Ms. Dru Yates, UBC, Vancouver).


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**About the author…**

Maja Krzic is a soil scientist with a passion for student focused communication of soil science. To augment and extend my research on land-use impacts on soil processes, I have integrated research, teaching, and community education through application of information technology and multimedia. I strongly believe that integration of research and effective communication allows science to become useful knowledge. To that extent, I helped the establishment of the Canada-wide group on Virtual Soil Science Learning Resources (VSSLR; http://soilweb.landfood.ubc.ca/promo/). The goal of VSSLR is to enhance soil science education through cooperation and innovative approaches to teaching and learning.