Place-Based Learning (PBL) at Riley Park: An Outdoor Educational Tool for BC Schools

Little Mountain Neighbourhood House / UBC Environmental Sciences

Cambie-Riley Park Neighbourhood, Vancouver BC

September 2018 – April 2019

Developed by: Lisa Iqbal, Tyreen Kapoor, Richard Park, and Ganimul Singh (UBC Environmental Sciences 400)

Supervised by: Tara Ivanochko

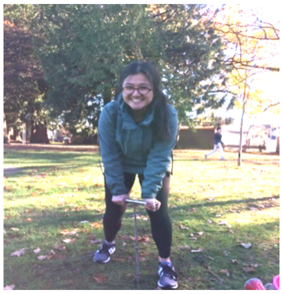
Prepared for Art Bomke, Anya Chase, Varouj Gamouchian, and Joanne MacKinnon at Little Mountain Neighbourhood House

Project Summary

In 2017 the British Columbia (BC) Ministry of Education implemented a new BC curriculum (New Curriculum) that places an importance on participatory learning experiences. Place-Based Learning is a growing pedagogy that focuses on participatory learning experiences such that students apply in-class curriculum content while engaging in relevant tasks outside the classroom to connect their learning to the real world. As the New Curriculum was updated recently (2017), there is a lack of Place-Based Learning resources for educators due to existing instructional tools having been designed around the old curriculum. A Soil Workshop at Riley Park, Vancouver has been developed to provide BC educators with a Place-Based Learning tool that supplements the BC New Curriculum. The workshop incorporates interactive activities that use local park soils as a medium for learning the arts, sciences, and social studies. The Soil Workshop is designed for Grade 6 & 7 students with minimal background knowledge of soils and takes 90 to 120 minutes to complete.

Table of Contents

UBC Undergraduate Research Team



Lisa Iqbal

Lisa is a fourth-year Environmental Science student at The University of British Columbia with an interest in soil science, sustainable food systems and community outreach. With experience in Integrated Pest Management, conducting research at the UBC Farm, and teaching refugee students, Lisa is looking to creatively involve the diverse community with their environment and increase food literacy.

Tyreen Kapoor

Tyreen is a fourth-year Environmental Science student at The University of British Columbia with a keen interest in integrating natural resource conservation, social science, and political science. With research experience at UBC Farm and a passion for community outreach through prior volunteer experiences, Tyreen believes a critical component to driving global environmental change is by increasing personal connections with the natural environment.

Richard Park

Richard is a fourth-year Environment Science student studying at The University of British Columbia. With some experiences in basic soil tests and identification, outreach and community through the orientation program JumpStart, and drawing and sketching, Richard hopes to share his knowledge and skill set in a way that others can be more involved and inspired of their local area and what they can do to be involved.

Ganimul Singh

Ganimul is a fourth-year Environmental Science student at The University of British Columbia. From her past experience working in a Montessori daycare center, Ganimul believes that having kids explore and learn outdoors is a great way to appreciate the earth. Having taken ecology and soil science courses she hopes that her knowledge will contribute to the project and encourage the students to be excited about soils.

1. Introduction

The BC curriculum is modernizing to prepare students for a future in which the ways we communicate, learn, and share information is constantly changing (Government of British Columbia, 2019). After consulting with local and international education experts, the BC Ministry of Education agrees that the new curriculum must be flexible, maintain a focus on literacy and numeracy, while also allowing space and time for students to develop skills through the application of knowledge. All areas of the BC curriculum have been redesigned on a Know-Do-Understand Curriculum Model to support a concept-based competency-driven approach to learning. The Know-Do-Understand model is based on three key components that work together to support all levels of education: Content (Know), Curricular Competencies (Do), and Big Ideas (Understand) (Figure 1) (Government of British Columbia, 2019).

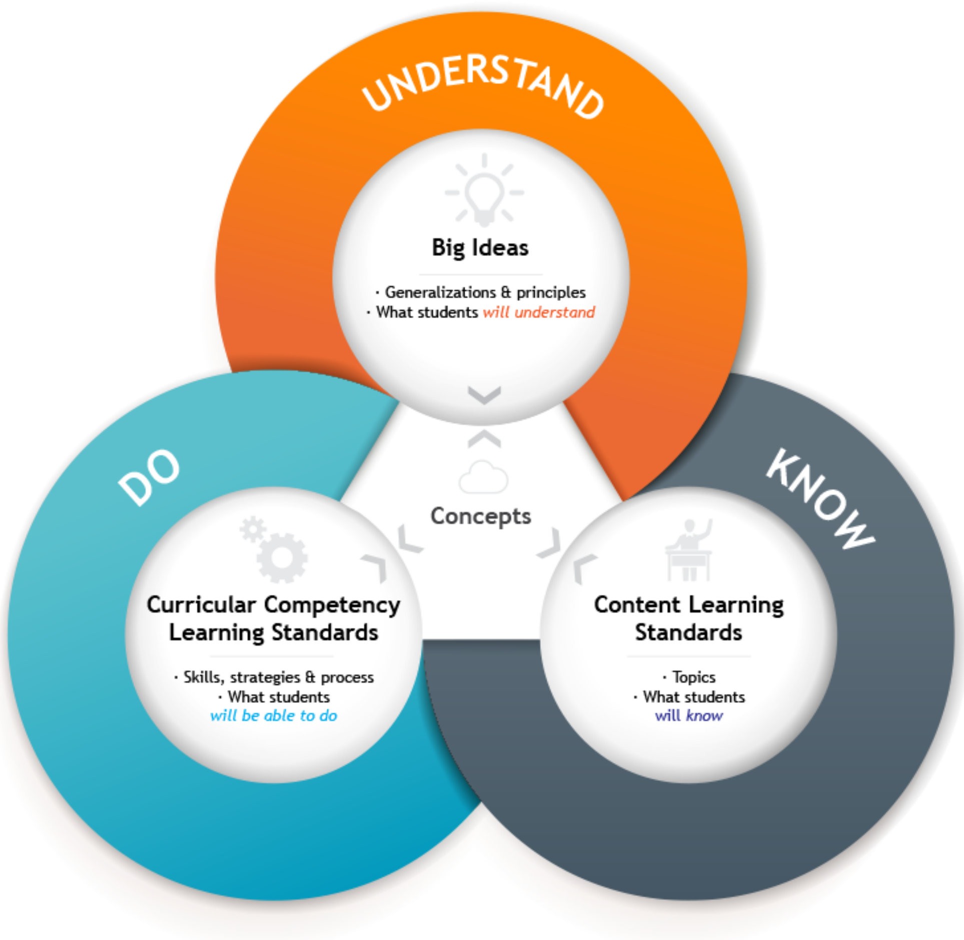


Figure 1. *A visual model of the Know-Do-Understand used in the BC New Curriculum (Government of British Columbia, 2019).*

> Allow students to become the creators of their knowledge.
> (Smith, 2002)

Place-Based Learning (PBL) is a growing pedagogy that shifts away from standard classroom environments and away from curriculum models that rely on rote memorization and recall of facts (Smith, 2007. Place-Based Learning is a participatory education experience that supplements the BC New Curriculum model of Know-Do-Understand. It is structured to provide students with a variety of experiences that allows them to connect what they are learning to their own lives, communities, and regions (Smith, 2002). Place-Based Learning as an educational tool is highly adaptable to the characteristics of a particular place and such unique characteristics can be used to allow students to become the creators of their knowledge (Smith, 2002). Therefore, PBL can take a wide range of forms and can include introducing students to community spaces and processes. By including students in all aspects of their community, including the economic, decision-making, and sustainability processes, they learn to become important members of society and understand their ability to address community needs (Smith, 2002).

Little Mountain Neighbourhood House (LMNH) is a grassroots volunteer-driven organization that contributes to its community by providing programs that address a spectrum of local, regional, and national issues that affect local residents. Riley Park, Vancouver is a central location in the Cambie-Riley Park neighbourhood and plays a critical role in the community development that LMNH strives to achieve. This park is also home to a rich geological history with various soil compositions. With the modernization of the BC Curriculum, there is a lack of PBL resources for local educators and students in the Cambie-Riley Park neighbourhood. LMNH has taken the initiative to contribute to the production of PBL resources that are accessible to local residents and educators in order to reinforce community engagement and accessibility. With the unique soil characteristics of Riley Park and the adaptable nature of PBL in mind, a Soil Workshop at Riley Park was developed by the UBC undergraduate research team in collaboration with LMNH to provide BC educators with a PBL tool that supplements the BC New Curriculum (Know-Do-Understand, Figure 1). By participating in the Soil Workshop, students have the opportunity to apply in-class curriculum content (Know) while simultaneously engaging in relevant tasks (Do) that connect their learning to the real world (Understand).

The workshop incorporates interactive activities that use local park soils as a medium for learning and applying the arts, social studies, and sciences curriculum content of the BC New Curriculum. The Soil Workshop is designed for grade 6 and 7 students with minimal background knowledge of soils. Drawing on the Know-Do-Understand model of the New Curriculum, the undergraduate research team organized key generalizations and principles (*Big Ideas)* that each student will Understand upon the completion of their grade (Table 1a and

Table 1b). The grade 6 and grade 7 *Big Ideas* were critical in the development of the Soil Workshop as they provided the undergraduate research team with a comprehensive understanding of the background knowledge participating students possess. This helped to guide the content and activity development of the Soil Workshop such that it followed the general criteria of PBL: *experiences that allow students to connect what they are learning to their own lives, communities and regions* (Smith, 2002).

Table 1a. *Grade 6 Big Ideas from the BC New Curriculum model of Know-Do-Understand. These are key generalizations and principles that students should understand upon the completion of their grade (Government of British Columbia, 2019).*

Grade 6 Big Ideas:	
Science	*Everyday materials are often mixtures.*
Arts Education	*Engaging in creative expression and experiences expands people's sense of identity and community.* *Artistic expressions differ across time and place.* *Dance, drama, music, and visual arts are each unique language for creating and communicating.*

Table 1b. *Grade 7 Big Ideas from the BC New Curriculum model of Know-Do-Understand. These are key generalizations and principles that students should understand upon the completion of their grade (Government of British Columbia, 2019).*

Grade 7 Big Ideas:	
Science	*Earth and its climate have changed over geological time.*
Social Studies	*Geographic conditions shaped the emergence of civilizations.*
Arts Education	*Engaging in the arts develops people's ability to understand and express complex ideas.* *Through art making, one's sense of identity and community continually evolves.*

The overarching goal of this research project is to collaborate with LMNH to prepare, develop, test, and implement a PBL Soil Workshop for grade 6 and 7 students that can be used as a supplementary teaching tool for the BC New Curriculum. By testing the PBL Soil Workshop at Riley Park, the UBC undergraduate research team seeks to fulfill the following project objectives:

Project Objectives	
I.	Determine the effectiveness of a PBL Soil Workshop as an educational tool that supplements the new and improved BC Curriculum Model.
II.	Determine if PBL increases student engagement.
III.	Determine if soils are an effective medium for learning scientific and spatial knowledge through the application of BC curriculum content in the arts, social studies, and sciences.
IV.	Illustrate that Community Mapping is an effective tool for expressing personal connections to place.

The structure, content, and model of the of PBL Soil Workshop is intended to be applied at Riley Park as it is designed around the geological history and soil composition that is unique to the park. However, the PBL Soil Workshop can be redesigned for other community parks and the unique geological history of the location of interest. For the purposes of this study, the undergraduate research team will be focusing only on the Soil Workshop, geological history, and soils of Riley Park.

2. Background and Rationale: The Knowledge Gap

2.1. What is Place-Based Learning?

PBL is a growing pedagogy that uses the local community and environment to teach concepts in the sciences, arts, social studies and other subjects in the curriculum (Sobel, 2001). This method of teaching emphasizes real-world, hands on learning experiences that have been shown to increase academic achievements, develop stronger community ties, and garner an appreciation for the natural environment (Sobel, 2001). PBL is a pedagogy that has been growing in popularity over the past 30 years, especially amongst educators in urban areas (Smith, 2002). According to David A. Gruenewald, the author of *A Critical Pedagogy of Place*, educators are predominantly interested in PBL as schools are often unable to utilize a sense of place, community, and nature to provide diverse learning experiences for students. *Place*, which includes the natural environment and community, is an important platform for teaching as it provides educators and students with a cultural landscape that includes ecosystems, bioregions, and unique interactions between humans and the non-human world (Gruenewald, 2006). Gruenewald also states the importance of "attention to experience", or personal connection, as a vital component of PBL as it emphasizes the notion of experiential and contextual learning. The personal connections that individuals build within place through PBL enhances student achievement, betters a community's environmental, social, and economic vitality, and ultimately creates a greater responsibility for individuals to serve as contributing citizens to society. This is an additional benefit to participating in PBL and contributes to building healthier social and natural communities (Figure 2) (Sobel, 2001 & Powers, 2002).

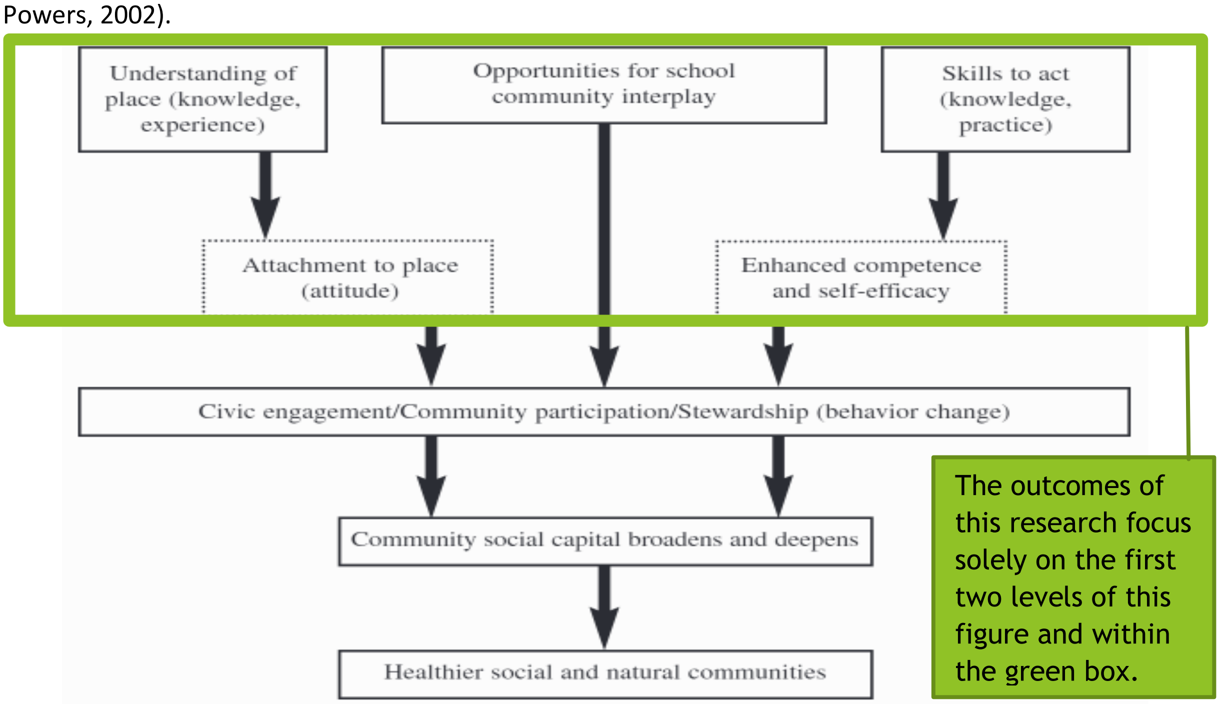


Figure 2: *Working model for the change of theory for Place-Based Education (Powers, 2002).*

2.2. Place-Based Learning in British Columbia

In 2017, the British Columbia Ministry of Education published the BC New Curriculum that provides a modernized education system critical for students to succeed in the 21st century. Local and international education experts were involved in building a curriculum that is flexible, maintains a focus on literacy and numeracy, and supports a deeper learning (Government of British Columbia, 2019). The curriculum was redesigned to give teachers more flexibility in creating learning experiences that engage students in relevant tasks that apply in-class curriculum, while allowing students the time and space to pursue personal interests and passions. In order to achieve the educational goals, set out by the BC New Curriculum, there is a greater consideration for local participatory learning experiences such as PBL. A key feature of the New Curriculum is that it is based on a Know-Do-Understand model that supports concept-based, competency-driven learning and includes three main elements: Content (Know), Curricular Competencies (Do), and Big Ideas (Understand) (Figure 1). The New Curriculum highlights “Personalized Learning”, “Ecology and the Environment”, as well as “Flexible Learning Environments”. This directly corresponds with the nature of PBL as it is consistent with the notion of “concept-based approaches that focus on the development of competencies to foster deeper, more transferable learning” (Government of British Columbia, 2019). As the New Curriculum is a fairly recent update to the education system in BC (updated in 2017), resources for educators that utilize PBL are lacking as the instructional samples available predominantly focus on in-class learning.

The New Curriculum highlights “Personalized Learning”, “Ecology and the Environment”, as well as “Flexible Learning Environments”.

2.3. Why is Riley Park a desirable location?

Riley Park is located on Ontario St. and 30th Avenue in Vancouver, BC, east of Queen Elizabeth Park (Figure 3). The location is a historical hub first attracting First Nations people 10,000 years ago, to settlers 200 years ago, and now the Riley Park Community (Bomke, 2017). In geological history, Riley Park was once on a volcanic trail before being covered by glaciers during the Ice Age. The Ice Age launched massive landscape transformations in which there was land compaction leading to the development of soil layers unique to Riley Park. With the melting and retreat of the glaciers, the land changes further contributed to the uniqueness of Riley Park soils (Bomke, 2017). A saltwater inlet also ran through the south section of the park area forming Glacial Marine soils in the south (Figure 3, P.3) and Glacial Till soils in the north (Figure 3, P.2.) of the park (Bomke, 2017). The park currently consists of the Riley Park community garden (Figure 3, P.1.), the fieldhouse, a parking lot, two playgrounds, a greenhouse, and a baseball field which all sit atop Glacial Marine or Glacial Till soils (Appendix A).

The unique land characteristics of Riley Park and its central location that allows it to act as a community center makes this park a desirable location for a Place-Based Learning workshop. The geological and social history that are unique to Riley Park provide a sense of place and community required for diverse teaching and learning experiences. Moreover, Riley Park is accessible to the public, educators, and students throughout the year ensuring that educational resources can be accessed at any time.

Figure 3. *Riley Park located on Ontario St. and 30th Avenue in Vancouver, BC. The Riley Park community garden is located at P.1. Glacial Till soils can be found at the north-end of the park by the parking lot (P.2), and Glacial Marine soils can be found at the south-end of the park by the playground (P.3).*

2.4. How is soil a useful medium for Place-Based Learning?

Soil science education provides an important basis to building sustainable societies as the knowledge acquired with respect to agriculture, environment, and resource management can contribute to important land-use and policy development (Barbarick, 1993). Traditionally taught at the university level and of interest within the sector of rural agriculture, students of younger ages who reside in urban areas often lack a soil science foundation (Letey, 1993; Minami, 2008). Soil science provides a better understanding of environmental issues through its interdisciplinary nature that involves geology, chemistry, physics and meteorology. Additionally, soil science and geological history are important components to understanding the culture, civilization, livelihood, and health of individuals residing in a particular area (Reese, 1993; Minami, 2008).

Soil is ultimately an effective medium for conducting PBL workshops in Riley Park for grade 6 and grade 7 students as it corresponds with the *science* and *social studies Big Ideas* of the BC New Curriculum (Table 1a and Table 1b). Furthermore, soil science education in community spaces helps to motivate students to develop a responsibility to care for the environment which can have positive long-term effects (Minami, 2008).

2.5. How is community mapping useful?

Community mapping is a cartographic practice that is important in the global movement towards participatory learning, community empowerment, and sustainable planning (Lydon, 2003). The practice of mapping involves utilizing spatial understanding as a tool for learning and provides a mode for individuals to visually depict their personal knowledge or views of their communities or surroundings (Lydon, 2003). Maeve Lydon, the Associate Director of the Institute for Studies in Innovation and Community University Engagement (ISICUE), describes community mapping as the "recovery and discovery of the connections that all communities share". This notion of community mapping is compatible with the concepts of PBL as it helps to instill a shared sense of place through observations of the unique characteristics of the land. Furthermore, including community mapping in a Riley Park PBL workshop corresponds with the *arts Big Ideas* of the BC New Curriculum and can incorporate the *social studies and science Big Ideas* depending on what a student chooses to include in their map. According to Amsden et. at., (2005), community mapping can be useful to students as both the participant and the facilitator of the mapping process. By using a PBL approach to community mapping, students will be able to produce creative and innovative products that foster a personal connection and identity with place (Amsden et. al., 2005)

2.6. What will the Soil Workshop entail?

The Soil Workshop is designed specifically to be executed in Riley Park and includes content that is based on the unique social, geological, and geographical history of the park. Riley Park serves as the *place* within PBL in which there is significant community presence and interaction with the natural environment. Riley Park, like any other park, has experienced landscape development, land use change, and various human impacts through time that are unique to the location. The unique land changes experienced by Riley Park, present state of the land, and the human interactions with the land all serve as a foundation for building a conceptual understanding of the park which ultimately helps to foster personal connections with the environment For example, it may be beneficial to describe the park as once being glacier covered land, which then transformed into settlements lived in by indigenous people, before becoming a cemented recreational area that once had a pool, and now is currently covered in greenery and has a food garden (Bomke, 2017).

Interactive workshop activities were structured specifically to incorporate the unique history and land characteristics of Riley Park into the PBL workshop. The Soil Workshop involves utilizing the subject of soils as an interactive medium for learning, in addition to community mapping as a tool for fostering creativity, awareness of surroundings, and developing a personal connection and identity with place.

2.7. Research Scope

The scope of this research can be represented by a systems map (Figure 4) that describes the boundaries, components and interactions that exist within this research. The boundaries of this research are PBL and BC Curriculum, and the intersection between these two boundaries is where the components interact. Educators and students visit Riley Park where the workshop is conducted. The workshop consists of social studies, science, and arts subjects that are explored through local history, soil science and community mapping. The overlapping layers within the systems map suggests that there may be other ways in which PBL can be presented in alignment with the BC Curriculum. The specific content of the PBL Soil Workshop, however, is a good fit for incorporating the elements of community and local environment into students' education.

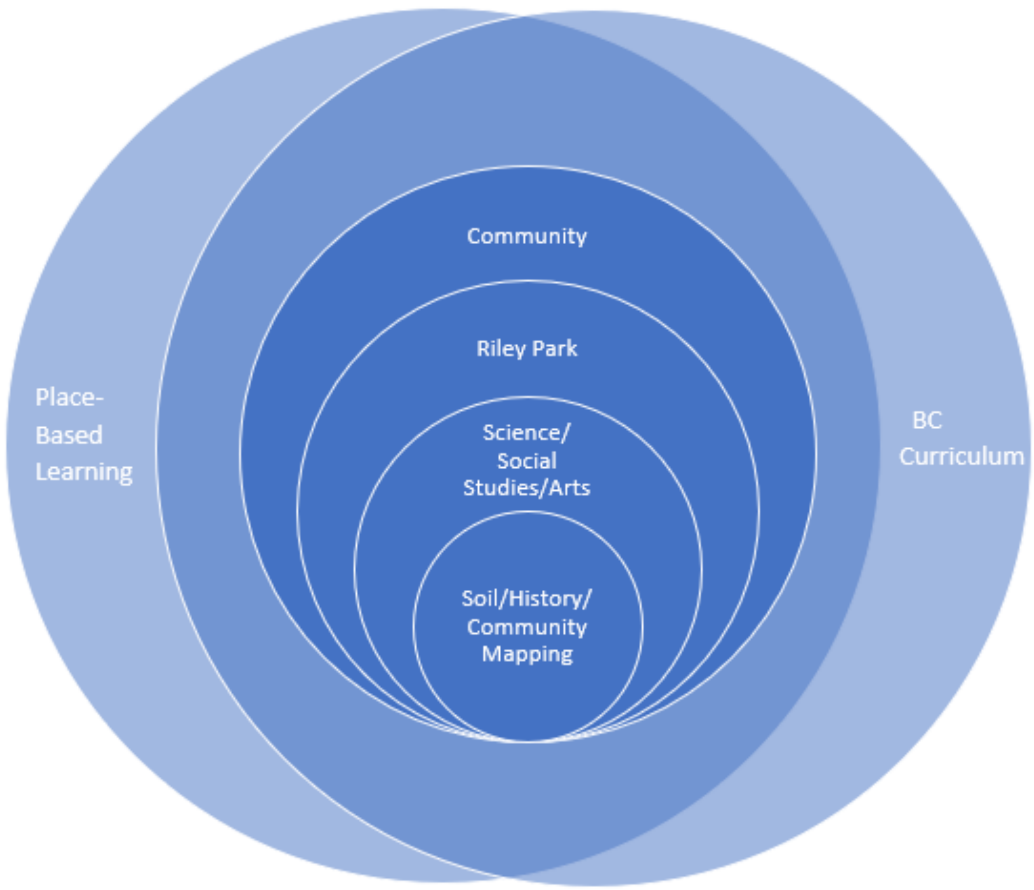


Figure 4: *Systems map representing the boundaries, components and interaction within this research.*

3. Methodology

3.1. The Soil Workshop Itinerary

The Soil Workshop consists of four sections (Table 2) that are carried out around Riley Park (Figure 5).

Table 2. *The Soil Workshop developed by the UBC undergraduate research team includes the following activities in order to effectively adhere to the components of PBL and incorporate the uniqueness of Riley Park.*

The Soil Workshop		
Workshop Section	**Description**	**Location**
Part A Getting to Know Riley Park	Students gain a brief introduction of the social, geographical, and geological history of Riley Park. This allows them to formulate a personal connection with *place*: Riley Park. *Big Ideas Match: Science & Social Studies* *Geological time and the recent impact of humans.*	Community garden (Figure 5, Pt. 1.)
Part B Soil Foundation	Students explore the physical properties of sand, silt, and clay soils through hand texturing. This enables students to determine the graininess, porosity, and water retention of various soils. *Big Ideas Match: Science* *Mixtures are separated and consist of differences in component properties.*	Community garden (Figure 5, Pt. 1.)
Part C Riley Park Soils	Students explore Riley Park, extracting soil samples at the Glacial Till and Glacial Marine locations to compare the physical properties and identify differences in landscape and vegetation. *Big Ideas Match: Science* *Everyday materials are often mixtures. Compare data with predictions and develop explanations for results.*	Glacial Till (Figure 5, Pt. 2.) and Glacial Marine (Figure 5, Pt. 3.)
Part D Community Mapping	Students add elements of their understanding and experiences onto a boundary map of Riley Park to enhance their geological and conceptual understanding of *place*. *Big Ideas Match: Social Studies and Arts* *Communicate ideas, explanations, and processes in a variety of ways to continually evolve sense of identity and community.*	Community garden (Figure 5, Pt. 1.)

Figure 5. *A map of Riley Park outlines the cyclical pattern students walk in to complete the Soil Workshop. Students begin the workshop in the Riley Park garden (Pt. 1) where they complete Part A and Part B of the Soil Workshop. Then, students walk to the Glacial Till and Glacial Marine areas of the park (Pt.2 and Pt. 3 respectively) where they complete Part C of the Soil Workshop. Finally, students walk back to the garden (Pt. 1) where they complete Part D of the Soil Workshop.*

3.2. Trial Workshops

The Soil Workshops were conducted from November 2018 to March 2019 in Riley Park, Vancouver. The Soil Workshop consisted of four parts outlined in *Table 2* and were tested on three grade 6 to grade 7 classes from the Cambie-Riley Park community ranging from 4 to 25 students. Due to time restrictions outlined by the school educators, the undergraduate research team conducted a Trial Workshop 1 which consisted of Parts A, B, and C of the Soil Workshop with 25 students from a single class (Class 1). Trial Workshop 2 was held on a different day and consisted of Part D of the Soil Workshop with 15 students from Class 1. A Full Workshop which combined Parts A, B, C, and D of the Soil Workshop was conducted on a different group of 4 students at a later date (Class 2) (Table 3).

Table 3. *Three workshops conducted by the undergraduate research team from November 2018 to March 2019 at Riley Park. Please refer to Table 2 for the Soil Workshop structure i.e. Soil Workshop Parts.*

Date	Workshop	Soil Workshop Parts	Class
November 23, 2018	Trial Workshop 1	Parts A, B, and C	Class 1 (25 students)
March 1, 2019	Trial Workshop 2	Part D	Class 1 (15 students)
March 8, 2019	Full Workshop	Parts A, B, C, and D	Class 2 (4 students)

Figure 6. *An instructor sharing and discussing soil samples obtained at the Glacial Till location (Part C of the Soil Workshop).*

Figure 7. *An instructor demonstrating how to insert a soil probe into the ground at the Glacial Marine location (Part C of the Soil Workshop).*

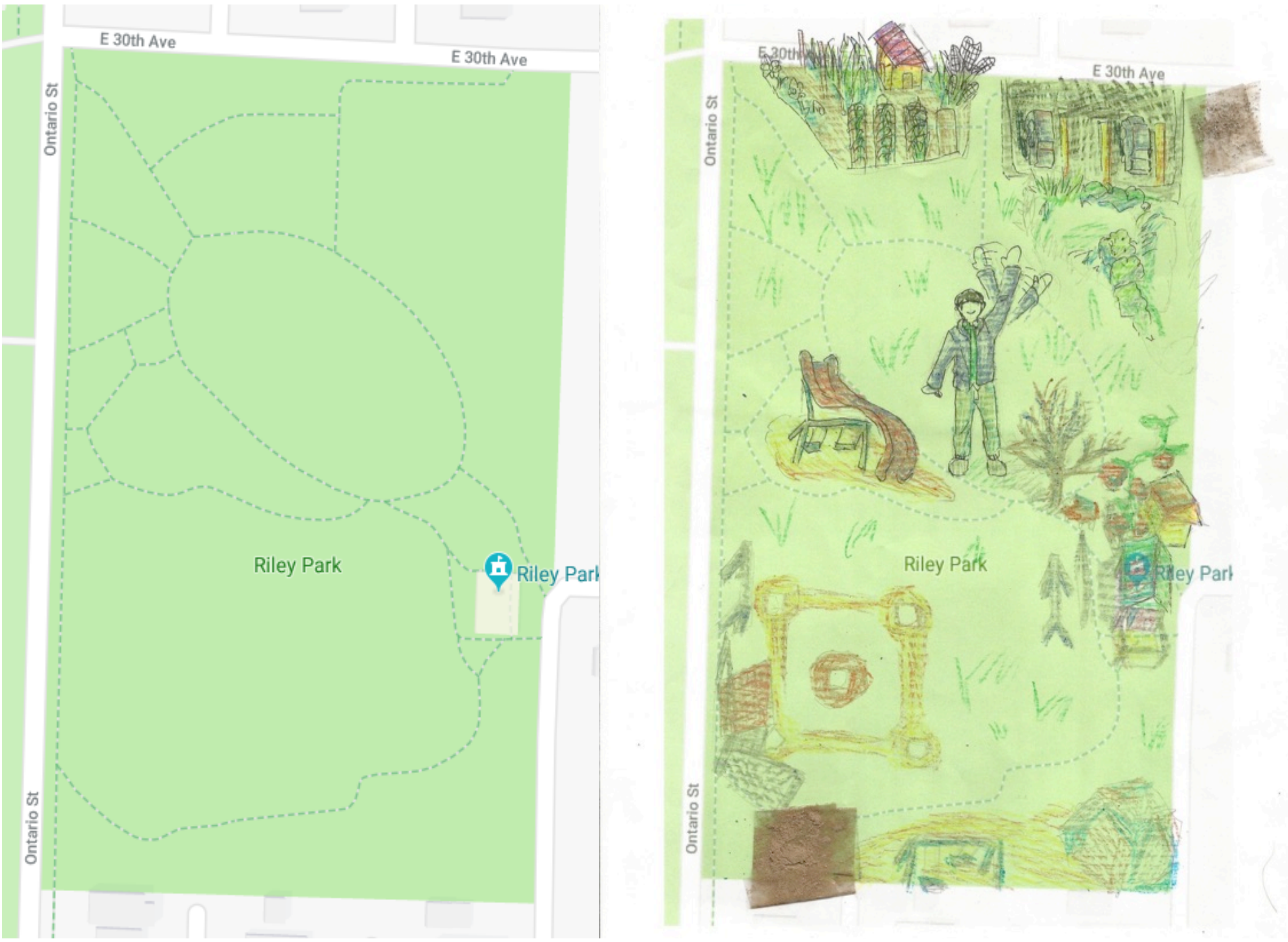


Figure 8. *A boundary map of Riley Park (right) was provided for each student to draw elements of their understanding and experiences onto. A complete community map can be observed on the left.*

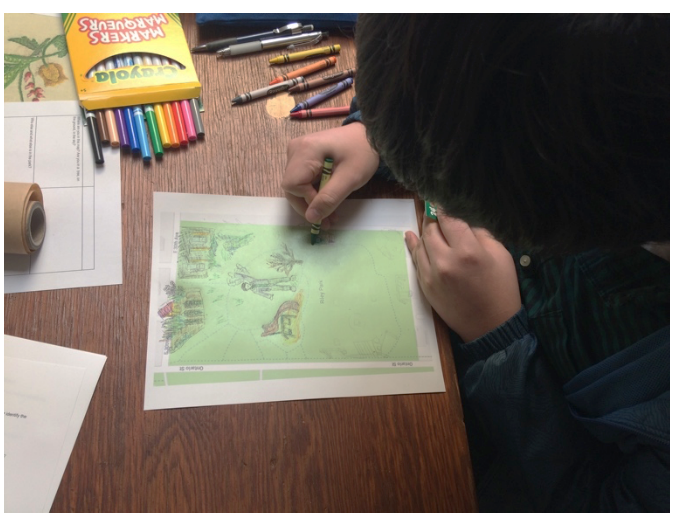


Figure 8.a. *A student drawing and filling in elements of their understanding onto a boundary map of Riley Park during Part D: Community Mapping of the Soil Workshop*

3.3. Tools for Analysis

The interdisciplinary nature of this research requires that the analysis be conducted both quantitatively and qualitatively to gain a holistic measurement of the effectiveness of the workshop. The tools used include a Questionnaire, the Classroom Observation Protocol for Undergraduate STEM (COPUS) and Community Mapping Point System.

3.3.A. The Questionnaire

To obtain quantitative data on the effectiveness of PBL as an educational tool, the undergraduate research team developed a questionnaire for students participating in the Soil Workshop to complete before and after the workshop (Appendix B). The questionnaire that consists of five questions collects information on the previous soil and mapping knowledge of students and provides information that allows the undergraduate research team to compare the pre and post questionnaire responses to identify changes in student understanding. The questions were thoughtfully structured to promote student thinking, as well as to obtain data regarding the effectiveness of the workshop in conveying the content. Questions 1,2, 4 and 5 were prompting questions intended to get students thinking about the park and the workshop activities and not used for analysis. Question 3 was designed specifically to obtain qualitative results. The answers obtained from the pre and post responses to this question were analyzed to assess changes in student association with soil terms.

3.3.B. Classroom Observation Protocol for Undergraduate STEM (COPUS)

COPUS is an assessment tool used at The University of British Columbia and characterizes both the instructor and students' interactions with each other during an educational period (Smith et al., 2013). It provides valuable feedback on how instructional time is spent by instructors and students. Since PBL focuses on student engagement, it is important that instructors do not spend the majority of an educational period lecturing and students do not spend the entire period waiting or listening. Instead, PBL emphasizes the importance of instructors and students actively engaging in discussions and hands-on experiences. Based on COPUS, the undergraduate research team developed a similar assessment tool to characterize the interactions between instructors and students during the Soil Workshop (Appendix C). During a Soil Workshop, one member of the undergraduate research team was delegated as the *observer.* The *observer* was responsible for observing the actions and interactions of the students and instructors at fixed time intervals and checking the appropriate boxes of COPUS based on their actions.

3.3.C. Community Mapping Point System

A point system was developed by the undergraduate research team in order to objectively analyse the maps and avoid judgement based on the artistic ability of the students. This was especially important as there were were students who felt more comfortable writing words than drawing on the boundary map. The list of possible points was created by deciding what elements we hoped the students learned from the project. Each student could obtain a total of 10 points on their map and received one point for each of the following elements that were included on their maps: infrastructure, soil, garden, vegetation, landscape, people, geological time, glacial soils, animals, weather (Table 4).

Table 4. *The community mapping point system developed by the undergraduate research team in order to objectively analyze the maps created by the students. A total of 10 points can be obtained for each map. One point is allocated to a feature of Riley Park that the undergraduate research team aligned with the Big Ideas of the BC New Curriculum i.e. concepts the students would have a better understanding of following the Soil Workshop.*

Map Elements	Points
Infrastructure	1
Soil	1
Garden	1
Vegetation	1
Landscape	1
People	1
Geological Time	1
Glacial Soils	1
Animals	1
Weather	1

4. Results and Discussion

4.1. Questionnaire

Question 3 of the questionnaire (Appendix B) asked students to circle words they associate with soil before and after the Soil Workshop. For the amount of times each word was circled, they were analyzed to characterize the change in student word association with soils (Figure 9). Increased word association demonstrates the PBL workshop is effective at teaching soil subject matter.

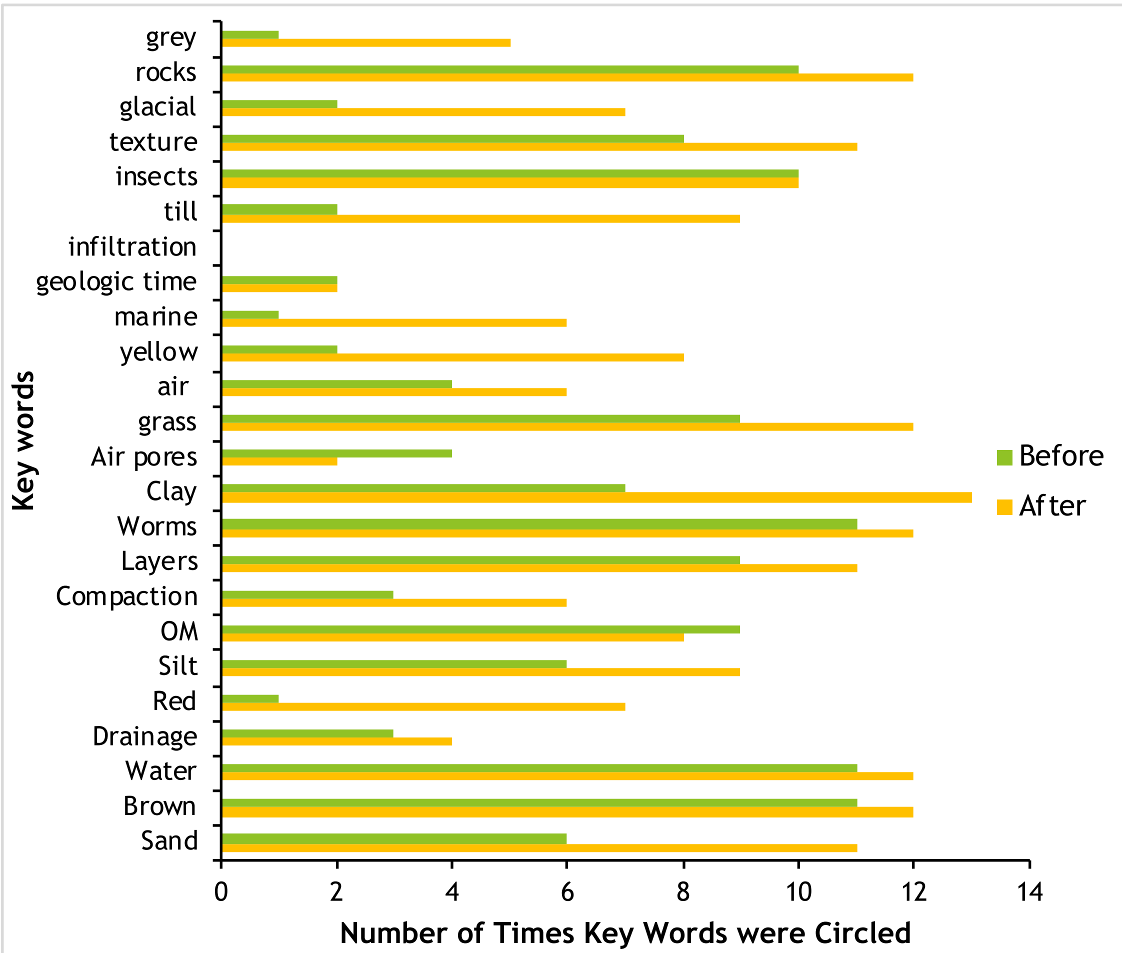


Figure 9. *The number of times student in Trial Workshop 2 circled words they associate with soil before and after the implementation of the workshop. OM is abbreviated for Organic Matter.*

As displayed in Figure 9, student word association with soil has increased after attending the workshop. The words 'red', 'yellow', 'marine', 'till', 'glacial' and 'grey' have a higher increase in association. These increases suggest that our learning was effective and understood by a majority of the group. Consequently, some words showed to have a negative response to the workshop. The words 'organic matter' and 'air pores' had decreased in association. In both questionnaires, before and after, only 'infiltration' was never circled.

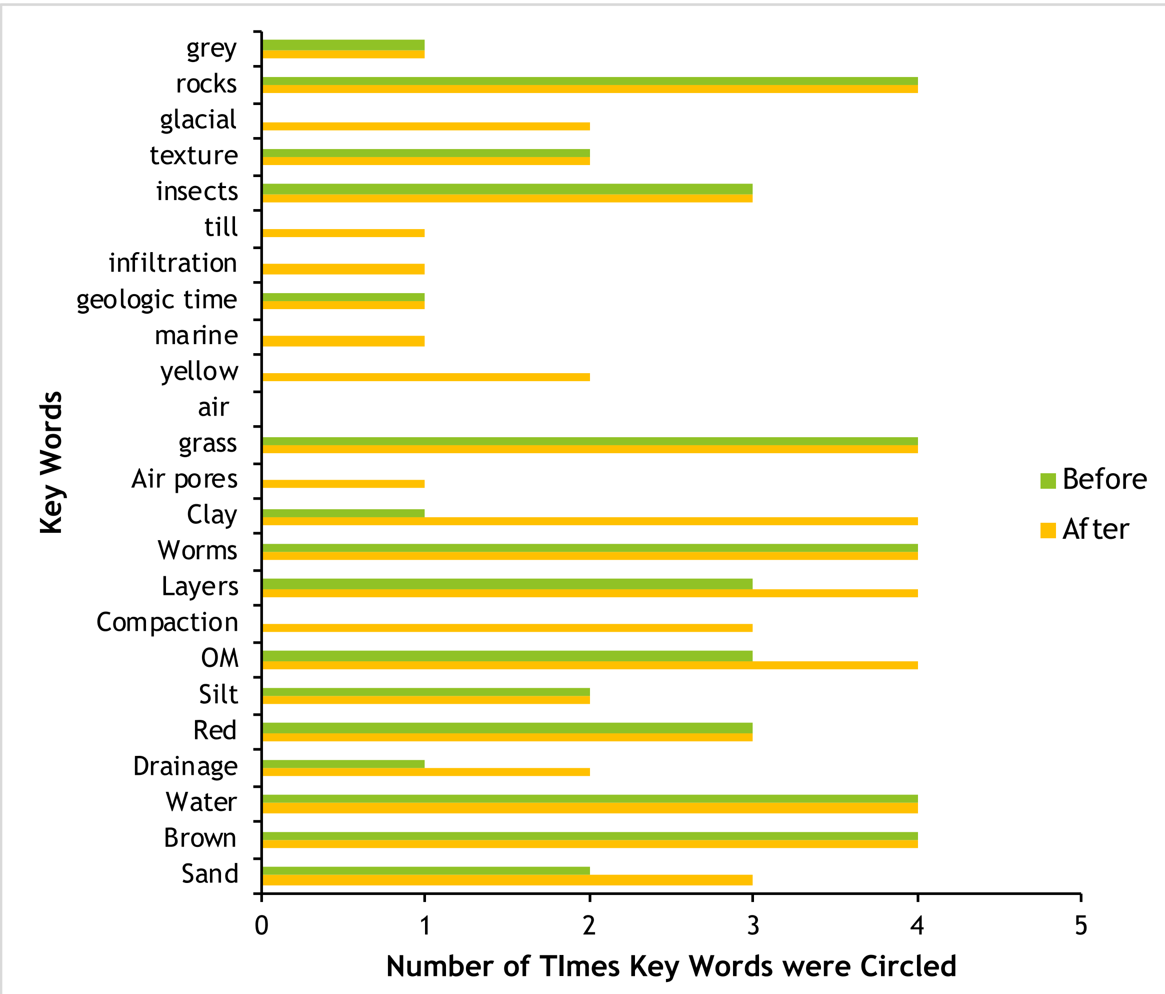


Figure 10. *A comparison of the number of times students from the Full Workshop circled key words before and after the workshop. OM is abbreviated for Organic Matter.*

As a result of a smaller class size for the Full Workshop (Class 2: 4 students), there was less variation in word association. A noticeable pattern is how word association either increased or did not change at all, since all 4 students were already familiar with the term (Figure 10).

Based on the increased usage of keywords in both workshops (Trial Workshop 2 and Full Workshop), we can infer that the workshop was successful in teaching the students characteristics of soils. By having them identify keywords, they show an understanding of what is associated with soil, may it be color, soil type or texture. Words that could be physically found in soil such as, 'water', 'worms', 'grass' and 'rocks', were most popular in the 'before' section (Figures 9 and 10). This is most likely because these are physical things that they are familiar to seeing, unlike 'drainage' and 'pores' which take more critical thinking.

Because of the difference in class sizes, Trial Workshop 2 showed higher variation in word association. Nonetheless, both workshops had high increases for the word's 'compaction', 'yellow' and 'glacial' (Figures 9 and 10). The positive relationship with these words is most likely due to the repetition of the words during the workshops. 'Glacial' was used often since it was in the titles of the soils and referred to when discussing the geologic history of the park. 'Yellow' was used regularly for describing the color of soils. 'Compaction' was used during the probing activity which was when the students were most attentive, and because they were more interested they could have absorbed more information. Repetition proved to be useful because the students became familiar with the words and how they are applied to soil science. Whereas, 'infiltration' was still low in both situations (Figures 9 and 10). This could be because when we wrote the questionnaire we intended to conduct an infiltration activity but due to weather constraints the soil was too solid to move forward with this plan. Thus, the word was not utilized as much as planned and we focused more on 'drainage' during the workshop. The focus on 'drainage' could be why we see an increase for that word and not 'infiltration'.

Furthermore, from analyzing the *before* and *after* data, Full Workshop had more 0's beforehand, meaning that they initially circled less words that they associate with soil (Figure 10). A reason for this could be the age difference between the two classes. The Full Workshop consisted of grade 5-7 kids, whereas Trial Workshop 1 and 2 had students from grade 6 and7. The workshop is intended for grade 6 and 7 students and was created alongside the grade 6 and 7 *Big Ideas*, which could be why they had identified more words prior to the workshop.

Question 4 of the questionnaire asked the students if they have ever drawn a map before. By counting the number of times students said 'yes' and 'no', the percentage of students who answered 'yes' was computed. 73.3% of students in Trial Workshop 2 had said they have drawn a map before, whereas 100% of students in Full Workshop had said they have drawn maps. Our hypothesis was that the maps drawn by students who said 'yes' would have a higher quality. Alternatively, after comparing the percentages to the presentation of maps created in the workshop, it was determined that there was no correlation to map quality.

Questions 1, 2 and 5 of the questionnaires were not part of our analysis because they were included as a way to get the students into a more focused mindset. Where by answering these questions, they would be thinking more critically about where they are, what the park represents and what they are about to learn. The benefit of them answering the questionnaire was to understand their baseline knowledge prior to the exercise.

4.2. COPUS

Analysis of the COPUS protocol reliably characterizes a class and their varied interactions with the instructor and with other students during the entirety of the PBL Soil Workshop. A COPUS analysis was done for Trial Workshop 1, Trial Workshop 2, and the Full Workshop. Trial Workshop 1 consisted of 25 grade 6 and 7 students and Trial Workshop 2 consisted of 15 grade 6 and 7 students from Class 1. The Full Workshop consisted of 4 grade 5 and 6 students from Class 2. The PBL Soil Workshop takes 90 to 120 minutes to complete and the time allocated was determined by the participating schools.

4.2.A Trial Workshop 1

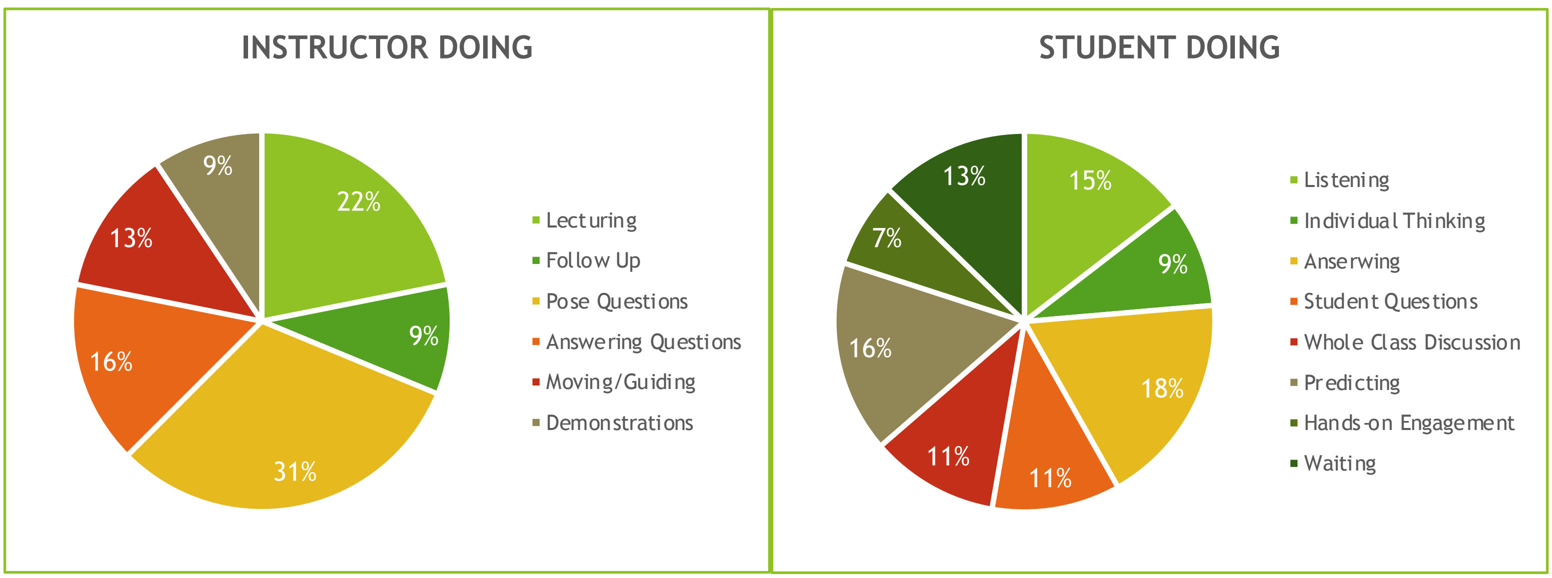


Figure 11. *A pie chart depicting the proportion of varied interactions of 25 grade 6 and 7 students from Class 1 with the instructors and with other classmates during the entirety of the 120-minute Soil Workshop.*

4.2.B Trial Workshop 2

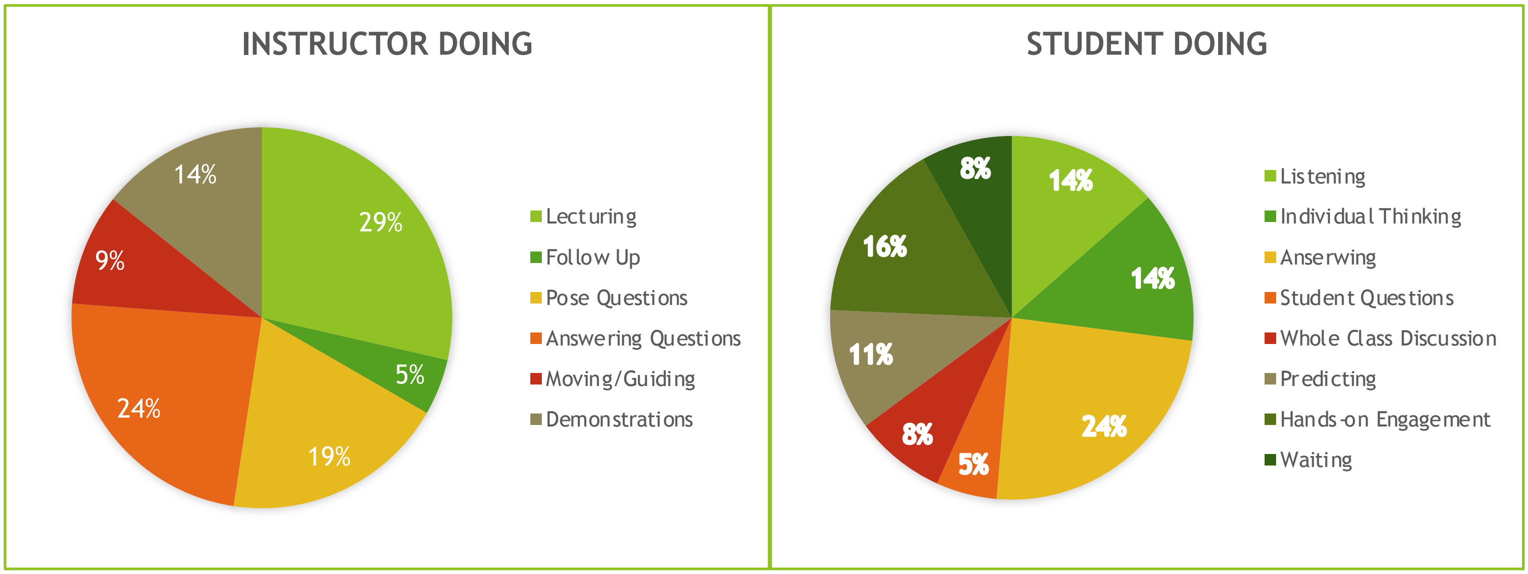


Figure 12. *A pie chart depicting the proportion of varied interactions of 15 grade 6 and 7 students from Class 1 with the instructors and with other classmates during the entirety of the 90-minute Soil Workshop.*

4.2.C. Full Workshop

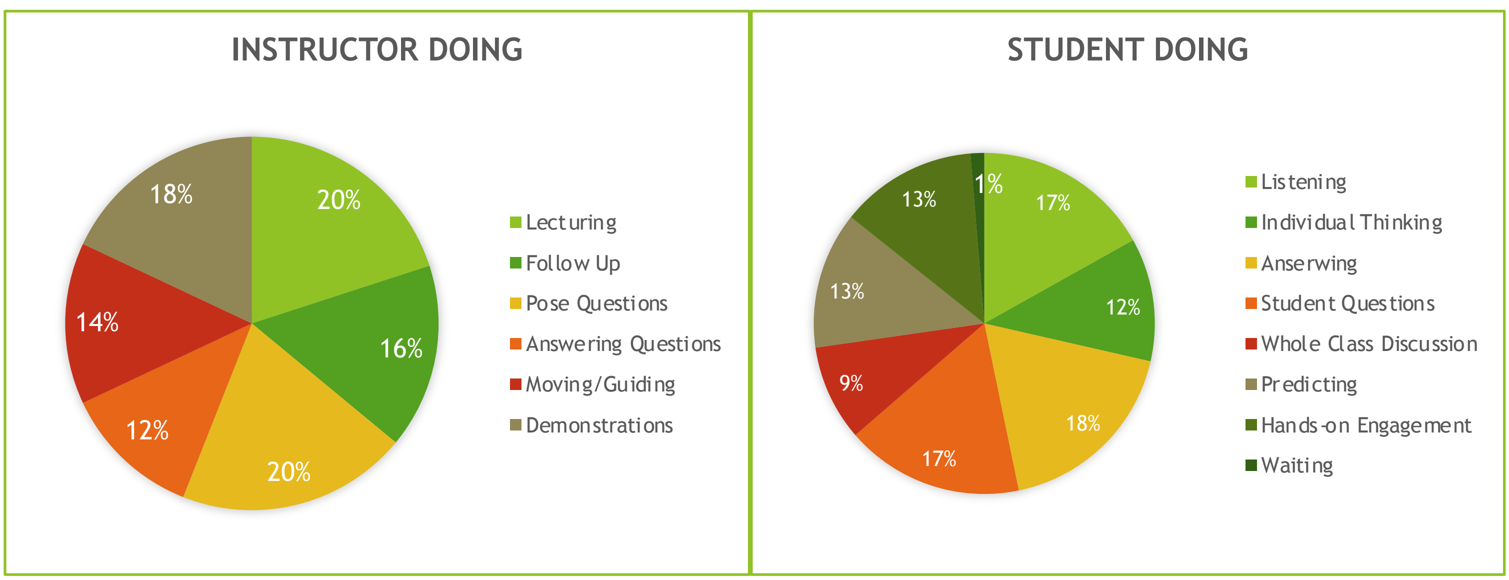


Figure 13. *A pie chart depicting the proportion of varied interactions of grade 5 to 7 students from Class 2 with the instructors and with other classmates during the entirety of the 120-minute Soil Workshop.*

When analyzing the results from COPUS for both Student Doing and Instructor Doing (Figures 11 - 13), great differences in the proportion of interactions can be observed for Trial Workshop 1, Trial Workshop 2, and the Full Workshop. It is important to note that the class sizes for all three workshops varied drastically from 4 to 25 students in a workshop, thus influencing the types of interactions that were observed.

When comparing the COPUS Student Doing results across all three workshops, it can be observed that the proportion of students waiting in Trial Workshop 1 (Figure 11) was significantly greater than for Trial Workshop 2 (Figure 12) and the Full Workshop (Figure 13). Specifically, students in Trial Workshop 1 spent 13% of their time waiting as opposed to 8% and 1% for Trial Workshop 2 and the Full Workshop respectively. Moreover, the proportion of student present varied across all three workshops with 7% in Trial Workshop 1, 16% in Trial Workshop 2, and 13% in the Full Workshop. Hand-on Engagement refers to the active participation of students with the soil materials and equipment. As mentioned previously, Trial Workshop 1 consisted of 25 students whereas Trial Workshop 2 consisted of 15 students and the Full Workshop was comprised of 4 students. These results suggest that larger class sizes influence the interactions among students and with the instructors such that more time is spent waiting and less time is spent actively participating in the workshop activities when the class size is large. The proportion of other interactions across all three workshops were relatively consistent except for student question. It can be observed that the proportion of time spent by students asking questions was larger for the Full Workshop, with 17%. Students posed questions 11% of the time for Trial Workshop 1 and only 5% for Trial Workshop 2. The proportion of student question varied most drastically for Trial Workshop 2 and may be due to the fact that Trial Workshop 2 consisted of students who had already participated in Trial Workshop 1 and were already familiar with the material (Figure 12).

When comparing the COPUS *Instructor Doing* results across all three workshops, Trial Workshop 1 showed the highest proportions in *pose questions* and lowest in *demonstration* (Figure 11). Trial Workshop 2 showed highest proportion for *lecturing* and the lowest proportion of *follow up* as compared to the other workshops (Figure 12). The Full Workshop showed the most even distribution of *Instructor Doing* amongst the three workshops (Figure 13). As the three workshops were conducted with varying structures, time frames, content and with different class sizes, the differing proportions of *Instructor Doing* can be expected. Differences in proportions can also be attributed to the changes were also gradually implemented to the overall workshop with each new execution of the workshops. This was done to gain a more comprehensive workshop structure that ensured that important knowledge was being conveyed and that students were engaged, whilst maintaining the nature of PBL. The results from Trial Workshop 1 *Instructor Doing* guided the workshop structure to reduce the amount of questions asked to the students and to increase the amount of demonstration. This change was effectively observed in Trial Workshop 2; however, the proportions remained skewed towards *lecturing, answering questions* and *pose questions*. The results from the Full Workshop showed more even distributions which demonstrates that positive changes were made to the overall workshop to increase its effectiveness.

4.3. Community Mapping

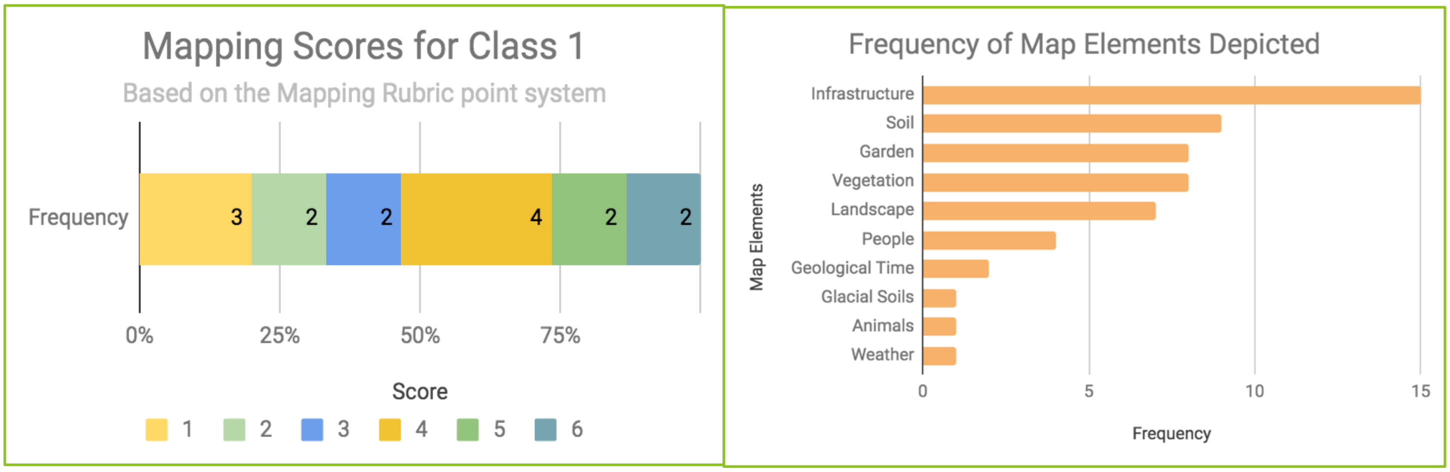


Figure 14. *Analysis of the mapping portion for Trial Workshop 2. On the right is a frequency chart of how many times each element was depicted on the maps. On the left, shows the frequency of total points that the students received for their maps.*

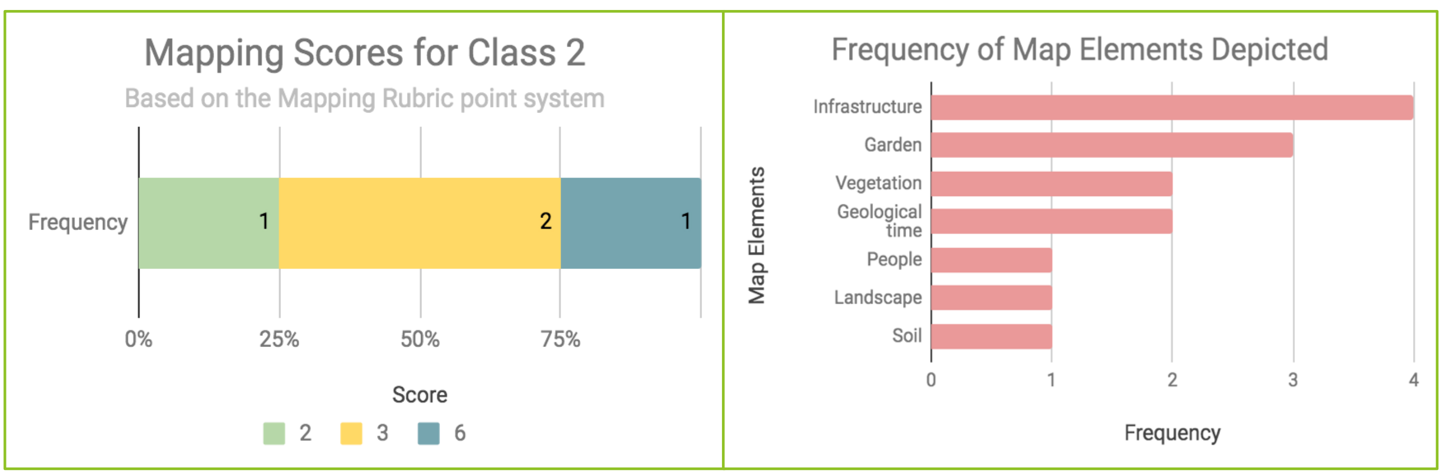


Figure 15. *Analysis of the mapping portion for the Full Workshop. On the right is a frequency chart of how many times each element was depicted on the maps. On the left, shows the frequency of total points that the students received for their maps.*

From the analysis of Community Mapping, the majority of the points obtained were within 3-6 points. For Trial Workshop 2, the most frequent elements depicted were ‘infrastructure’, ‘soil’, ‘garden’ and ‘vegetation’. Moreover, for the Full Workshop, the most frequently used elements were ‘infrastructure’, ‘garden’, ‘vegetation’ and ‘geologic time’. A discrepancy between the two is that Trial Workshop 2 showed more representation of soil.

A point system was created for analysing the maps in order to stay objective and avoid judgement based on artistic/ visual presentation, since there were students who felt more comfortable writing words than drawing. The list of possible points was created by deciding what elements we hoped the students would learn from the project and thought of ways they could be interpreted in points (Table 5). It was found that most of the maps received a point score between 3-6 points. These results, though relatively low to the maximum possible points of 10, do not diminish the effectiveness of the workshop. The community mapping activity is indeed a tool to synthesize student learning and is an additional effort to keep students thinking about their experience. It is also useful to note that grade 6 and 7 students have minimal experience with map making.

Every student is expected to have a personal experience at the park and make different connections. Yet, there were elements that were present on the majority of the maps. These popular elements consisted of ‘infrastructure’, ‘garden’ and ‘vegetation’, whereas elements like ‘glacial marine’, ‘animals’ and ‘weather’ were barely present (Figures 14 and 15). One reason for the vast difference is that infrastructure and trees are obvious things that you can see and connect with. As a child it is easier to connect to a playground than a certain type of soil because the playground is something you see at every park and makes you happy. Whereas, weather and glacial soils are more abstract and require more thought. Trial Workshop 2 presented a higher frequency of ‘soil’ drawn on the map most likely because they received more time learning about the soils through the trial workshop (Figure 15). Having that extra workshop time and then returning for another activity is a form of repetition that would have allowed the students to be more familiar with the element. Thinking about it more often could lead to them thinking about soil more critically, leading them to include it on the map.

6. Conclusion

This research demonstrates that all components of the PBL Soil Workshop: Getting to know Riley Park, Soil Foundation, Riley Park Soils, and Community Mapping were successful in building art, science, and social studies content that supplements the BC grade 6 and 7 curriculum. The Soil Workshop effectively utilizes PBL methods that enhance student experiences and awareness of place in Riley Park. The structure of the workshop closely aligns with the BC curriculum Big Ideas and provides a useful teaching supplement for BC educators as the current curriculum lacks PBL resources that are also flexible within the time constraints of a regular classroom.

This study demonstrates that PBL increases student engagement. The structure of the Soil Workshop, which was based on successful PBL methods, produces diverse learning experiences for students. Diverse learning experiences were observed through COPUS analyses of the Soil Workshops and demonstrated that students spend significant portions of a PBL learning period participating in hands-on activities, whole class discussions, and posing questions. Moreover, instructor teaching styles contributed to increasing student engagement as PBL methods rely less heavily on lecturing and emphasizes posing questions to students, moving, and guiding.

Analysis of the questionnaire demonstrates that soils are an effective medium for learning scientific knowledge as observed through increased soil word association upon completion of the Soil Workshop. The community mapping activity demonstrates that soils are also an effective medium for learning spatial knowledge. Students successfully included elements and characteristics of Riley Park that exhibit their understanding of their surroundings and environment after analyzing different soils in varied locations in the park.

Analysis of the community mapping activity demonstrates that it is an effective tool for expressing personal connections to place. This was analysed by objectively valuing personal connections to place through a metric of analysis developed by the undergraduate research team (community mapping point system). Students show different levels of connection to place through varied representations of their experiences in Riley Park and depict this on a boundary map of the park.

PBL Soil Workshops at Riley Park are ultimately an effective educational tool for BC educators to incorporate into their lesson plan. The Soil Workshop supplements the BC New Curriculum and is an important initiative that should be continued to diversify learning opportunities. This research project was effective in developing a PBL Soil Workshop and testing the effectiveness of this workshop as an educational tool in BC schools. However, this research project was limited and did not test the effectiveness of a PBL Soil Workshop when different instructors with varied teaching styles were facilitating the workshop, and how this can impact student learning and engagement. Further studies of this nature are critical in developing a PBL Soil Workshop that is reproducible by any educator. We hope that this research has served as a positive contribution to the BC New Curriculum in the search for accessible PBL resources for educators. Additionally, we hope this research can help to further engage the Cambie-Riley Park community with local environments and initiatives.

Acknowledgements

Sincere appreciations are owed to our supporters, both within and outside the university, who have helped us from the preparation to the completion of this project. Our special gratitude goes to LMNH for their partnership and giving us the opportunity to work on developing and testing a PBL Soil Workshop. We could not be more grateful for this practical learning experience and having this project outcome be put into good use for the greater Cambie-Riley Park Community.

In particular, our most heartfelt appreciation goes to Joanne MacKinnon and Varouj Gamouchian for supporting and guiding us throughout the development and execution of the Soil Workshops. To Dr. Art Bomke, who brings so much valuable knowledge and experience working with soils in community spaces. To Anya Chase and Yael Stav, for sharing your background in education and helping to coordinate the classes, we could not have done it without you!

Lesley Dampier of UBC Land and Food Systems. Throughout this project, Lesley advised, educated, and shared resources with us that greatly contributed to the success of our research. Her guidance and feedback have shaped the outcome of this project in all respects. For that, we would like to say a big thank you to Lesley for her enormous enthusiasm and support.

We also would like to take this opportunity to acknowledge the constructive feedback and valued recommendations of our project supervisor, Dr. Tara Ivanochko, and TA Manuela Haym whose collective effort is deeply ingrained in every bit of this project. Their contribution to this project as well as to our overall academic development is incredibly profound. Our undying gratitude, therefore, goes to them beyond this project.

References

"About Us." *Little Mountain Neighbourhood House*, web2.lmnhs.bc.ca/about/.

Amsden, Jackie, and Rob Vanwynsberghe. "Community Mapping as a Research Tool with Youth." *Action Research*, vol. 3, no. 4, 2005, pp. 357–381., doi:10.1177/1476750305058487.

"BC's New Curriculum." *Curriculum Overview | Building Student Success - BC's New Curriculum*, curriculum.gov.bc.ca/curriculum/overview.

Hartemink, Alfred E., et al. "The Joy of Teaching Soil Science." *Geoderma*, vol. 217-218, 2014, pp. 1–9., doi:10.1016/j.geoderma.2013.10.016.

Lydon, Maeve, and Jon Corbett. "5. Community-Based Mapping: A Tool For Transformation." *Learning and Teaching Community-Based Research*, 2014, pp. 113–134., doi:10.3138/9781442699397-011.

Minami, Katsuyuki. "Soil and Humanity: Culture, Civilization, Livelihood and Health." *Soil Science and Plant Nutrition*, vol. 55, no. 5, 2009, pp. 603–615., doi:10.1111/j.1747-0765.2009.00401.x.

Powers, Amy L. "An Evaluation of Four Place-Based Education Programs." *The Journal of Environmental Education*, vol. 35, no. 4, 2004, pp. 17–32., doi:10.3200/joee.35.4.17-32.

Smith, Gregory A. "Place-Based Education: Learning to Be Where We Are." *Phi Delta Kappan*, vol. 83, no. 8, 2002, pp. 584–594., doi:10.1177/003172170208300806.

"Soil Science Education: Philosophy and Perspectives." *SSSA Special Publication*, 1994, doi:10.2136/sssaspecpub37.

Appendices

Appendix A: Map of Riley Park with Infrastructure

A map of Riley Park and the infrastructure that it currently consists of. At the park you can find a community garden, two playgrounds, a baseball field, a fieldhouse and a parking lot.

Appendix B: Student Questionnaire

The Questionnaire was specifically designed to invoke student thinking, to assess the knowledge background of the students, as well as to obtain data regarding the effectiveness of the workshop in conveying the content. Questions 1,2, 4 and 5 were prompting questions to get students thinking about the park and the activities that will be conducted. Answer changes for these questions were expected but not used for analysis. Question 3 was designed to obtain results. The answers obtained from the pre and post responses to this question were analyzed to assess changes in student association with soil terms.

Name: ______________________________

School: _____________________________

1. What is your favourite spot or feature of the Riley Park?

---

2. Name three things that you can find in soil:

i. __________________________________

ii. __________________________________

iii. _________________________________

3. Circle the following words that you identify with soil:

Sand	Red	Layers	Grass	Geological Time	Texture
Brown	Silt	Worms	Air	Infiltration	Glacial
Water	Organic Matter	Clay	Yellow	Till	Rocks
Drainage	Compaction	Air pores	Marine	Insects	Grey

4. Have you made a map before (circle one):

Yes No

5. List two important uses for maps:

i. ________________________________

ii. ________________________________

Appendix C: COPUS

This checklist was adapted from the Classroom Observation Protocol for Undergraduate STEM (COPUS) to meet the needs of the workshop. This checklist was used throughout the workshop to obtain qualitative observations to indicate the different approaches taken by the instructor and the different levels of student participation.

Time (min)	Student Doing								Instructor Doing									Notes
	L	**InT**	**A**	**SQ**	**WCD**	**P**	**HE**	**W**	**Lec**	**FU**	**PQ**	**AQ**	**M/G**	**1o1**	**D**	**W**	**O**	
0-2																		
2-4																		
4-6																		
6-8																		
8-10																		
10-12																		
12-14																		
14-16																		
16-18																		
18-20																		
20-22																		
22-24																		
24-26																		
26-28																		
28-30																		

Student Doing:

L – Listening **InT** – Individual Thinking **A** – Answering **SQ** – Student Questions **WCD** – Whole Class Discussions
P – Predicting **HE** – Hands-on Engagement **W** – Waiting

Instructor Doing:

Lec – Lecturing **FU** – Follow-Up **PQ** – Pose Questions **AQ** – Answering Questions **M/G** – Moving/Guiding
1o1 – 1 on 1 **D** – Demonstrations **W** – Waiting **O** – Other

Appendix D: The Soil Workshop Agenda

The Soil Workshop agenda was developed by the undergraduate research team to be flexible to the needs of different educators and time constraints of participating classes. It is important to note that this workshop agenda has only been executed by the undergraduate research team and has never been tested by other instructors.

Materials Required:

- Copies of the questionnaire (optional)
- Clipboards
- A cup of sand, silt, and clay in three separate bowls
- Squeeze bottles filled with water
- A hand shovel
- A soil probe
- Copies of the boundary map of Riley Park
- Coloured pencils / markers

The Soil Workshop		
Activity	**Location**	**Instructions**
Part A: Getting to Know Riley Park (5 mins without history, 10 mins with history)	Riley Park Garden	• Introduce each member of the team • Land Acknowledgement: We would like to begin by acknowledging that we gathered on the unceded, ancestral, and occupied land of the Musqueam, Tsleil-Watuth, Sechelt, and Squamish Nations of the Coast Salish peoples. • OPTIONAL: Students partake in a *before* questionnaire. This is an optional workshop activity that can help educators to assess changes in soil understanding. • OPTIONAL: A brief introduction of the social, geographical, and geological history of Riley Park can be done at this point in time, or it can be integrated into each workshop activity.
Part B: Soil Foundation (20 mins)	Riley Park Garden	• Set up a "hand-texturing" station at a table in the garden.

		• Encourage each student to first grab a fistful of sand. Prompt Question: *What does this soil feel like? Can you feel individual grains?* • Add water to each students' handful of sand Prompt Question: *Can you make a worm out of the sand? Can you make a ball with the sand? Can you make a patty with the sand and does it stick?* • Encourage each student to grab a fistful of silt. Prompt Question: *What does this soil feel like? Can you feel individual grains?* • Add water to each students' handful of silt Prompt Question: *Can you make a worm out of the sand? Can you make a ball with the sand? Can you make a patty with the sand and does it stick?* • Encourage each student to grab a fistful of clay. Prompt Question: *What does this soil feel like? Can you feel individual grains?* • Add water to each students' handful of clay. Prompt Question: *Can you make a worm out of the sand? Can you make a ball with the sand? Can you make a patty with the sand and does it stick?*
Part C: Riley Park Soils (40 mins)	1. Glacial Till, North East of Riley Park, next to the parking lot	Prompt Question: *Who has heard of the Ice Age? Can someone tell me what a glacier is? Do we notice that we are at a higher elevation here in the parking lot than at the playground?* • Explain that Glacial Till soils were formed after glaciation and formed at high elevations. The last time the entire earth froze over was known as the last glaciation and that was approximately 20 000 years ago. • Explain that a glacier's weight and gradual movement can reshape the earth over thousands of years. As the glacier melts and moves, it breaks up the earth, soil, and rocks. Because of this, we have fairly young soils here

		known as Glacial Till which are about 11 000 years are approximately old. • The instructor digs a hole of at minimum 30 cm deep and 15 cm in diameter. • Make a pile on the ground of the dirt you collect. • Encourage the students to play with and hand texturize the soil. Prompt Questions: *What do you see and feel? Does this soil feel like the sand or the clay that we were playing with earlier? Do you notice a lot of roots in the soil? What colour is this soil?*
	2. Glacial Marine, South end of Riley Park, next to the playground	• Explain that just like the Glacial Till, the Glacial Marine soils were derived after the glaciation and are approximately 11 000 years old. Prompt Question: *Can anyone guess why these soils have the word "marine" in them? Do you think these soils will be more wet or dry than the Glacial Till soils?* • Explain that Glacial Marine soils were formed through interactions between ice and ocean water. • The instructor inserts the probe into the soil. How to Safely Insert Soil Probe: • The instructor should demonstrate putting the probe into the ground. This may take several tries as you might encounter rocks that do not allow you to penetrate the ground. • Probe must be 90° from the ground to ensure the probe does not bend. • Pushing the probe into the ground requires some force. • Once the probe is in the ground, do not twist the probe, simply remove it from the ground.

<table>
<tr><td></td><td></td><td>Empty the contents of the probe using your hands.
Repeat these steps in the same hole until you notice variations in soil colours i.e. yellow, gold, and grey soils.
Prompt Question: What colours do you see?
Encourage the students to play with and hand texturize the soil.
Prompt Question: Are there different textures present? How is the Glacial Marine Different from the Glacial Till? Do you think there is more water in this soil than the Glacial Till?</td></tr>
<tr><td colspan="3" align="center">BREAK TIME (10 mins)</td></tr>
<tr><td>Part D: Community Mapping

(40 mins)</td><td>Riley Park Garden</td><td>Prompt Question: Who can name some different kinds of maps that they have seen before? Would anyone like to share important things they would like to include in their map?
Assist the students in orienting their maps and identifying where they are standing in the map.
Walk around the park and add elements to map.
OPTIONAL: Students partake in an after questionnaire. This is an optional workshop activity that can help educators to assess changes in soil understanding.</td></tr>
</table>

Appendix E: Examples of Community Maps

Below are maps drawn by students who received 6 points on their maps. Six points is the highest score of all the workshops. On the left, is a map drawn by a student from Trial Workshop 2. This student received points for including landscape, infrastructure, glacial soils, garden, vegetation and soil. On the right, is a map drawn by a student from the Full Workshop. This map included people, garden, infrastructure, vegetation, landscape and soil.