Glaciers and Blueberries: Development and Trial Runs of a Field-Based Earth Science Workshop Designed for Nova Scotia Teachers

by

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ABSTRACT

Glaciers and Blueberries was a field-based earth science workshop developed and conducted in May and October 2018 for grade 4 and 7 teachers within the Chignecto Family of Schools catchment area. Quantitative and qualitative data consisted of questionnaires completed by an expert panel of 10 geoscientists and eight participants from the two separate workshops, as well as an analysis of completed workbooks by the workshop participants created specifically for the workshop. The teachers’ pre- and post-field trip views show an increase in their confidence and comfort with conducting a field trip. The expert panel emphasized logistics, field trip activities, and knowledge as key characteristics, which closely aligned to the teachers’ views. The workshops were effective in providing hands-on activities, an inquiry-based approach, and increased knowledge of earth science processes and concepts. Improving teacher attendance, developing a modularized workbook template, and integrating field-based learning were identified as future areas of development.
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DEDICATION

I first met Dr. Vic Levson at the University of Alberta, Vic was completing his PhD and I my Masters in Quaternary Geology over 30 years ago. We hadn’t spoken to each other for almost 20 years when we connected again at the beginning of this thesis. When it came time to decide on a thesis supervisor, I was so pleased that Vic accepted. I knew from his years of experience in supervising other students that he would make a great supervisor, mentor, and be deeply committed to supporting and assisting me through my thesis journey. I was deeply saddened by news that he had passed away. He will never know how privileged I felt for having him as a supervisor, and just as importantly, for getting to know him for who he truly was, a tremendously humble man, so knowledgeable, generous and genuine. I wish we could have shared this journey to the end, but I am grateful that we at least walked together along the path most of the way.
INTRODUCTION

Several years ago, I volunteered with a science education outreach organization that arranged for me, a geologist, to visit grade 3 classrooms to teach rocks and minerals. This long-lasting, positive experience of sharing my knowledge in earth science with such inquisitive young minds is what has renewed my interests in developing and participating in outreach education programs. The impact of these experiences, combined with my passion for raising awareness about the importance of earth science education, are what led me to pursue my current research.

I decided early on in my research that I wanted to focus on hands-on activities outside the classroom by showing teachers how they could run a field trip by participating in one that was designed for their students. This “learning-by-doing” approach was first established more than 100 years ago by Dewey (1985/1916), a philosopher and educational theorist. Dewey viewed education as a process that connects mind and body. Whereby the mind is what takes in the knowledge and the body, in turn, wants to act out that knowledge by doing.

When an activity is continued into the undergoing of consequences, when the change made by action is reflected into a change made in us, the mere flux is loaded with significance. We learn something. (Dewey, 1985/1916, p.163)

In this quote, Dewey explained the importance of the activity, or “doing”, and how the connection to action (by the body) is where learning takes place. Dewey (1985/1916) also stated that the role of the teacher is to guide the student in the “doing”.

Grounding my research on Dewey’s approach of “learning-by-doing” was the main impetus for doing this research. As such, my focus was to learn about developing and conducting an earth science field trip to help teachers with ways of “doing” earth science using a field-based learning approach. I chose to do my research in Parrsboro, Nova Scotia because this is where I
will continue with this endeavour post-thesis as I plan to build future opportunities for teacher professional development. A key factor in determining where I would conduct my research project was the opportunity to partner with the Fundy Geological Museum (https://fundygeological.novascotia.ca/), an important earth science resource for this rural area of Nova Scotia. Additionally, I chose to focus my outreach on teaching earth science in its natural setting, as a field-based workshop because I believe field trips and workshops can be highly effective ways to engage students.

Earth science curriculum is contained in the conceptual framework for the Canadian science curriculum under the headings of Science-Technology-Society-Environment (STSE); Skills; Knowledge; and Attitudes (Council of Ministers of Education (Canada), 1997). Knowledge topics include: Life Sciences; Physical Sciences; and Earth and Space Sciences (ESS). Included in ESS are the topics of earth science, meteorology, and astronomy. I developed workshops for grade 4 and 7 teachers because earth science first appears in grade 4 (Nova Scotia Department of Education and Early Childhood Development, 2015) where students first learn about rocks, minerals and erosion and then in grade 7 (Nova Scotia Department of Education and Early Childhood Development, 2014) where the topics include plate tectonics, geologic time, rocks, minerals, weathering, soil and the rock cycle. The earth science component in both these grades makes up 25% of the science curriculum.

For at least 16 years, starting in 1992, the Nova Scotia EdGEO Workshop Committee conducted 2-day, field-based workshops annually in the month of August (Van der Flier-Keller, Clinton & Haidl, 2009). These workshops provided Nova Scotia teachers with useful, first-hand, information about Nova Scotia’s geology, numerous curriculum-focused hands-on activities in the field setting, and resources which were invaluable in building teachers’ knowledge in earth
science. In recent years (since 2016), this committee has not conducted the 2-day field trips, but continue to provide EdGEO workshops at the Atlantic Science Teachers conference held annually on the professional development day in October. Based on a review of the workshops conducted by Nova Scotia EdGEO Workshop Committee, it appears that a field-based approach that teaches teachers how to conduct a field trip had never been done. It is for this reason that I created a workshop which provided teachers with a guide on how to conduct a field trip that they could take their students on in an area of close proximity to their school and included practical, curriculum-specific, hands-on activities to learn useful earth science field skills.

**Terminology**

In the context of this research project, I have provided a list of terms for the reader that this research will refer to:

*Earth Science:* predominantly geology-related topics that can include physical geography.

*Field Trip:* an excursion that takes place outdoors and is observed in its natural environment. In the context of this thesis, it does not include excursions to a zoo, aquarium, museum, or other locations that are predominantly reconstructions of natural settings.

*Geopark:* natural areas that have sites of geological interest.

*Outreach:* education provided by subject matter experts. In the context of this thesis, these subject matter experts generally include geologists, geographers and other geoscientists.

*Workshop:* a professional development venue for teachers that focuses on a specific topic related to their work and enhanced skill-building.

**Research Objective**

The main objective of my research is to gain a better understanding of how to effectively integrate field-based learning into grade 4 and grade 7 earth science curricula and as a result,
hopefully contribute my expertise in earth science, and provide a positive benefit to other environmental educators. I will achieve this by gaining insight from teachers about their approaches to teaching earth science and, more specifically, their views about conducting field trips. I will also seek additional insight from an expert panel of geoscientists who have experience with outreach and conducting teachers’ workshops that include a field-based component. In order to get first-hand input from teachers, I will develop a field-based workshop to teach teachers how to conduct a field trip linked to grade 4 and 7 earth science curricula. By experiencing a field trip, it is my hope that the teachers will gain a better understanding of its value and be persuaded to think more favourably about using field trips as a learning approach. Additionally, teachers will benefit from resource materials and templates they will receive which can assist them in organizing a future field trip for their students. After developing and leading the grade 4 and 7 workshops, I will also draw from my own personal learnings, to gain a better understanding of how to effectively integrate field-based learning into earth science curricula.

A pan-Canadian (Campbell et al., 2016) study on the status of teachers’ professional learning asserts that teachers find it important that they be provided with “opportunities to engage in and with external expertise and sources of professional development” (p.8) and “professional development that is practical and relevant to their needs” (p.9). Field-based teachers’ workshops provide excellent professional development opportunities to expand earth science knowledge in a field context. Equally critical, is familiarizing teachers with practical, hands-on activities to do in the field and where to conduct a field trip that will meet learning requirements. My efforts will concentrate on recruiting teachers from the local area to mitigate some of these challenges by conducting a field trip in close proximity to Fundy Geological
Museum (Museum). Schools within the Chignecto-Central Family of Schools are all within an hour’s drive of the Museum.

**Research Questions**

The research questions for this study are:

1. What are teachers’ views of field trips?
   a. Are teachers’ views altered after the workshop?

2. What are the views of an expert panel of field trips?
   a. How do they compare to the teachers?

3. How effective was the workshop?

4. What techniques worked best?

**Research Project**

To meet my objective and to answer my research questions, I developed a workshop to teach teachers elements of a field trip designed specifically to meet Nova Scotia curricula requirements for grade levels 4 and 7. Equally important in designing this field trip workshop, was incorporating practical field activities where the teachers would gain experience in observation, collecting data, and understanding the glacial landscape through their individual and collective scientific inquiry. Data collected from questionnaires completed by the teachers and an expert panel, in addition to an analysis of the teachers’ workbooks and personal observations, will form the basis for my research.
LITERATURE REVIEW

To better understand how to effectively integrate field-based learning into earth science curriculum, I conducted a literature review to form a knowledge base for developing and conducting a field-based workshop for teachers. This literature review will touch on concepts of earth science literacy, field-based learning and field trip design, followed by a review of earth science outreach programs available in Canada.

Earth Science Literacy

Earth science literacy is developed through cognitive and metacognitive skills that involve several forms of thinking, such as analogical, dynamic, logical, systems, spatial, temporal, and conceptual (Orion & Trend, 2009). Thus, teaching earth science requires thinking geologically and employing somewhat different approaches than the more traditional sciences of biology, chemistry and physics. In King’s (2008) global study of earth science education literature, he concluded more work needs to be done, in the areas of: effective professional development and teaching methods; earth science instruction using a systems-thinking approach; teaching spatial awareness and geological time; field work approaches; and eradicating misconceptions about earth science. This study included a comprehensive review of earth science curriculum of the United Kingdom, Europe, United States of America, and parts of Asia, Africa and South America.

Earth science is both an interpretive and historical science (Frodeman, 1995; Mogk & Goodwin, 2012) that requires spatial, temporal and retrospective thinking. The science of interpreting earth material relies on skills and training, such as: distinguishing between observations that are important and irrelevant; recognizing pattern and shapes; and reading and creating graphs and maps that represent the natural environment (Ishikawa & Kastens, 2005;
Reynolds, 2012). Earth science theory cannot be tested solely by experimentation and quite often the data can lead to one or more possible conclusions (Bond, Philo, & Shipton, 2011). In addition, the historical aspect of earth science requires an understanding of the key concepts of time (specifically, geologic time) and space (from one to three dimensional), and alignment of these two scales (Delgado, 2012; Grossner, 2012; Newcombe, 2012; Resnick, Atit, & Shipley, 2012). Geological time involves an understanding of both absolute time (measured in millions or billions of years) and relative time (in relation to sequence of events). Strategies to understand relative scales are more easily understood than absolute time (King, 2016) and can incorporate an understanding of temporal and spatial scales by visualizing or making a connection or association between events and time (Dodick, 2012). For example, an approach could include small scale examples such as annual tree rings or sediment layers in lake sediment or ice cores (Cervato & Frodeman, 2012) or much larger scale examples such as the Grand Canyon (Fenton, 2012).

Teachers may not know what strategies work best to teach earth sciences and unfortunately, most teachers will rely on the assigned textbook to design their curriculum (Brusi, Calonge, & Souza, 2016; King, 2008; Lydon & King, 2009). Practical approaches that engage critical thinking, employ hands-on inquiry-based instruction, and inform on knowing how to ask questions and interpret responses are examples of effective tools that teachers can learn to instruct earth science (Field, 2003; King, 2016; Lewis, 2008; Lou, Blanchard, & Kennedy, 2015; Orion & Kali, 2005). As well, teacher attributes such as confidence and experience are extremely beneficial in developing positive attitudes and values in students (Mogk & Goodwin, 2012). The “earthlearningidea” initiative is an excellent example of how a no-cost 90-minute professional development workshop (Lydon & King, 2009), sustained over a 16-year period (2009 to 2015),
led to more than half of the high schools in the United Kingdom and Wales in 2015 requesting a workshop (King, 2016). The significant volume of requests in 2015 for the workshop and the fact that two thirds of schools, within a year of completing the workshop, were using new teaching approaches learned from the workshop, attest to the success of this initiative. Products of this initiative were the development of guidelines on how to launch a similar workshop (King & Thomas cited in King, 2016) and on creating a web-based teachers’ resource for earth science activities (King, 2016). At the time King’s (2016) paper was being written, the Earthlearningidea website contained 250 curriculum-related earth science activities.

“Field instruction has been at the heart of geoscience curriculum for a century and a half” (Mogk, 2011, p.477). Mogk made this statement in the context of all levels of earth science instruction, starting with students in primary grades where they learn about rocks and minerals, up to professional geologists. Earth science is best learned by doing hands-on activities in the outdoors, where it can be studied in the natural environment. As such, teachers should be encouraged to augment their classroom learning activities by incorporating field-based instruction in order to provide students with a deeper understanding. There are a number of factors that influence the effectiveness of field-based learning. A few studies comparing instructional approaches demonstrated that students had deeper engagement and understanding of conceptual ideas as a result of an inquiry-based approach in comparison to an application of a linear, lecture-based and teacher-dominated approach (Gomes et. al., 2016; Remmen & Frøyland, 2014; Tretinjak & Riggs, 2008).

Teachers can also benefit significantly from earth science professional development training where they can gain procedural knowledge and develop effective classroom and field trip activities that enhance the cognitive and social thinking required in understanding geological
concepts. The Paleo Exploration Project (PEP) and GEOTEACH are examples of different approaches of field-based earth science professional development for K-12 teachers that were conducted in the summer by universities in the United States. Teachers in the PEP program attended three weekend workshops to gain knowledge in geology and palaeontology and learn how to use a variety of field measurement tools to investigate stratigraphic units (Almquist et. al., 2011). This was followed by a one-week field research project. Two years after completing the PEP program, 16 of 26 teachers responded to a survey, with 75% reporting that as a result of the program they had implemented changes to their curriculum. Teachers who had difficulty changing the curriculum gave reason such as: lack of school resources in technology, insufficient time, and wanting additional training to develop skills. The GEOTEACH program involved eight K-12 science teachers participating in three week-long field-based research experiences that were conducted over an eight-month period (Helmer & Repine, 2006). The successes of this program included such things as: the teachers’ increased confidence in geology topics; their ability to conduct effective inquiry-based lessons and construct hands-on activities; and their overall understanding of earth science processes. In another study, a comprehensive review of the Connecticut State-wide grade 7 earth science curriculum was the impetus for developing a museum-based professional development workshop for middle to high school teachers (Pickering et. al., 2012). Forty-seven teachers participated in a three-day workshop, which included a full day field trip, informed the teachers of the changes and introduced them to interdisciplinary, inquiry-based methods using hands-on activities. Based on self-report surveys, teachers indicated they had improved their earth science knowledge and were more comfortable with teaching strategies specific to earth science. Student outcomes also showed improved results in test scores in comparison to scores from the same teacher prior to participating in
GEOTEACH. All three of these examples represent different approaches that have been used by professional earth science institutions to provide effective, field-based research experiences for teachers of all grades to enhance knowledge and field skills in earth science.

**Field-Based Learning**

“The best geologist is he who has seen the most rocks” (Read as cited in Young, 2003, p. 371)

Read made this assertion at an address entitled “Metamorphism and igneous action” in 1940 during a time when there were heated debates about the origins of granite (Young, 2003). Doing fieldwork was and continues to be fundamental to understanding geology. A thematic paper by Mogk & Goodwin (2012) provides a comprehensive overview of field-based learning. They believed that field-based learning is framed by three aspects: the psychological processes of embodiment experienced by a person’s interaction with nature and the social environment; inscription when constructing maps, sketches, diagrams and other materials representing nature; and community of practice developed by selecting and using appropriate tools and communicating important aspects of the fieldwork. Much of the research on field-based learning shows there are cognitive gains, as well as the, equally important, element of social learning (Kastens, et.al, 2009; Mogk, 2011; Orion & Trend, 2009).

The cognitive and metacognitive learning goals for field-based education are predominantly aimed at learning by doing (Dewey, 1985/1916) through mastering field skills such as observing, measuring, writing field notes, sketching, creating maps and other representations of nature to essentially “read and tell the story of Earth” (Mogk, 2011, p.479). Another term that is in use is “geocognition”, coined by Libarkin (2006) in reference to geological thinking. Field-based education provides opportunity for problem-based exercises in the natural environment aimed at learning science by doing science. Metacognitive learning
takes place when concrete observations are conceptualized by constructing abstract models based on processes of interpretation, analyses and formulating hypotheses (Mogk & Goodwin, 2012; Orion, 1989). In the process of conducting field investigations and thinking geologically, field-based learning is developed by questioning what they are doing and why, determining what is interesting or important, reflecting on what was learned and identifying what new problems ensued (Mogk, 2011; Petcovic, Libarkin, & Baker, 2009). Practicing these field skills in the complex environment of nature generally leads to better understanding of the geologic concepts of spatial and temporal thinking.

Simultaneously with cognitive and metacognitive learning, a field trip facilitates collective social learning through interactions among peers and the field trip leader(s) (Hutchins & Renner, 2012; Mogk & Goodwin, 2012; Stokes & Feig, 2012; Streule & Craig, 2016). In addition, the shared experience of becoming part of a “community of practice” and building a sense of identity as a geoscientist is enhanced by engaging in field activities and using the tools of a geologist (Stokes & Feig, 2012; Streule & Craig, 2016). A positive experience of being immersed in nature also engages the affective domain (emotion, attitudes, motivation, values and perceptions), impacting positively on social learning (Mogk, 2011; Van der Hoeven Kraft et.al., 2011).

Social learning also includes what is referred to as situated and embodied learning (Hutchins & Renner, 2012) and also place-based learning (Semken et.al., 2017). Embodiment situates the observer in nature and it is the biological processes of the observer’s interactions with the natural environment, as well as with the tools that are used and activities performed in the field, that leads to learning. Place-based learning results when there is an attachment to a place, which inevitably is the result with field-based education. The “sense of place provides a
practical way to operationalize that relationship for purposes of research, teaching, and assessment” (Semken et al., 2017, p.544).

Undergraduate field-based courses are considered essential in preparing students for careers in earth science and remains a requirement to graduate with a degree in geology at many universities in Canada. A survey of participants attending the Geological Survey of America Annual Meetings in 2010 and 2011 indicated that fieldwork experience forms an integral part to learning and should be a requirement to graduate (Petcovic & Stokes, 2014). Other university faculties also consider field work to be very valuable, such as geography (Kent, Gilbertson, & Hunt, 1997; Speights-Binet & Gamble, 2008) and archaeology (Cobb & Croucher, 2012; Mytum, 2012).

Different approaches have been employed to provide effective field-based learning for undergraduate earth science students. For example, a newly designed second year geology course at the University of Alberta that incorporated a “simulated” field environment to allow students to practice field skills resulted in students being better prepared (Waldron, Locock, & Pujadas-Botey, 2016). This was based on student surveys that compared students who completed the course before and after the new course was implemented. In another study, improved course results from 21 students on two courses at the University of Pittsburgh demonstrated that student-led field trips and learner-centred teaching improved learning (Davis Todd & Goeke, 2012). The final assignments for this course included a poster presentation at the campus research symposium and creating a geology field guide of the week-long field trip. A case study of a multidisciplinary geology and geography course attended by students in geology, environmental sciences, environmental studies, and geography at Slippery Rock University in Pennsylvania is another example of an effective field-based learning approach (Schiappa &
Smith, 2018). Student evaluations and faculty experiences and observations concluded that the course enhanced peer-based and collaborative learning. Another study reported that an undergraduate at-sea field program achieves the same level of enhanced learning as effective land-based field programs based on the students’ proper application of the skills required to meet scientific objectives (Law, 2012). University field-based courses play a significant role in enhancing earth science learning. They have the ability of transferring the theory learned in the classroom to applying and learning field skills that demonstrate proof of deeper learning and understanding.

**Field Trip Design**

The goal of a field trip should be to provide effective field-based learning. This can be achieved by ensuring learning takes place from the experiences of being in nature and that this learning is then transformed into knowledge. Transformational learning that results from an experience is defined by Kolb (1984) as experiential learning. Kolb developed his four-stage model from models of three educational theorists, Dewey, Lewin and Piaget, the founders of experiential learning approach. Kolb’s (1984) model involves transforming the concrete experience to an abstract conceptualization, and also includes affective factors such as reflection and experimentation. Experiential learning is enhanced when a field trip has both quality, first-hand experiences and “novelty space” factors that influence learning (Orion, 1989; Orion & Hofstein, 1994). Quality, as defined by Orion & Hofstein (1994), consists of an effective element that relates to structure, learning materials, teaching method, and being able to “direct learning as concrete interactions with the environment”.

One of the pioneers in the study of field-based learning, using field-trips as a key form of education, was Orion (1989). He contended that in order for a field trip to be an effective
learning experience it must include both pre- and post-field trip activities. He concluded that the preparation leading up to the field trip, referred to as “novelty space”, was one of the most important design elements of a field trip. The aim of the pre-field trip preparation was to reduce the effects of “novelty space” which he defined as having three components: previous knowledge (e.g. cognitive), previous outdoor experience (e.g. psychological) and acquaintance with the field trip area (e.g. geography). Orion believed that having previous knowledge of the topic being studied would enhance the cognitive aspect of learning. Students with previous outdoor experience were seen to have reduced psychological aspect of fear and without this previous experience the outdoors may be uncomfortable due to it being in an unfamiliar setting. The aspect of being acquainted with the geography of the place being visited on the field trip was also seen to help reduce the potential negative impact associated with being in a place for the first time (the unknown) and not knowing what to expect.

An example of a comprehensive study involving almost 300 high school students in Israel taking part in a one-day field trip was completed by Orion & Hofstein (1994). Their study compared three groups of students that received different levels of preparation and took part in the field trip at different times during the earth science unit. Data was collected from interviews, questionnaires, observations of performances in the field, achievement test and the teacher’s self-report and at three stages (before, during and after the field trip) of the research. Group 1 conducted their field trip in the middle part of the unit and followed Orion’s (1989) field trip model consisting of pre- and post-field trip activities. Group 2 had no pre- nor post-field trip activities and took part in the field trip in the middle of the unit. The third group waited until the end of the unit to go on the field trip and they also had no pre- nor post-field trip activities. Group 1, with the highest level of preparation of the three groups, had “significantly higher
scores on the knowledge test and gained more positive attitudes than the others” (Orion & Hofstein, 1994, p.1115). The results from Group 1 demonstrated the importance of reducing the novelty space by conducting the pre-field trip preparation.

An important component to include in the field trip design, is creating relevant curriculum materials. These materials should include a teacher’s field guide, student’s field guide, and instructional aides, such as mini-posters, to help guide the field observations (Esteves, Fernandez, & Vasconcelos, 2015). The student’s field guide explained the activities planned for the field trip, but still allowed the students to decide (with teacher guidance) what to observe and why, as well as how to represent and interpret their field observations in a meaningful manner (Mogk & Goodwin, 2012).

A number of studies provide guidance on how to conduct some common field activities effectively, such as rock identification, field observations, and field sketching (Clary & Wandersee, 2010; Frøyland, Remmen, & Sørvik, 2016; Hawley, 2002; Reusser, Corbett, & Bierman, 2012; Tucker & Tucker, 1998). Frøyland et.al. (2016) compared elementary and secondary students to see how well they would complete a rock identification exercise one year after they had learned it. The secondary students, who focussed on geological terminology and learning rock names, had more difficulty distinguishing rock types than the elementary students who learned about the rock types by noticing patterns and interpret features. For example, the elementary students associated patterns such as “layer upon layer” as sedimentary and were able to recall what they had learned one year later. Hawley’s (2002) pedagogical approach to distinguishing rock types focussed, as well, on observations of rock textures. After learning patterns of “grain relationships” and “grain arrangements” and guided by simplified diagrams outlined on a worksheet, separate groups of students (aged 7-11 years and 11-14 years) were able
to successfully sort a group of rock into the proper rock types. Another pedagogical approach that results in success entailed geomorphology students creating a map of the field study area and adding captions that demonstrated their understanding of geological processes and interactions taking place at different locations (Reusser, Corbett & Bierman, 2012). This is a similar concept to the Geoscapes posters there were created for several Canadian cities and Geotour guidebooks highlighting various locations in British Columbia and Ontario which increased public awareness of earth science and are excellent resources for teachers (Turner, 2013).

After completing their learning in the field, a reflection activity to cap off the field trip is a worthwhile approach to get a sense of the affective domain of the participants. Two of the common measurement tools that are widely used are the Connectedness to Nature Scale (CNS) (Mayer & Frantz, 2004) and Nature Relatedness (NR) scale (Nisbet, Zelenski, & Murphy, 2009). A number of studies conclude that a strong connection with nature leads to greater well-being and caring more deeply for the environment (Beery, 2013; Braun & Dierkes, 2017; Nisbet & Zelenski, 2013; Williams & Chawla, 2016; Zelenski & Nisbet, 2014).

Very few studies were found on the post-field trip activities and studies on field trips that indicated that follow-up activities were included, generally, provided few details about the activities that were performed. One study, however, by Remmen & Frøyland (2015) evaluated the follow-up activities of six classes (three teachers in three high schools) using video observations, instructional and student end products, and teacher interviews concluding that overall students performed poorly. The recommendations that followed were similar to Mogk & Goodwin’s (2012) explanation of a geology field course, which begins with giving context such as posing a question, or suggesting a dilemma as Remmen & Frøyland (2015) concluded. Thus, the follow-up activities will have greater purpose when, as a group, the findings are discussed
and they decide on an interpretation. The final report, therefore, is not simply a compilation of the field activities, but rather a continuation of their learning by conceptualizing the data they collected in the field and leading to a deeper understanding.

A study surveyed 178 biology and geology teachers in elementary and secondary schools in Portugal, identified several reasons that discourage teachers from conducting field trips (Gomes et al., 2016). Field based programmes for undergraduate geosciences also faces similar challenges (Maskall & Stokes, 2008). A comparison of barriers (Figure 1) demonstrates similarities between these two types of field-based learning. Both programmes noted lack of knowledge in teaching earth science in the field, lack of administrative support, difficulty dealing with time constraints, either access to or unfamiliarity with field sites, and costs as barriers. Most of these challenges are logistical factors and as such, have the potential to be mitigated over time. However, the lack of knowledge, if it persists as a barrier, will likely become more and more difficult to overcome.

<table>
<thead>
<tr>
<th>barriers for undergraduate fieldwork (from Maskall &amp; Stokes, 2008)</th>
<th>barriers for school field trips (from Gomes et al., 2016)</th>
</tr>
</thead>
<tbody>
<tr>
<td>- staff expertise and motivation</td>
<td>- teachers do not feel prepared</td>
</tr>
<tr>
<td>- fieldwork is less likely to be a compulsory part of training</td>
<td>- difficulty completing programmes due to administrative causes</td>
</tr>
<tr>
<td>- time for planning and delivery</td>
<td>- time constraints</td>
</tr>
<tr>
<td>- access to sites</td>
<td>- lack of suitable sites</td>
</tr>
<tr>
<td>- students’ reluctance to give up extra time</td>
<td>- students’ economic constraints</td>
</tr>
<tr>
<td>- cost in comparison to lecture-based teaching</td>
<td>- unfamiliarity with areas of geological interest</td>
</tr>
<tr>
<td>- health and safety</td>
<td>- difficulties in planning due to lack of support materials</td>
</tr>
<tr>
<td>- equal opportunities</td>
<td></td>
</tr>
</tbody>
</table>

*Figure 1. Comparison of barriers for two types of field-based programmes.*

Two informative references on planning and implementing a field trip are summarized in two guidebooks intended for instructors conducting fieldwork for geography, environmental and earth science (GEES) subjects at the University of Plymouth, in the United Kingdom (Butler, 2008; Maskall & Stokes, 2008). Butler (2008) provided guidance on how to teach earth science
in the field and emphasised the importance of developing strong field skills. Although the guide has a university-level context, practical guidance was provided on types of fieldwork, field activities, how to prepare for fieldwork, and issues related to cost and health and safety. Maskall & Stokes (2008) included a number of similar topics to Butler (2008), but targeted a broader scope of disciplines that included environmental and natural sciences, in addition to earth science. A framework defining the influences and elements of fieldwork design (Figure 2) framed the detailed discussions of Maskall & Stokes (2008), which also included several case studies that provided insight into real-life experiences. These GEES guidebooks provided essential components of the field trip of knowing what activities to conduct and how to conduct them.

<table>
<thead>
<tr>
<th>Influences of fieldwork design</th>
<th>Elements of fieldwork design</th>
</tr>
</thead>
<tbody>
<tr>
<td>educational theory; curriculum requirements; characteristics of students; costs and resources; new technology; staff time and motivation; access to field sites; equal opportunities; health and safety; and professional requirements.</td>
<td>style; mode and duration; class and group size; locations and sites; pre-field activities; field activities; post-field activities; assessment; evaluation; and aims</td>
</tr>
</tbody>
</table>

*Figure 2. Two frameworks for designing fieldwork (Maskall & Stokes, 2008).*

The elements of fieldwork design listed in Figure 2, developed in the context of geoscience degree programs in the United Kingdom, resemble many of the factors identified in Orion’s (1989) model. Notably, the inclusion of pre-field, and post-field activities is foremost in these two models. The Maskall & Stokes (2008) model can be easily translated into terms that would apply for designing a field trip for elementary and secondary students, signifying there is not much difference when it comes to designing a field trip, notwithstanding the education level.

**Field-Based Earth Science Learning in Canada**

Throughout most of Canada there are a number of organizations offering excellent field-
based earth science learning for teachers. A list of some of these organizations is as follows:

- EdGEO (managed by the Canadian Geoscience Education Network)
- Mining Matters; and
- UNESCO Global Geoparks.

Canadian organizations such as EdGEO and Mining Matters are similar in that they offer teachers’ earth science resources and workshops in a number of provinces, including Nova Scotia. The EdGEO program was the product of a movement started by the geoscientist community in the 1980s to increase the general public’s awareness about earth sciences. Thus, outreach opportunities were initiated specifically for teachers to help them improve the quality of earth science education. In the 1990s, the Canadian Geoscience Council founded the Canadian Geoscience Education Network (Vodden, 2009). This is a national organization that is primarily focused on science education and outreach throughout Canada, of which EdGEO is one of its core programs. Educational products distributed at EdGEO teachers’ workshops in Nova Scotia have generally consisted of modified geology field guides (J. Bates, personal communication, 17 May 2017). Unfortunately, these products do not include practical exercises or applications that the teachers can use in designing a field trip for their own students.

Mining Matters initially began as an outreach organization to bring awareness to the importance of the mining industry to Ontario schools. It continues to expand, reaching out to new geographic locations and providing both teacher and student outreach programs and resources for primary to high school levels (Bank, Jackson, & Hymers, 2009). The workshops offered by this organization typically begin with a morning of hands-on classroom activities, followed by an outdoor experience where they mostly observe and learn.
Valuable resource opportunities that offer earth sciences education on a global scale are UNESCO Global Geoparks. Their mandate involves three main tenets—namely conserving a healthy environment, providing geoscience (referred to as ‘earth science’ in other parts of this paper) education, and safeguarding a sustainable local economy (Nowlan, Bobrowsky, & Clague, 2004). The potential for earth science education in its natural environment, outside the classroom, has become more feasible with the increasing number of new UNESCO Geoparks established since the program was initiated in 2002 (Dowling, 2011; Ruban, 2015). Canada is fortunate to have the Stonehammer UNESCO Geopark, located in St John, New Brunswick, Tumbler Ridge UNESCO Geopark in British Columbia, and Gaspe UNESCO Geopark in Quebec. In addition to these there are also the UNESCO Aspiring Global Geoparks. These are Geoparks that have formally applied for formal admission into the UNESCO Global Geoparks Network. It’s encouraging to see that there is growing interest in promoting natural environments for the purpose of providing earth science education.

UNESCO Geoparks provide a large spectrum of different approaches to earth science education to three main target areas; tourists, schools (both students and teachers), and local communities. Based on the Global Geopark Network Annual Report for 2016, only eight of the 119 Geoparks reported that they provided teachers’ training, which included the Stonehammer UNESCO Geopark. Stonehammer is participating in one of the working groups of the UNESCO “Drifting Apart” initiative to develop a toolkit that will include teacher resources (G. Bremner, personal communication, 31 October 2017). This initiative includes seven countries (Canada, Iceland, Ireland, Northern Ireland, Scotland, Norway, and Russia) joined by a common geoheritage. The products they develop will be accessible and shared amongst them to provide visitors a global experience that will take them beyond the Geopark they are visiting. This toolkit
will be useful for outreach organizations developing professional development opportunities for teachers.
METHODOLOGY

My research used a mixed method approach to gain views of field-based earth science workshops, including a workshop I specifically developed for Nova Scotia teachers. Questionnaires were created for two participant groups, namely the teachers and an expert panel. Additional data were collected from a detailed review of the teacher’s workbooks that I created and distributed at the workshop for them to complete. Data were analyzed to determine common themes on views of the workshop including improvements and recommendations for design and instruction. The results of this analysis will help to develop future workshops and field trip programs for both teachers and students.

As this research involved human participation, an ethics review was carried out and approved by the Royal Roads University Research Ethics Board prior to work being conducted. This ethics process included a sponsor agreement signed by the Fundy Geological Museum and all participants consenting to participate in this research by signing an informed consent form. Permissions were also granted by the workshop participants to include their original works from the workbooks they completed during the workshops. As well, Dr. Ralph Stea and Mrs. Pat Welton granted permission to use their photos in this thesis.

Workshop Setting

The first step in developing my workshop was choosing a field location. I selected the Parrsboro River valley and the vicinity of the town of Parrsboro in Nova Scotia to conduct my field trip because of its open terrain and multiple road network. The area had multiple sites that were readily accessible and included glacial landscapes such as, glaciofluvial terraces, kettle lakes, kames, and end moraine and glacial lake terrain that could be easily investigated. Another deciding factor was the Fundy Geological Museum (the Museum), located in Parrsboro, agreeing
to sponsor the workshop. As part of the agreement, I felt it would be useful to develop a field trip that could be easily integrated into the Museum’s field programs. The Museum is centrally located for schools in the Chignecto-Central Family of Schools catchment area and commonly visited by many of them for school field trips, thus making it an ideal meeting place for the workshop. The Museum assisted with the workshop by providing some of the administrative support to organize the field trip and classroom space for the workshop.

To develop the workshop as a one-day event, the field trip portion had to be in close proximity to the Museum. There are many local areas with various geological interests to choose from, but it was the unique glacial landscapes, which is my area of expertise in geology, of the Parrsboro River valley that made me decide this was an ideal location.

The Parrsboro area is one of the most productive areas for the wild low-bush blueberry industry (refer to photo in Figure 3) in Nova Scotia due to the local geology. The glacial deposits in the Parrsboro River valley are ideal sediments for blueberries due to their well drained acidic soil properties (Kinsman, 1993). To showcase this industry, I arranged for the owner of the Newville Farm Ltd to provide a short presentation about their blueberry production. They also included information on their maple syrup production. Since they have a full restaurant on-site, they even generously offered to provide a home-cooked lunch for the field trip using some of their favourite blueberry recipes.
Figure 3. Wild low-bush blueberry fields at the terrace stop (photo from Stea, n.d.).

Curriculum Links

The complex and varied geology of Nova Scotia and adjacent provinces has resulted in glacial deposits that contain a large assortment of igneous, sedimentary, and metamorphic rock types. The abundance of easily accessible locations to view glacial landforms and sample glacial deposits in the Parrsboro area make it an ideal setting for a field trip that can be well integrated into the grade 4 and 7 earth science curricula. The gravelly nature of the glacial deposits contained in the terraces (Figure 5) and kame fields (Figure 6) are excellent locations to learn about glacial landscapes, as well as sites to collect samples that represent the three different rock types.
To highlight both the glacial geology and the rich history of the blueberry industry, the initial intent was to integrate both the science and social studies curriculums into the field trip. The lists, by grades and topics, of related curriculum links are given in Table 1. The May workshop included field activities linked to social studies curriculum, but these were removed from the October workshop. The reason for removing the social studies was based on feedback from most of the participants of the May workshop who recommended running separate field trips for the earth science and social studies curricula. Additionally, because the duration of the field trip portion of the October workshop was reduced by two hours to accommodate classroom activities prior to and after the field trip, there was not sufficient time to complete both the earth science and social studies field activities. Consequently, the October workshop focused solely on earth science curriculum.
Table 1

**Nova Scotia Curriculum Topics Linked to the May Workshop**

**Grade 4 Science**
- Explore rocks in the environment, collect samples, and record observations.
- Classify and compare rocks and minerals according to their characteristics.
- Explore uses of rocks.
- Explore the connections among the rock cycle, soil, and weather.
- Investigate an example of erosion.

**Grade 4 Social Studies**
- Explore different types of physical environments, which can include mountains, rivers, islands, and oceans.
- Explore how the physical environment impacts where people live and how they live.
- Examine the climate, vegetation, and natural resources found in each physical region of Canada.
- Interpret print and digital photographs to gain an understanding of the varied geographical features of Canada.

**Grade 7 Science**
- Classify minerals and rocks on the basis of their characteristics and method of formation, and compare with classification key.
- Investigate and explain various ways in which rocks can be weathered and explain the rock cycle.
- Relate various meteorological, geological, and biological processes to the formation of soils.

**Grade 7 Social Studies**
- Analyze how commodities that lead to economic empowerment have changed.
- Investigate the various ways economic systems empower or disempower people.
- Analyze trends that could impact future economic empowerment.

**Workshop Participants**

An information package to recruit teacher participants for the field trips was created to explain the workshop and curriculum topics that would be covered. I came up with the name “Glaciers and Blueberries” for my workshop title to include these two important elements and to also attract attention by using a catchy title. Most of the glacial landforms visited on the field trip are covered with low-bush wild blueberries that are harvested every fall. The Parrsboro area is well known for their wild blueberries, with extensive fields found ubiquitously in the areas
surrounding the town of Parrsboro and the river valley to the north. Including blueberries in the workshop title lead to a decision to add social studies curriculum to the workshop activities. The thinking was that the workshop would attract both social studies and science teachers, and thus greater teacher participation.

The first opportunity to recruit teachers was done by handing out the workshop information package at a booth set up by the Fundy Geological Museum at the annual Atlantic Science Teachers Conference on 27th October 2017, held in Halifax. Following this event, I focused my efforts on attracting teachers from the Chignecto-Central Regional School Board (CCRSB) as the primary target audience for my workshop. I distributed an information package via email to the CCRSB principals, through the help of the CCRSB science consultant (G. Nix, personal communication, 24 November, 2017). As well, the staff at the Halifax office of the Geological Survey of Canada – an organization that has conducted several EdGEO teachers’ workshops – sent out the information package to teachers on their mailing list. The Museum also advertised the workshop on their Facebook page and reached out with phone calls to local schools in the area and their other established contacts providing information on the workshop.

The initial intent was to conduct the workshop on the province’s professional development (PD) day taking place on 18th May 2018. Unfortunately, the date had to be rescheduled for a weekend day as CCRSB denied permission for the teachers to attend the workshop on their PD day and I did not have financial resources to pay for substitute teachers to allow them to be absent on a school day. To avoid the Victoria Day holiday weekend, I advertised workshops for Saturday, 26th and Sunday, 27th May 2018 to allow for greater participation. The Sunday date was cancelled a week prior due to low registration numbers. It was hoped that a minimum of 10 teachers would register. Three teachers from three different
CCRSB schools registered for the grade 7 workshop that took place on Saturday, 26th May 2018 (Figure 5). In addition to the teachers, three museum staff volunteered to complete the grade 4 workbook at the May workshop. Two of the Museum staff were second-year university science students hired for the summer and the third was full-time staff.

Due to the low teacher turnout at the May workshop, a second one was organized for the fall of 2018. Recruitment for the second workshop began immediately after the May workshop. Several attempts to contact CCRSB via email and phone in early June were unsuccessful. This may have been attributed to the fact that the province had recently dissolved all their regional school boards, replacing them with one provincial board and resulting in staff changes. The CCRSB was renamed the Chignecto Central Regional Centre for Education (CCRCE) and the area around Parrsboro was designated as the Chignecto Family of Schools. In early September, I found contact information on the new board’s website and sent an email to the Chignecto Family
of Schools superintendent. I was able to arrange a meeting the following week where the superintendent facilitated getting the CCRCE board’s permission for teachers to attend the workshop on the PD day on 26th October 2018. The superintendent sent out notices and provided the school principals with information about the workshop. After a number of weeks and with no one registered for the workshop, I sent out workshop information to principals of all the elementary and junior high schools (13 schools in total) using email addresses listed on the, newly created, board’s website. As well, the Museum, once again, advertised this second workshop on their Facebook site and went out with phone requests.

Despite the permission being granted, no teachers from the CCRCE board registered for the October workshop. It is possible that the information did not reach the teachers, and if it did, perhaps they had already registered for the Atlantic Science Teachers (AST) conference that took place the same day as the workshop. The AST conference is organized by the Nova Scotia’s Teacher Union and it takes place every year in Halifax on the fall PD day, usually the last Friday of the month of October. I had registered the workshop with the AST conference but removed the application once I was made aware of the requirement to charge a $100 registration fee and that it was my responsibility to arrange transportation because the teachers had to depart from Halifax to attend the workshop. Going ahead with this arrangement meant that only teachers attending the AST could register for the workshop and that significant modifications to the activities would have been needed to account for the four hours on the bus driving back and forth to Halifax. As well, the pre- and post-field trip activities would have had to have been completed on the bus – a setting that would have likely been extremely challenging for learning.

The October workshop was attended by two teachers (Figure 6). One was a junior high teacher from a Reserve school and the second was a home-schooling mother with children in
grades 4, 7 and 9. Since the junior high teacher was not with the provincial school board, the day scheduled for the workshop was not a PD day for their school. In order to attend the workshop, her principal had to grant her permission to attend, as well as provide to reimbursement for her travel expenses and covered the cost of a substitute teacher for the day. In the case of the home-schooling mother, she had to arrange care for her three children as this was not a planned day off for them.

Prior to the start of both workshops, I explained my research project to the participants and requested their consent to participate in my research on a voluntary basis. All participants consented.

**Expert Panel Participants**

Prior to conducting the workshop, I recruited an expert panel to help guide me in refining the structure and type of activities planned for the field trip, as well as to provide additional data from their perspective.

![Figure 6. October workshop at the terrace (a) and kame field (b) stops (photos by Pat Welton).](image-url)
The expert panel (EP) was selected from geoscientists who responded to a member-wide email distributed to Atlantic Geoscience Society members requesting volunteers to complete the expert panel questionnaire for this research project. In addition, recommendations for other panel members were provided by research colleagues, recent contacts I made through inquiries on outreach organizations, and by people who were referred to me from some of the other expert panel members. A total of 10 geoscientists (five women and five men), all subject matter experts in earth science outreach programs, agreed to participate in my research project.

Six of the geoscientists had over 20 years of experience in outreach activities, three had between 10 and 15 years, and one had four years. Collectively, they had work experience in all Canadian provinces (with the exception of Newfoundland and Labrador) and isolated parts of the Canadian Arctic. One conducts workshops exclusively to college and university instructors, while the remainder span educational levels from Kindergarten to grade 12. Half of the expert panel indicated they are actively involved in developing outreach activities and all have led field trips as part of a teachers’ workshop. When asked, based on their personal involvement in workshops, what percentage of them took place outside, as a field portion; two answered ≥ 80%, four ranged between 45-50%, three between 25-30%, and one answered 5%. The expert panel members are employed (or retired) by a wide range of organizations, including the Geological Survey of Canada, provincial geological surveys in New Brunswick and Nova Scotia, Mining Matters, universities in British Columbia, Ontario and New Brunswick, and a museum in Manitoba. Collectively, their outreach experiences have been delivered in locations across Canada and some remote northern communities. Overall, the expert panel represents a good diversity of geoscience researchers and educators, based on the demographic information that was provided.
Field Trip Design

The first phase in developing the workshop was to structure and integrate the grade-specific relevant earth science curriculum links around the field trip activities. The composition of the glacial sediments in the Parrsboro valley consist of a large variety of rock types, making them an ideal source for activities related to rock identification – a curriculum topic for both grade levels 4 and 7. I decided this would be the main activity for the field trip and included additional activities related to erosion and soil which are also in the curriculum for these grades.

A major component of the field trip design was determining the itinerary, with the major constraint being time. To allow teachers time to get to the Museum and to return home at a reasonable hour, the workshop began at 9 am and ended at 4 pm. In addition to the travel time, I allotted a total of 90 minutes for classroom activities (prior to and after the field trip portion of the workshop), as well as time to complete the teacher questionnaire. Thus, less than five hours remained to conduct the field-trip portion of the workshop after subtracting 30 minutes for lunch.

The potential stops for the field trip stem from a unique publication, Vista 3 (Stea, n.d.) which provides information on the glacial geology of the area and the location of key sites in the vicinity of Parrsboro. A tour of the area, prior to developing the workshop, was arranged with Dr. Ralph Stea, a provincial geologist with detailed and expert knowledge of the glacial geology of Nova Scotia, and specifically, the Parrsboro area. The glacial landscape and exposures of glacial sediments we visited were easily accessible by road and were excellent locations to incorporate earth science-related activities that could be tailored to the grade levels 4 and 7 curricula. The surficial geology of the Parrsboro River valley and the town of Parrsboro (shown in Figure 7) shows the diversity of glacial deposits and landforms of this area. Based on the information from Stea’s first-hand knowledge and further research of relevant publications (Stea
& Finck, 1986; Stea, Finck, & Wightman, 1986; Stea et.al, 2011), a draft itinerary and structure for the field trip was created. The area was revisited to determine the exact locations for the field trip stops and what activities would be appropriate for each location. As well, since all locations were on private land, the Museum staff contacted each of the land owners to get permission in order to access their land for the workshop. I developed various curriculum activities to be done at the field trip stops and created a workbook with exercises and questions for the teachers to complete.
Figure 7. Glacial geology of the Parrsboro area (maps modified with permission from Stea and Fink, 1986)
Field trip locations and itineraries

The map illustrated in Figure 8 shows the field trip stops that were visited in the May workshop. The town of Parrsboro, Nova Scotia is located immediately south of the lower map boundary. The distance travelled by road from the first stop to the end is approximately 20 kilometres. Notice that all stops are located next to the road or within a few minutes walking distance from the road, thus easily accessible.

*Figure 8. Field trip locations shown by Stop #s for the May workshop (map modified with permission from publicly accessed NTS topographic map from the Natural Resources Canada website).*
Due to the reduced number of hours for the field trip portion of the October workshop, the gravel pit stop was removed and the sequence of the remaining field trip stops was readjusted to fit the revised itinerary.

**Field trip activities**

Both workshops began with pre-field trip activities that included information about the research project, signing consent forms, completing the pre-field trip questionnaire and reviewing the field trip activities. Based on the incomplete and lack of rock descriptions completed by the teachers at the May workshop and feedback suggesting that rock descriptions could be completed in the classroom, it was clear that changes had to be made to the next workshop. Thus, additional time was allotted for the pre-field trip activities to provide a lesson and hands-on practice to learn how to identify rock textures and rock types (Figure 9), as well as for the post-field trip activities to complete rock identifications. This implied field trip activities would also need to be changed with less time to complete them than the first workshop.

*Figure 9. Pre-field trip activities from the October workshop (photo by Pat Welton).*

The field trip activities for both workshops included writing responses to questions in the workbook, sketching, collecting rock samples and completing an erosion experiment (or parts of the experiment for the October workshop). To complete the field activities, the participants were
provided with resources. These included a binder containing the field trip workbook and field supplies, commonly used by a geologist, such as a hand lens, cloth sample bags and a field notebook, as well as a water bottle, clip board, large plastic bucket, marker, pencil, eraser, ruler and backpack. Some of these field supplies can be seen in Figure 10a. For the erosion experiment conducted during the May workshop, the teachers were provided with a plastic sieve (Figure 10b.). The teachers kept all these resources with the intent that they would be used for teaching earth science to their students in future.

Prior to leaving the Museum for the field trip, a few minutes were taken to briefly skim through the workbook to explain the field activities, as well as go through the field supplies. While on the way to each site, the teachers were asked to review the site-specific information in the binder and to place the relevant exercise forms on the clip board to take with them to the site. Upon arrival at the site and as the teachers looked over the area, I spent about 10 minutes talking about the glacial history, formation of the landforms they would be investigating and explaining the activities to be completed. At the terrace and kame field sites, a brief lecture was also
provided on the blueberry fields that surrounded them, including some of the harvesting practices. Teachers were reminded about how long they had at the site to complete the exercises. While at the site, I walked around to see if there were questions and to assist them, if required.

The post-field trip activities planned for the May workshop were intended to take time to discuss the teachers’ feedback of the field trip and to complete the post-field trip questionnaire. Because all the teachers had questions about their rock descriptions, I spent time, individually, with each of the teachers discussing their observations of the rocks they had collected in place of the feedback session. For the October workshop, the intent was to complete the rock descriptions, as well as an erosion experiment designed to be conducted in the classroom. Both teachers at the October workshop had done minimal work on the rock descriptions while they in the field, indicating that most of the time at the field trip stop was spent finding rocks that looked different and that included the three different rock types.

**Reflection activity**

The last stop of the field trip consisted of a silent walk through the forest and stopping at a lake side where teachers they were instructed to reflect on the day. During this reflection the participants were instructed to go to the page in their workbook for this stop. The explanation on this page asked them to reflect and provided suggestions to write down their thoughts or perhaps a poem, sketch, or even just reflect in silence (Figure 11). Following this, they completed a Nature Relatedness survey (Nisbet, Zelenski & Murphy, 2009) consisting of 21 questions. The teachers were instructed to place their surveys in the envelope provided for them and then put it in a larger envelope so as to keep their responses anonymous.
Workbook Design

The workbook was designed as a guide for the teachers to follow and structured such that they could use it to lead their students on this field trip. As such, I conducted the workshop by following the structure of the workbook to demonstrate how to conduct a field trip, including relevant geological information of the field trip’s glacial environment and curriculum specific topics, instructions on how to complete the field activities, and documents to complete. A key consideration for the workbook was use of common vocabulary written for the student. This meant using terminology to describe the geology and instructional activities that the students would understand. The teachers were provided an electronic copy of the workbook to use as a field trip template that they could modify and use for their students.

I searched through a number of websites for educational resources looking for ideas for field trip activities and examples of field trip guides, including: EdGEO; Grade 4 TERC Inquiry Project; National Association of Geoscience Teachers and Pacific Education Institute. I also received paper copies of grade 3 (Cridland, Hein & Nowlan, n.d.) and grade 7 (Nowlan, Ross & Rheinstein, 2014) earth science field trip guides created by the Calgary Science Network.
Although neither of these field trips were conducted in Nova Scotia and the type of geology was different, they provided a useful framework and examples of practical activities that I could modify for my own field trip. I reviewed glacial geology information for the Parrsboro area to write up site specific background information for each of the planned stops for the field trip. In addition to these references, I applied my experience with developing, planning and implementing activities in the outdoors for military training events and geology field trips I had attended to the development of the workbook.

Prior to conducting the May workshop, I received feedback on the workbook from a number of the expert panel members, as well as a retired science teacher (suggested to me by an expert panel member). Their input helped to improve the workbook by providing better clarity to the written text, providing advice on making sure the “what” and “whys” were clearly defined, suggestions to be mindful of time constraints, and be careful not to plan too many stops and activities while in the field.

**May workshop workbook design**

I created separate workbooks for each of the two grade levels for the May workshop. The first section of each workbook explained my research project and what was involved in the request to consent to participate in the research. The second section was a teacher guide explaining the curriculum links, the field trip design and feedback questions to fill out during the conduct of the workshop. These first two sections were designed for the teacher’s use and not for distribution to students as part of the field trip. The third section, and most substantial part of the workbook, was the student workbook. This section was subdivided into three subsections: Introduction, Handouts and Exercise Booklet. The Introduction subsection contained an introduction on glacial geology and information about the field trip including; a map showing the
locations of the field trip stops, an itinerary, field trip activities, a list of field supplies and a safety brief. The Handout subsection included background information, the activities that had to be completed and reference material for each of the stops. The Exercises Booklet subsection contained the questions to complete at each stop. The last section was a list of reference material.

The main field activities for the May workshop included rock collecting, sketching, note taking, and conducting an erosion experiment. To encourage organic observations and self-inquiry, I purposefully wrote broadly-phrased instructions and avoided asking for specific details. The intent was to encourage the teachers to describe the rocks using common vocabulary, to determine for themselves what characteristics distinguished one rock from the other, and to sketch whatever they felt was important from their observations. I didn’t want the teachers to worry about having to use geological terms. For example, an acceptable description could have been “contains bits of rocks” in place of a “clastic texture”. This strategy of noticing rock characteristics using common vocabulary proved to be more effective in learning how to distinguish rock types in comparison to learning geologic terminology and memorizing rock names (Frøyland, Remmen, & Sørvik, 2016; Tucker & Tucker, 1998). The teachers were given a field notebook with headings annotated on the first page to provide a template for the information to include in the rock description. The teachers collected rocks from the terrace (Prospect Road) and the kame (Highway 2) field stops and were instructed to find at least five different types of rocks from each site.

The sketching activity was completed at four field stops: the terrace (Prospect Road), kame field (Highway 2), end moraine (Gilbert Lake) and glacial lake (Hébert River). Blank spaces were provided in the workbook for the teachers to sketch the landscape at each of these field stops.
The erosion experiment was conducted at a gravel pit stop. It consisted of sieving a shovel-full of gravel from an exposed bank and then comparing the larger rocks (those that remained in the sieve) to the smaller rocks (those that passed through the sieve). The workbooks included tables to record results of the erosion experiment and to answer erosion questions about their observations.

**October workshop workbook design**

Based on additional feedback from the expert panel and the retired teacher, in addition to suggestion in the teacher questionnaires and my personal insight from the May workshop, I made significant modifications to the structure of the workbook and the field trip stops. The most significant change was restructuring the workbook into three major sections; the Pre-Field Trip, Field Trip and Post-Field Trip booklets.

The Pre-Field Trip section contained a geology review on rock textures and rock identification, an introduction about glaciers, field trip general information and field trip activities. The field materials and activities planned for the field trip were also reviewed in the Museum classroom prior to going out on the field trip. The structure of the Pre-Field Trip section provided the teachers with a lesson plan of what should be done in the classroom to prepare for the field trip. This was not included in the May workshop because I made the assumption that teachers would know how to prepare the students by ensuring they had the knowledge base needed prior to conduct the field activities. Additionally, including this section would have reduced the amount of time available to do the field trip and I didn’t want to rush through the planned field activities. However, the rock descriptions completed by the teachers at the May workshop did not include relevant observations related to rock textures which are key in distinguishing different rock type and therefore, I decide to include this section in the October
workshop. I was aware that the pre-field trip preparation was an essential element (Orion, 1989) and I learned that I should not make the assumption that teachers know to do this. Hence, it must be included for all field-based workshops.

The field trip section was modified to fit within the new time constraints as a result of adding the pre- and post-field trip sections. The stop at the gravel pit, where the erosion experiment was conducted for the May workshop, was eliminated and replaced with a new erosion experiment primarily because there wouldn’t have been sufficient time to complete it, but also based on the feedback from the teachers at the May workshop that it should be removed. Instead of sorting large rocks from smaller ones using a sieve, the instructions were to hand pick two groups of rock sizes for their collection. The larger-sized rocks had to be described using the rock identification forms. The smaller-sized rocks were placed in a bag to be compared with the larger-sized rocks in the classroom following the field trip. Separate rock identification forms were created for grades 4 and 7 and included in the workbook to provide a better understanding of what information was needed for describing the rocks they collected. The teachers were told that additional time would be available after the field trip so they could finish filling in the form. The sketching activity was not modified for the October workshop.

The Post-Field Trip section, like the first section, was created to provide a lesson plan for the activities to be done in the classroom following the field trip. During this last section, the teachers were given 90 minutes to complete the rock identification forms and conduct the erosion experiment. Both teachers used the entire time to complete rock descriptions on a handful of samples and therefore, didn’t complete descriptions on all 10 of the larger-sized samples they had collected. Consequently, the erosion experiment was not completed.
The teacher’s guide section, which was included in the May workshop, was inadvertently missed in the production of the October workbook. So as not to exclude some qualitative data, the feedback questions in this section of the May workshop were handed out to the participants to complete.

**Data Analysis**

The data analysed for this mixed methods research project included quantitative and qualitative data from questionnaires completed by teachers (n=5), Museum staff (n=3), and an expert panel (n=10); a review of the workbooks completed by the teachers; and personal observations. Qualitative data collected from responses to open-ended questions in the questionnaires, was analysed using an open coding approach. This entailed reading through the data several times and creating a meaningful representation of the information based on what stood out. Due to the small number of participants, there was no requirement to use a software program for analysis.
RESULTS

Quantitative Data

A significant portion of the data collected for my research project stemmed from information gathered from two questionnaires. The workshop participants (i.e. teachers and staff) completed the teacher questionnaire and the expert panel (EP) completed the EP questionnaire. Quantitative data was needed to make comparisons of teachers’ views prior to and following the workshop, as well as comparisons with the EP responses. To accomplish this, both the teacher and EP questionnaires contained the same 13 statements with slight modifications to accommodate proper context (Table 2). The teachers and Museum staff responded to statements specifically related to this workshop, whereas the EP responded to the statements as it related to their overall experience with workshops. Although the Museum staff were not teachers, they completed the teacher questionnaire and responded based on their personal views and workshop experience. The statements used a 5-point Likert scale expressed as strongly disagree (1), disagree (2), neutral (3), agree (4) and strongly agree (5). The statements were created based on a questionnaire used in a study conducted in 2009 (Pickering et. al., 2012) with wording modified in order to be aligned with specific details relevant to this study. Copies of the questionnaires are provided in Appendices A and B.

Table 2

Statements from the Expert Panel Questionnaire

<table>
<thead>
<tr>
<th>Q1</th>
<th>Field workshops help most teachers learn how to plan and organize a field trip focused on earth sciences for their students.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q2</td>
<td>Field workshops enhance most teachers’ confidence in guiding their students on an earth science field trip.</td>
</tr>
<tr>
<td>Q3</td>
<td>Field workshops increase the confidence of most teachers in providing guidance and feedback to their students as they analyze and interpret grade-specific, earth science related curriculum topics in a field setting</td>
</tr>
</tbody>
</table>
Q4 Field workshops increase the comfort level of most teachers in guiding their students to make relevant grade-specific, earth science related curriculum observations in a field setting.
Q5 Teachers feel more informed about instructional strategies for conducting a field trip.
Q6 Teachers feel the curriculum topics contained in the field trip were relevant to the grade level(s) they teach.
Q7 Teachers feel their confidence in teaching earth science material in a field setting has increased as a function of attending the workshop.
Q8 Teachers feel the workshop reflected careful planning and organization.
Q9 Teachers feel they were provided with activities that they will be able to use to lead their students on a field trip.
Q10 Teachers feel they increased their knowledge in earth sciences.
Q11 Teachers feel the workshop met the curricular and grade-specific topics for earth sciences.
Q12 Overall, teachers thought the workshop was successful.
Q13 Teachers feel the workshop was an excellent opportunity to build relationships with other participating teachers and experts.

Both questionnaires included the same nine additional quantitative statements (Q5 to Q13). These statements related to instructional strategies, grade-specific curriculum topics, confidence level teaching in a field setting, the workshop planning and success, field trip activities, earth science knowledge, and building relationships with other teachers. In general, all responses showed there was an overall agreement to strong agreement with some slightly lower scores by some EP members. A summary of the Likert-scale responses from the teacher and EP questionnaires is provided in Figure 12.

There were some statements that scored lower in comparison to others. One EP member disagreed that workshops helped teachers to plan and organize field trips (Q1). One teacher scored neutral for two of the statements which asked about their comfort guiding students with analysis and interpretation (Q3) and observation (Q4). Neutral scores for the expert panel at 10% (1/10) were noted for Q2 (teachers are confident guiding students on a field trip), Q9 (teachers are able to lead students through activities) and Q13 (workshops provide opportunity to build relationships with teachers and experts).
<table>
<thead>
<tr>
<th></th>
<th>Teacher Questionnaire</th>
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<th>Expert Panel (EP) Questionnaire</th>
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<tr>
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<td>3</td>
<td>2</td>
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<td></td>
<td>post</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
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<td>pre</td>
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<table>
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<td>Disagree</td>
</tr>
<tr>
<td>3</td>
<td>Neutral (3* = 3.5)</td>
</tr>
<tr>
<td>4</td>
<td>Agree</td>
</tr>
<tr>
<td>5</td>
<td>Strongly Agree</td>
</tr>
</tbody>
</table>

*Note 1 – Statements Q1 to Q4 for the workshop participants indicate their scores to the same questions before the workshop (“pre”) and after the workshop (“post”).*

*Note 2 – The questions numbers shown above correspond to the order that the statements appear in the questionnaires.*

*Figure 12. Likert-scale responses from the teacher and expert panel questionnaires.*
Boxplot summary of the Likert-scale responses

To display quantitative results, a boxplot representing the Likert-scale responses in percentages was constructed (Figure 13). The box symbol is the middle 50% of all the responses and the line symbol (referred to as whiskers) is the lower quartile (25% extending below) and upper quartile (25% extending above) groups. If there is only one whisker, then this quartile is added to the box and with no whiskers the box represents 100% of the scores. The “x” drawn inside the box represents the median score and the dot symbol indicates an outlier. The length of the symbols represents the range of scores. The boxplot in Figure 13 was constructed based on a table of the percentages of EP responses per statement (horizontal axis) for each of the five categories of the Likert scale (vertical axis). For example, the percentage scores represented for the responses to Q5 (refer to Figure 12) would be: 80% of the teachers responded “agree” and 20% responded “strongly agree”; 100% of the staff responded “agree”; and 70% of the EP responded “agree” and 30% responded “strongly agree”.

![Boxplot summary of the Likert-scale responses](image)

*Figure 13. Summary comparison of Likert-scale responses. Note that this figure represents the workshop participants (teachers and Museum staff) responses to the post-field trip responses for Q1 to Q4.*
The data in Figure 13 demonstrates that all groups have very positive views of field trips based on the fact that the higher percentage scores and the median within each group is highest in the “agree” response and also higher in the teacher and EP groups in the “strongly agree” responses. All the teacher responses, with the exception of one “neutral”, were either “agree” or “strongly agree” with the highest median percentage score of 55% and 75% of the responses between percentage scores of 40 to 60%. The shorter length (i.e. narrower range of percentages) of box heights in the EP group indicates stronger agreement within the group on their views in general to all the statements. Further support to this statement is shown by the median percentages for the “strongly agree” responses which are relatively consistent across the three groups, ranging between 35% (EP group) and 50% (staff group). The results from the quantitative data suggest teachers benefit significantly from field-based learning, including the workshop conducted for this research.

**Pre- and post-field trip responses (Q1 to Q4)**

Prior to the workshop, the teachers and Museum staff responded to four statements (i.e. Q1 to Q4). The first statement related to their view on whether they knew how to plan and organize an earth science field trip. The remainder related to views about their comfort level and confidence in guiding students on an earth science field trip and also, their comfort level in guiding their students through the processes of analyses, interpretations and observations. These four statements were meant to establish a baseline of their general knowledge in planning, organizing and leading an earth science field trip and their level of confidence in teaching earth science in a field environment. They responded to the same four statements following the field trip to gauge changes, if any, in their views.
Figure 14. Teacher and staff responses to pre- and post-field trip statements.

The teachers’ post-field trip views of field trips consistently showed positive change to the same four statements relative to pre-workshop responses. Prior to the field trip, 80% to 100% of the teachers responded (blue boxes in Figure 14) that they had neutral or lower views to all four statements, suggesting generally low confidence in planning, organizing and leading a field trip. Their confidence significantly improved following the field trip, indicated by 80% to 100% responses (red boxes in Figure 14) showing that they either “agreed” or “strongly agreed” on their views of field trips. The lowest pre-field trip score was from Teacher 2’s response with a
“strongly disagree” response to her ability to confidently guide students with analyses and interpretations on an earth science field trip (Q3). This score, specifically, increased to the “agree” response (refer to Figure 12), representing one of the greatest pre- to post-field trip increases in views. Teacher 5 showed the greatest increase in confidence, with pre-field trip responses of “disagree” to a “strongly agree” in the post-field trip response to three of the four statements (Q1 to Q4). Clearly, these teachers’ experiences were very positively impacted. In general, it can be concluded that all teachers improved their views of field trips as a result of attending the workshop and that the workshop was effective in changing their views in a positive manner.

The responses by the Museum staff showed different results in comparison to the teachers. There were minor improvements to their views when comparing their pre- and post-field trip responses indicated in the green and purple boxes, respectively, in Figure 14.

Most of the EP responses to Q1 to Q4 either agreed or strongly agreed that workshops with a field-based component help to increase teachers’ confidence in planning, organizing and leading students on a field trip (Figure 12). The exception was EP4 was of a much lower opinion (Figure 12), disagreeing that workshops help teacher to plan and organize a field trip (Q1) and neutral to the workshops improving a teacher’s ability to lead a field trip (Q2). Overall, the views of the workshop participants and the EP were comparable indicating that my workshop was equally effective as those the EP have experienced.

Curriculum related statements (Q6 and Q11)

Some of the higher percentages in the lower agreement responses (“neutral” and “disagree”) were recorded in responses to curriculum related statements; specifically, Q6 which related to views that workshops include relevant curriculum topics and Q11 which related to
views that workshops met curriculum topics (Figure 15). The staff responses showed the lowest agreement responses in comparison to the teacher and EP responses.

![Figure 15. Responses to curriculum related statements (Q6 and Q11).](image)

All the teachers either “agree” or “strongly agree” that the curriculum was relevant and that the workshop met the curriculum topics. This is in contrast to views of two of the three Museum staff who responded either “disagree” and “neutral” to the same statements. The staff views likely differed because of two factors; they had completed the grade 4 workbook and they attended the first workshop in May. There was one teacher who completed the grade 4 workbook at the October workshop, and because her workshop was slightly different from the first workshop that the staff attended a true comparison between these two groups cannot be made. The EP responses were comparable to the teachers with seven out of ten responding either “agree” or “strongly agree”. Despite some slightly lower agreement responses by the staff, the results demonstrate that the workshop effectively addressed curriculum requirements and also, that it was equally effective as workshops conducted by members of the expert panel.
Qualitative Data: Teacher Questionnaire

The qualitative portion of the questionnaire consisted of five open-ended questions that were answered at the end of the workshop. The teachers were asked questions specifically about the workshop, as it related to their expectations, what elements to keep, what were key elements, what elements didn’t work, and what they would like to see in future workshops (Table 3). Additional comments were also collected from the EdGEO post-workshop survey that was completed as an EdGEO requirement.

Table 3

Open-Ended Questions in the Teacher Questionnaire

- What were your expectations for this workshop? Please provide some specific examples of expectations and how they were and/or were not met.
- What do you feel were the most important characteristics of the field trip you experienced?
- What important characteristics do you think should have been included in the field trip?
- Now that you have experienced the workshop, are there any changes or new topics you would like to see for future workshops? If so, what?
- Do you have any other comments about the workshop that you would like to share?
- What should be kept or emphasized?
- What could have been done better or should be changed?
- What should be removed or didn’t work well?
- Write down any additional questions or comments you may have.

All workshop participants (teachers and Museum staff) indicated that their expectations for the workshop were met. A few of their comments of what met their expectations included: “gain ideas for field trip with students, where to go, what they can do while they are there, how it connects to the curriculum”; and “I wanted knowledge of how to take my students off-site to apply knowledge of land formations and rock sampling”. Most workshop participants identified the hands-on activities as the most important characteristics of the field trip. Other comment indicated they enjoyed learning about how glaciers influenced the landscape and created the landforms observed during the field trip (i.e. terraces, kames, end moraines, kettle lakes and glacial lakes). Many commented on how they loved being in the field even though the weather
for both workshops was not ideal. It rained most of the day during the May workshop and it was bitterly cold during the October workshop, which created unique challenges on their own for completing the field activities. Having transportation nearby and going indoors for the lunch stop provided a much-appreciated break from the elements. It was important to continue with completing the field activities despite the weather, as they will likely encounter similar challenges when they take their students in the field.

Some comments on improvements and what didn’t work well related to: suggestions as to how to better organize the workbook binder; reducing the number of stops and rock samples to collect; allowing more time to complete the activities; and requests for more hands-on activities. Based on the comments from the May workshop, changes that were done for the October workshop included reorganizing the binder so that the relevant questions followed each stop. Despite this reorganization, one of the teachers felt it was cumbersome to take sheets in and out of the binder to fill in the forms on the clip board. The number of stops was also reduced by one for the October workshop and the erosions exercise was eliminated, yet there were still comments to reduce the amount of field activities. None of the participants from either workshop commented specifically on learning about rock types or how to identify the rocks they collected, which was an important curriculum outcome for the workshop.

Overall, the feedback was very positive and constructive. Other comments include: “I would come to any you had to offer”; “Thought it was fabulous”; and “Thank you for a great day”. At the end of the day, when we were in the classroom, I could see that many of the teachers were struggling with the rock identification. Despite this, my sense is that they had thoroughly enjoyed the experience.
Qualitative Data: Workbooks

At the end of the workshop, copies of the completed workbooks during the field trip were collected and the originals returned to the workshop participants. A review of the workbooks helped me to gain additional insight into their learning and understanding of the field trip activities.

Sketches

At the stops where a sketching exercise was employed, I instructed the workshop participants to sketch whatever they felt was important. There was no specific instruction in the workbook that asked them to sketch a specific feature and nor was there an explanation of how to approach the sketch, such as looking close up and far away at different aspects of the landscape that surrounded them. The reason behind this was for them to sketch what they considered to be important observations without feeling there was a right or wrong way to do it. They were given a time parameter to complete their sketches and for collecting their rock samples at two of the stops. For the May workshop the workshop participants were given 75 minutes at the terrace stop and 45 minutes at the kame field to complete both the sketching and rock collecting activities. It was left up to them to manager their time accordingly to complete both exercises. In the October workbook, I included more specific instruction, suggesting separate time allotments for sketching and rock collecting as I felt the teachers at the May workshop spent too much time sketching and not enough time collecting and examining the rocks. A sample sketch of each site visited on the field trip is provided below (Figure 16).
At the terrace stop, all workshop participants at the May workshop had similar looking sketches which included only one terrace level. In contrast, both teachers at the October workshop included two terrace levels as shown in Figure 16a. This was an important distinction for them to notice. It’s not certain why there was a difference since the explanation I provided to both groups discussed the two terrace levels. The differences suggest that the workshop participants may have benefited with greater emphasis and a more thorough explanation to focus their attention on the important details.

Figure 16. Sample sketches by different workshop participants at the four field stops.
Two workshop participants included field notes about the glacial environment and blueberry fields. One (Figure 16a) added information about the rocks they collected and included a sketch of the hills with a blueberry field some distance away. Recording observations that were both close and far away demonstrated an ability to think spatially, which is an important field skill to develop further (Reynolds, 2012).

Based on my observations at the kame field, most workshop participants appeared to enjoy sketching at this stop, and more so here than at any other of the sites we visited. Perhaps the hilly open terrain was easier to sketch and had more obvious details to draw, which was apparent in all the drawings at this stop in comparisons to the other sites. Most included variations in the steepness of the slopes and the different heights of individual kames. Two workshop participants included two sketches, with one looking north (towards the kame field) and the second looking south where the terrain was flatter. One noted finer details such as areas where the gravel was exposed (Figure 16b).

The stop at Gilbert Lake, in my opinion, was difficult to sketch. This stop was along a roadside with thick vegetation on either side. The road was situated directly over a glacial end moraine which, as a result of this being formed, created a drainage divide in the valley. Without providing specific instructions to the workshop participants on what they should sketch, one drew a cross-section of the glacial end moraine showing a steep slope down to Gilbert Lake and level of the lake water (Figure 16c). This method of describing a landform is an important skill that demonstrates spatial recognition (Newcombe, 2012). The notes included for Gilbert Lake explained the different water levels, but this is not discernable from their sketches. Another wrote down notes but did not include a sketch of the landscape.
The Hébert River stop was included because of its contrasting, flat landscape and because it occurs in a setting where there were no blueberry fields to demonstrate that the type of glacial environment (a glacial lake) and soil (one that is mostly silt and clay) plays a major role in where blueberries can grow. The flat landscape was noted and drawn by all workshop participants and most noted these sediments were clay and not gravel (Figure 16d).

The key learning from the sketching activity was that they were unaware of the importance to add information, such as: scale to show height and length of features; labels to identify details such as terrace levels; different shapes and sizes of the kames; varying slopes of the end moraine in relation to ice direction; cardinal points to orient the sketch. For future workshops it will be important to explain that sketching involves discerning relevant features and that labels should be included to put context to their sketches. The approach used for sketching is often referred to as the “skill of disembedding, which involves observing a complex scene (whether an outcrop, landscape, or map), observing and recognizing patterns, and isolating the important aspects (“the signal”) from distracting, nonessential ones (“the noise”)” (Reynolds, 2012, p.75). Thus, sketching, in some ways, uses a similar approach to rock identification in regards to determining what is important and what is not. Providing some examples of sketches completed by geoscientists beforehand might be helpful to their understanding. Lessons on how to read a topographic map and create a cross section would be useful for the grade 7 level to include in the pre-field trip preparation. Providing clear instructions prior to the activity and monitoring the participants during the activity in the field will provide useful context and focus for this exercise in future workshops.
Rock descriptions

Both workshops included instructions to collect rock samples from two locations: the terrace stop and the kame field stop. At the May workshop, the participants were instructed to complete their rock descriptions in a field notebook using the template that was provided on the first page. However, it appears that my instructions were not effectively communicated as one of the teachers wrote descriptions of the stops rather than individual rock descriptions (Figure 17) and another teacher drew sketches in her notebook. The third teacher did not use field notebook. The Museum staff also did not follow the template provided for the rock descriptions despite the fact that two of them would have had prior experience describing rocks. This was further evidence that my instructions were poorly communicated.

Figure 17. Rock descriptions by a teacher from the May workshop.

To remedy the issue, a rock description form was created and added to the workbook, with different forms for Grade 4 and 7. To make the rock description slightly simpler than the Grade 7 form, the Grade 4 form included boxes where they could choose words to describe the texture and excluded the box to describe the rock shape. In the example provided for the Grade 4 rock description (Figure 18a.), the teacher was not able to provide descriptions of their observations and could not decide which rock type it was. Difficulties were also apparent for the Grade 7 teacher (Figure 18b.), who described the surface texture instead of one of the rock
textures that were reviewed in the pre-trip portion and also could not decide which rock type it was. In comparing the rock description examples of the two teachers (with a pre-field trip session on rock identification) to the staff member (with no pre-field trip session, but educated in first year university-level geology), they contain similar levels of detail, with the exception that the staff member used “grains” to describe the Sample #1 rock texture.

![Sample #1 rock description for Grade 4](image1)

![Sample #1 rock description for Grade 7](image2)

Figure 18. Rock descriptions by teachers from the October workshop.

Both teachers at the October workshop waited until they were back at the Museum after the field trip to complete their rock descriptions. As a result, the entire 90-minute timeframe allotted for the post-field trip session was used up in completing the forms and as a consequence, the erosion experiment was not completed. Both teachers waited until they were back in the classroom to start their rock descriptions. My assessment of why this happened is because they likely took the entire time allotted in the field for collecting and could not accomplish both tasks. This exercise would have been more effectively executed had they been instructed to collect fewer samples and also, with the field trip leader monitoring more closely and coaching them
through the exercise. In fact, one of the teacher’s comments was to reduce the number of samples they had to collect at each site.

One method that could be introduced to improve the workshop participants’ performance with rock identifications is to walk them through their first description, or, if it is a large group, demonstrate to the group by verbalizing the process of noticing different features and pointing at where and how to look for specific clues. Differentiating between grains and crystals, determining their relationship (e.g. interlocking or glued), and how they are organized (e.g. random, layered or wavy) may be difficult to notice with an untrained eye. However, once it is noticed and with more practice, they may begin to notice relevant details more quickly and then notice more detailed features about it overall. This process is what anthropologists refer to as “professional vision”, which is to have the ability to see from the perspective of a professional what is specific to their practice (Goodwin, 1994).

Erosion experiment

The workshop participants paired up to conduct the erosion experiment I created for the May workshop. The results reported were inconclusive as no relevant observations were noted that distinguished differences between the larger rocks (those that remained in the sieve) and the smaller rocks (those that passed through the sieve). The general consensus was that the two groups of rocks were similar. The intent was for the participants to look for signs indicating different intensities of erosion and the type of erosion causing agent (water, wind, ice or gravity). However, what can be concluded from some of the observations was that erosional processes are not well understood. Two responses included “freezing and thawing” as an erosion process, but this is a weathering process. Another wrote “physical weathering, deposition, movement of
rocks” which are the three sedimentary processes, with “movement of rocks” describing the process of erosion.

The feedback in the questionnaire from two of the three teachers was to either remove or change the experiment. Some found the instructions confusing and they weren’t sure what they were doing with the samples. It was clear from the incorrect use of terms in the responses and my observations at the workshop that there was a lack of knowledge of rock types and erosional processes precluding them from making valid conclusions with the erosion experiment. This experiment was replaced with a different one for the October workshop, but unfortunately, it was not completed due to there being insufficient time at the end of the workshop.

**Connectedness to nature**

During a period of approximately 15 minutes of reflection at the last stop of the field trip, all workshop participants chose to use the sheet of paper to write down their thoughts, a poem or to sketch. The reflections completed by the participants included comments about the landscape, such as: “What was this same area like hundreds of thousands of years ago?”; “What did this landscape look like 100, 1000 & 1 million years ago?”; “I will take away a better understanding of the topography of our area …”; and “This experience has grown my sense of how nature is ever-changing and will forever be shifting and sculpting itself into new landscapes”. These comments demonstrated that they have grasped the concept of geological time and that geological processes have changed the landscape. One comment about “our area” suggests the teacher had an attachment or connection with a sense of place since this location was familiar to her. As such, this experience provided an opportunity for place-based learning which, based on some studies, will have a deeper meaning than if it were an unfamiliar setting (Semken, et.al.,
For most participants this reflection seemed to have had a calming effect, as shown in the examples from two participants (Figure 19).

Figure 19. Reflections from two teachers at Leake Lake.

Following the reflection, workshop participants completed the Nature Relatedness (NR) survey (Nisbet, Zelenski & Murphy, 2009). The survey statements have been reorganized in Table 4 into the three dimensions of experience (their comfort being in nature and desire to be involved with nature), perspective (their concern about the effect human’s action has on the environment) and self (how much a person identifies with nature). The number at the beginning of each statement indicates the sequence in which they appeared in the survey. As well, the statements indicated by note (1) have been reversed in order to compare with other scores. For example, the score recorded in the survey as “2” has been reversed to “4”. Thus, the scores of statements (2), (3), (10), (11), (13), (14), (15) and (18) have been reversed. The expert panel was not asked to complete the NR survey because it was conducted to capture an individual’s responses following an outdoor experience, such as the workshop’s field trip. As this was an
anonymous survey, the columns showing an individual’s scores cannot be linked to a specific participant.

Table 4

*Anonymous Responses to the Nature Relatedness Survey*

<table>
<thead>
<tr>
<th>NR</th>
<th>Questions</th>
<th>Response scores</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1) I enjoy being outdoors, even in unpleasant weather.</td>
<td>4 5 3 4 5 4 3</td>
</tr>
<tr>
<td></td>
<td>(4) My ideal vacation spot would be a remote, wilderness area</td>
<td>4 3 4 3 5 5 2 4</td>
</tr>
<tr>
<td></td>
<td>(6) I enjoy digging in the earth and getting dirt on my hands.</td>
<td>4 5 5 2 5 5 3 4</td>
</tr>
<tr>
<td></td>
<td>(9) I take notice of wildlife wherever I am</td>
<td>4 5 4 4 5 4 4 5</td>
</tr>
<tr>
<td></td>
<td>(10) (1) I don’t often go out in nature.</td>
<td>5 5 5 5 5 5 3 2</td>
</tr>
<tr>
<td></td>
<td>(13) (1) The thought of being deep in the woods, away from civilization, is frightening.</td>
<td>3 3 4 4 4 4 3 5</td>
</tr>
<tr>
<td></td>
<td><strong>Average score for Experience</strong> (2)</td>
<td>4 4 4 4 5 5 3 4</td>
</tr>
<tr>
<td></td>
<td>(2) (1) Some species are just meant to die out or become extinct.</td>
<td>3 4 5 1 1 2 4 5</td>
</tr>
<tr>
<td></td>
<td>(3) (1) Humans have the right to use natural resources any way we want.</td>
<td>4 4 4 5 4 5 5 5</td>
</tr>
<tr>
<td></td>
<td>(11) (1) Nothing I do will change problems in other places on the planet.</td>
<td>4 5 5 5 1 5 5 5</td>
</tr>
<tr>
<td></td>
<td>(15) (1) Animals, birds and plants should have fewer rights than humans.</td>
<td>3 4 5 3 1 5 4 5</td>
</tr>
<tr>
<td></td>
<td>(18) (1) Conservation is unnecessary because nature is strong enough to</td>
<td>5 5 5 5 2 3 5 5</td>
</tr>
<tr>
<td></td>
<td>recover from any human impact.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(19) The state of non-human species is an indicator of the future for</td>
<td>4 5 4 5 5 4 3 5</td>
</tr>
<tr>
<td></td>
<td>humans.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(20) I think a lot about the suffering of animals.</td>
<td>4 4 4 3 3 5 3 4</td>
</tr>
<tr>
<td></td>
<td><strong>Average score for Perspective</strong> (2)</td>
<td>4 4 5 4 4 5 5 5</td>
</tr>
<tr>
<td></td>
<td>(5) I always think about how my actions affect the environment.</td>
<td>3 4 5 3 4 2 4 4</td>
</tr>
<tr>
<td></td>
<td>(7) My connection to nature and the environment is a part of my</td>
<td>3 4 5 5 5 4 3 5</td>
</tr>
<tr>
<td></td>
<td>spirituality.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(8) I am very aware of environmental issues.</td>
<td>4 4 5 4 5 3 4 4</td>
</tr>
<tr>
<td></td>
<td>(12) I am not separate from nature, but a part of nature.</td>
<td>4 5 5 5 5 5 4 5</td>
</tr>
<tr>
<td></td>
<td>(14) (1) My feelings about nature do not affect how I live my life.</td>
<td>4 4 4 4 5 4 3 5</td>
</tr>
<tr>
<td></td>
<td>(16) Even in the middle of the city, I notice nature around me.</td>
<td>5 5 4 4 5 4 4 5</td>
</tr>
<tr>
<td></td>
<td>(17) My relationship to nature is an important part of who I am.</td>
<td>5 5 4 5 5 5 3 5</td>
</tr>
<tr>
<td></td>
<td>(21) I feel very connected to all living things and the earth.</td>
<td>4 4 5 4 5 3 3 5</td>
</tr>
<tr>
<td></td>
<td><strong>Average score for Self</strong> (2)</td>
<td>4 4 5 4 5 4 5 5</td>
</tr>
</tbody>
</table>

NR = Nature Relatedness dimensions
# - the number indicates the order of the questions as they appeared in the survey
(1) - indicates scores that were reversed (e.g. the reverse score of 2 is 4)
(2) - all average scores were rounded up to the nearest whole number
(modified from Nisbet, Zelenski, & Murphy, 2009)

The NR score is a measure of a person’s experiential (experience), cognitive (perspective), and affective (self) aspects of their connection with nature and is representative of an individual’s trait-like characteristics (Nisbet, Zelenski & Murphy, 2009). The higher numbers in Table 4 indicate, overall, that all participants have a stronger connection with nature (Nisbet, Zelenski, & Murphy, 2009) and their connectedness with nature appears to be evenly distributed.
across all three dimensions. Exceptions were with two average scores (highlighted in yellow), one in each of the domains of experience and perspective, that were lower in comparison to the group indicating a lesser connection with nature, but only in one of the three dimensions.

Based on the small sample size, it cannot be stated definitively that all participants have a strong connection with nature. However, it can be speculated, that together, the participants’ reflections and survey responses make a strong case to support this assertion and that the field trip was a positive social experience (Mogk, 2011). This strong connection with nature enhances learning by engaging the affective domain of emotion, attitude and motivation (Van der Hoeven Kraft, 2011).

The intent of this survey was to provide a broad representation of the groups’ connectedness with nature and to also expose the participants to an exercise that they might consider doing with their students. There was uncertainty about what reaction I would receive as I have never participated in a field trip that included a reflection. Neither positive nor negative feedback was received from the participants on the survey and therefore, I concluded that they did not object to doing this exercise. Base on my personal observations, I sensed that they enjoyed the opportunity to reflect at the end of the field trip.

**Qualitative Data: Expert Panel Questionnaire**

The second portion of the EP questionnaire asked five open-ended questions (Table 5). These included four questions on what they believed teachers gained by attending a workshop, what were their goals and main barriers in conducting a workshop, and what were the key elements of a workshop. The last question asked for additional comments.
Table 5

Open-Ended Questions in the Expert Panel Questionnaire

1. What are the most important aspects teachers gain by attending your professional development activities that are conducted in a field setting?
2. What are you, or your organization, aiming to achieve by conducting your professional development activities in a field setting?
3. What are the key elements that lead to an effective professional development in a field setting?
4. What are the main barriers/constraints/challenges teachers face with trying to provide both themselves and their student’s opportunities to learn in a field setting?
5. What additional information and advice would you like to offer?

Through the process of conducting an open coding approach to analyze the responses, it was noticed that several words were frequently repeated and appeared in more than one question. This led to identifying the prevalence of words which were then categorized into eleven keywords and groupings of words related to the keywords. The keywords in Table 6 are listed in the order of the most frequently used keyword from top to bottom.

Table 6

Keywords to Open-Ended Questions by the Expert Panel

<table>
<thead>
<tr>
<th>Keyword</th>
<th>Related keywords and groupings of related terms</th>
</tr>
</thead>
<tbody>
<tr>
<td>logistics</td>
<td>logistics; costs; transportation; accessible; safe; well planned; set parameters/timelines for activities; where &amp; number of stops</td>
</tr>
<tr>
<td>activities</td>
<td>hands-on activities; observations skills; practical</td>
</tr>
<tr>
<td>knowledge</td>
<td>knowledge; science background; deeper understanding; concepts; processes</td>
</tr>
<tr>
<td>confidence</td>
<td>confidence; comfort; inspire; encourage</td>
</tr>
<tr>
<td>experts</td>
<td>access to experts; knowledgeable experts; mentoring</td>
</tr>
<tr>
<td>learning</td>
<td>placed-, inquiry-, field-based learning; critical thinking; discovery</td>
</tr>
<tr>
<td>curriculum</td>
<td>curriculum component</td>
</tr>
<tr>
<td>ideas</td>
<td>new ideas</td>
</tr>
<tr>
<td>networking</td>
<td>networking with experts and teachers</td>
</tr>
<tr>
<td>resources</td>
<td>educational resources</td>
</tr>
<tr>
<td>classroom</td>
<td>classroom teaching before and/or after field trip</td>
</tr>
</tbody>
</table>

The next step was to devise a system to count the number of times each category appeared in the responses. If a category appeared more than one time in an individual’s response
to the same question it was only counted once. For example, if an individual had both “gaining knowledge” and “understanding concepts” in their response to a question this was counted as one response in a specific category. Hence the maximum number of responses that can be counted for each question is ten, corresponding to the number of expert panel members. However, if an individual’s response to a question included words that were in more than one keyword category, then more than one occurrence was counted in the same question. For example, a response to a question that included “networking” and “access to experts” would count as two (i.e. one response per category). The results of this process are presented in Figure 20.

*Figure 20.* Keyword responses from the expert panel open-ended questions.

The eleven keyword categories (Figure 20) are listed in decreasing order based on the total number of responses, ranging from 20 responses for both the “logistics” and “activities” to three responses for both the “resources” and “classroom” keyword categories. The number of
responses by category are indicated by the numbers shown within the bar graph with the colour corresponding to the question (dark blue = Q#1; red = Q#2; green = Q#3; purple = Q#4; and light blue= Q#5). Thus, there was a total of three responses for the keyword “classroom” with one response each for Q#2 (red), Q#3 (green) and Q#5 (light blue).

Logistics and activities

The two terms with the most responses were “logistics” and “activities” (Figure 20). The use of the “logistics” keyword related to planning the itinerary for field trip and what important aspects should be considered. In addition to the use of the term “logistics”, other terms included: cost; transportation; accessible; safe; well-planned; set of parameters and timelines for activities; and where and number of sites. The terms included in the “activities” keyword were not in the context of planning or scheduling time for the activities, but more so about the activities themselves. In most instances, the most commonly used term in the “activities” category was specifically in reference to hands-on activities. Less frequently used terms were observation skills and practical activities.

Based on the high frequency in relation to other responses, “logistics” were identified by the EP as one of the more essential planning considerations in conducting a field trip. They are important both as a key element (7 responses) to planning a field trip and a consideration of, potentially, a major barrier (9 responses). One EP commented that “the key elements include thorough planning of the experience to ensure the content is understandable” and “the locations selected are important to the quality of the experience”. In identifying barriers, an expert panel wrote “awareness and access to sites of interest and relevance; logistical challenges; cost; permission; liability; lack of equipment, including Personal Protective Equipment”. A carefully planned and organized field trip that is safe and easily accessible are factors that the field trip
organizer can control, but some expert panel members identified “lack of administrative support for field activities”; “the hassle of getting permissions and waivers” and that “many of the challenges are related to funding and logistics” as barriers discouraging teachers from planning a field trip. There is no doubt that logistical considerations are critical to the success of the field trip and equally important for mitigating potential barriers.

Determining the types of field activities to do and where go to may be difficult for teachers with no field experience and with no knowledge of potentially suitable locations for a field trip. The “activities” keyword category was noted in all five of the questions by at least 30 to 50% of the EP, suggesting that they are another essential component that can also form barriers, along with “logistics”, for conducting field trips. Comments from the EP stated that field-based workshops are important for teachers to “experience activities that help to illustrate geological concepts”; “they get to try out activities in the field”; and “ensure teachers have practical hands-on experience in the field”. They also “improve the ability of teachers to create and run effective field modules” and feel that “field work can go from ‘time spent outside’ to effective field activities that transform the classroom”. Additionally, the EP indicated that not knowing what to do and how to do these types of activities can also create a set of challenges that will deter the teacher from planning a field trip altogether.

**Knowledge, confidence and learning**

The “knowledge” and “confidence” keywords had more than 12 responses and “learning” was slightly lower with 10 responses (Figure 20). In most instances “knowledge” and “confidence” appeared together. This is shown by similar response numbers recorded for all five questions with either four of five responses in Q#1 and Q#2, and one or two responses in the remaining questions. In addition to the word “knowledge”, other terms under this category
included: science background, deep understanding, concepts and processes. All these terms were considered to be the different types of knowledge that can be gained from the workshop. The “confidence” keyword included: confidence, comfort, inspire and encourage. These terms relate to adjectives to describe aspects of the teachers’ attitudes towards teaching earth science in a field setting. The “learning” keyword was in the context of the pedagogical approach used to gain knowledge. This keyword included: placed-based learning, inquiry-based learning, field-based learning, critical thinking and discovery.

A few EP members noted that field-based workshops help teachers “gain a better understanding of the scale at which earth sciences can be observed and grow a better understanding of the processes, the cycles, and the results of such processes and cycles” and to “begin to develop an understanding of the multidimensional nature of Earth Science; this is something that is very difficult to get across in a classroom setting”. As well, “field study also provides a deeper understanding of processes of formation/environments”. Gaining knowledge in earth science in the field setting is an important first step and with it, the teachers will hopefully gain confidence and comfort teaching and applying this knowledge in the field.

The link between knowledge and confidence was noted several times by the expert panel. A number of the comments indicated that gaining knowledge in earth science helps teachers’ confidence, and as some noted, it leads to “more confidence in teaching these concepts and processes” and “confidence in running a field trip”. Giving teachers confidence should always be one of the goals in conducting a field trip. As well, the field experience allows teachers to “feel more comfortable with the topic” and “to feel comfortable, knowledgeable enough, and inspired to take their students out into the field as part of their learning”. The terminology used and how the earth science information is explained must also be easily understood. Confidence will not be
built if a teacher struggles with information which is too technical and therefore not easily translated to teach this new knowledge. One EP noted that, confidence and comfort in knowing how to teach earth science will “inspire teachers in that outdoor geology is important, possible and easier that they think – even without a geology degree”.

Teaching in the field is quite different from the classroom. Thus, it is important that the activities and the locations visited on the field trip create an environment that allows teachers to discover, inquire and think critically about what they are observing. One EP commented, “to make teachers aware of the wonderful opportunities around them; Nova Scotia especially is a magnificent laboratory” and another stated that the field setting allows “ideas to develop critical thinking skills”.

Experts

A total of eleven key word responses to the five questions were counted in the “expert” category, relating either to access to a knowledgeable expert or the mentorship role experts provide to teachers. Workshops provide the teachers opportunity to “work with experienced earth scientists to practice ‘doing’ science as opposed to just hearing or reading about it”, but one expert panel also noted that “leaders need to be knowledgeable and dynamic”. For example, choosing a geology context where I felt I could provide expert knowledge was an important consideration in choosing a glacial environment as the setting for my field trip. I knew I would be comfortable providing my expertise in explaining glacial landscapes and answering questions about the glacial history of the area.

Curriculum, ideas, and networking

Curriculum was noted in six responses, including two responses each in the question identifying key elements (Q#3) and the one commenting on barriers (Q#4). The “ideas” and
“networking” keywords were used less frequently but were also viewed by the expert panel to be components to take into consideration in planning a field-based workshop.

In order to make the professional development event as worthwhile as possible for the teachers and to help in gaining approval from school administrators, it is essential to have curriculum-specific activities incorporated into the field trip. A few EP members noted key elements, such as “connecting activities to curriculum so that it is connected to what teachers need to teach and how they are being asked to teach” and that “the field setting should relate back to the curriculum and the classroom experience”. Another EP eluded to the curriculum as a constraint, noting that “curriculum is extremely comprehensive (especially for high school students) leaving little time for a day or half-day outdoors”.

Generating new ideas and networking with other teachers are associated benefits that occur organically and without necessarily planning for them. The multifaceted characteristics of being in the field has the potential to generate new ideas and the collaborative environment is conducive to creating new relationships and building networks. Being in the field provides “exposure to new ideas”, “ideas for local geo-hot spots”, “practical ideas on how the theories learned in the classes can be integrated into the real world” and “new ideas for presenting material to their students”. Workshops facilitate “an opportunity to develop a new network with professionals, including experts and fellow teachers”, “networking with other teachers and with the Department” and “having a group of other teachers who can provide professional support to each other”. Thus, networks are formed with both teachers and the experts they meet through the workshop. These benefits are perhaps taken for granted and not realized until after the workshop.
Resources and classroom

The least used keywords included “resource” and “classroom”, each with a total of three responses for all five questions. The EP comments that identified these as key elements of a workshop included “acquisition of useful resources for their classroom” and that “the field setting should relate back to the curriculum and to the classroom experience, which will most of the time spent on the subject”. Both these components were important considerations for the workshop developed for this research project.

Comparison of Qualitative Data in the Teacher and Expert Panel Questionnaires

The three keyword categories that contained more than 15 responses (“logistics”, “activities” and “knowledge”) from the EP were also the most commonly noted keywords in the workshop participant responses, suggesting consistencies with teachers’ views. It also points to the fact that there are commonalities in the themes (i.e. keyword categories) even though different open-ended questions were posed in the two questionnaires (teacher and EP).

Planning the logistics for a field trip was time consuming and entailed taking into consideration several different factors, as noted by the EP and several studies that highlighted its importance (Gomes et.al., 2016; Haskall & Stokes, 2008). Based on my personal experience of the time and effort that was put into the two workshops, my sense is that planning future field trips will continue to be a “trial and error” process of tweaking and improving on effectiveness. The main consensus from the teachers and Museum staff was that there needed to be more time to complete the hands-on activities and that the binder could be better organized. It’s difficult to predict the ideal time required to complete the activities, but there is a finite amount of time and managing that time will take practice and experience. The workshop participants and the EP both
agreed that logistics is a key element, but logistics can also be barriers that need to be mitigated in order to provide an effective field trip experience.

The workshop participants most frequently commented that the most important elements of the field trip were the hands-on activities and doing science in the field. These views also resonated with most of the EP, who noted activities as a key element but they also indicated it was the most important aspect that teachers gain and what they aim to deliver in their workshops. Teachers require meaningful activities (Mogk & Goodwin, 2012) and materials to complete them (Esteves, Fernandez, & Vasconcelos, 2015).

The workshop participants and EP both noted that knowledge was what teachers wanted to gain the most from the field trip. One EP noted “many (teachers) know very little when they arrive and most are surprised by how much they learn” which is somewhat similar with one of the teachers that commented she, “Was hoping to learn more about glaciers and their role in the landscape in NS. This certainly happened.”

**Research Shortfalls**

**Delimitations**

The outcome of this research was a teachers’ workshop that focused specifically on aspects of conducting a field trip. Due to the limited scope of the workshop, there were no linkages to specific learning requirements that should take place prior to and following a workshop. Thus, the focus of the research is restricted by the fact that the workshop lacks adequate pre- and post-field trip classroom instruction and does not represent a fully comprehensive model for teachers’ workshops in earth science.
Constraints and limitations

The research is limited by the short timelines of this study and the small sample of research participants (n=18). As well, post-workshop measures to observe affects over time on the teachers’ long-term learning were not possible. These are significant limitations and therefore, the workshop focused primarily on increasing the teachers’ knowledge in curriculum grade-specific earth science topics concurrently while showing teachers how to conduct a field trip. This was done to help elucidate any misconceptions or hesitations around organizing an earth science field trip for their classrooms.

Assumptions

One of my main assumption was that most teachers enjoy field trips and are interested in improving their knowledge by learning how to conduct an earth science field trip. I assumed that the teachers who participated in the workshop would gain positive attitudes to field trip learning and increase their confidence in conducting a field trip with their own students, therefore they would likely use a design similar to the workshop they attended. Although the results represented in this thesis generally support that this assumption is correct, direct correlations cannot be claimed and there certainly were exceptions.
DISCUSSION

Based on the lessons learned from conducting two workshops, there are three main areas that could be considered in order to improve the workshop and provide more effective field-based learning experience for teachers.

**Teacher Attendance**

Two attempts to recruit teachers for an earth science field-based workshop resulted in poor attendance. The likely reasons for low teacher attendance at the workshops include: the time of year, the teachers not receiving the information, unfamiliarity with the type of workshop being offered, and too small of a catchment area. Many factors were considered when planning the timing for the workshop. Foremost, was the summer residency requirement for the thesis programme. This posed a significant barrier to scheduling a workshop in the month of August, primarily because of the logistical arrangements that needed to be confirmed (e.g. land access, bus rental, teacher registration, ordering field supplies) prior to the conduct of the workshop. August appears to be the best month based on well attended workshops conducted by the NS EdGeo Workshop Committee and a comment by one of the teachers was that she would like to see a workshop offered in August. Once support from the Museum was confirmed in September of 2017, it took until May 2018 to complete the design of the field trip and develop the first workbook. Consequently, the workshop was conducted on a weekend in May to avoid delaying it until June, the busiest time of the school year for teachers. Since an August workshop was not an option, the next logical target date was the PD day in October to take advantage of conducting the workshop on a weekday. Unfortunately, neither of these dates were successful in attracting teachers.
Prior to the conducting of both workshops, I was confident that the school principals had been informed and had distributed the information to the teachers. The information for the May workshop was facilitated by the board’s science consultant and the October workshop was passed on by the Chignecto Family of Schools’ superintendent. Based on the facts that none of the teachers at the May workshop had received the information about the workshop from their principals and that no teachers from the schools targeted attended the October workshop, strongly suggests that the communication between the principals and the teachers was not effective in recruiting teachers.

Continuing to conduct the same workshop with the Museum in the same location and at the same time of year on an annual basis may eventually lead to higher attendance. Keeping with the same field trip might lead to advantages such as: opportunity to develop more effective designs and approaches by trial and error; a routine schedule so teachers can plan ahead; and cultivating an understanding of field-based learning and of the benefits of field trips.

Future efforts should also investigate additional methods to engage teachers such as, targeting schools both in the local and regional areas. Local efforts could involve visiting schools in person to disseminate information and advertising in local media to get the word out at the community level. Regional efforts could include seeking endorsements from the Association of Science Teachers of the Nova Scotia’s teacher’s union by means of promoting the workshop on their website and collaborating with the NS EdGeo workshop committee to conduct the workshop. During the process of reaching out to teachers it will be critical that they contribute their feedback and curricular knowledge to help me continue to improve this workshop. That way, having teachers’ input and buy-in will be tremendously useful and may have implications for future workshops. It is expected that it will take a number of years to establish a viable
status. I believe that no matter how many teachers register for a workshop it must not be
cancelled, even if only one teacher registers. Because I believe engaging just one teacher is
important. The teacher has made a significant commitment to be there and so too, have I, as the
facilitator to conduct it. I am determined to keep trying and to engage as many teachers as
possible so that eventually I might be successful in inspiring teachers to make the field trip an
integral part of their earth science curriculum.

Workshop Workbook

It was important that the workshop provide the teachers with a workbook template that
they could easily modify and adapt for their use. For the most part, the workbook provided the
right information and had instructions that were easy to follow. However, it needed
improvements to get the material in the right sequence. A number of the teachers commented
that the organization of the binder could be improved, but also commented that they were very
pleased with the information. For the May workshop there were two separate workbooks, one
with the information and a second with the exercises. The teachers didn’t like having to go back
and forth between the documents each time we came to a new site. To remedy this, I placed
some of the reference material with the stop information, but the teachers complained it was too
cumbersome and difficult to sort through to find the exercise sheets that needed to be filled in.
Thus, the best solution appears to be that the stop information and exercise sheets are placed
together, and all the reference material placed together at the end of the binder. Also useful,
would be to have laminated sheets of some of the key reference material, such as the rock
textures, the rock cycle and sedimentary processes.

The initial workbook for the May workshop provided background information to
familiarize the teachers with the field trip area and focused primarily on the field activities.
However, changes to the October workshop, resulted in sections being added to the workbook to include pre- and post-field trip activities. This was a significant improvement to the May workbook as it provided information about rock types, the rock cycle, and strategies for rock identification. These activities were designed to be instructed in the classroom and included practice with learning rock textures. Unfortunately, the 90 minutes allotted for the pre-field trip review was not enough time to gain an appropriate understanding and the post-field trip activities, also 90 minutes, was not enough time to complete the rock identifications and to conduct the erosion experiment that were planned. In future, I would conduct the pre- and post-field trip activities as separate one-day workshops taking place apart from the field trip and develop three separate modules. This modularized structure would follow Orion’s model (1989) with a pre-field trip workbook focused on reducing novelty space that included reviewing the curriculum-specific geology knowledge, the outdoor activities that will take place, and the location where the field trip will take place. The field trip workbook designed for this research would be customized, using the same format, to the curriculum-specific field trip being planned. The itinerary would essentially stay the same, using the 90 minutes prior to going in the field to do a quick refresher of the curriculum topic and the same time allotment at the end of the day to debrief the field trip activities and review what activities will follow. The post field trip workbook would be designed to lead the students through group discussions and interpretations related to the data collected and observations recorded during the field trip. The modularized format would provide teachers the flexibility to participate in one, two or all three workshops.

There are several other earth science curriculum topics that would benefit from a field-based learning approach and delivered using the same format as described above. Further themes that could be developed for an earth science field trip, in addition to learning the rock cycle and
Identifying rocks and minerals, are the concepts of geologic time, fossils, and plate tectonics. Depending on the field site, the field trip could be designed to focus on one or more of these topics. There are obvious limitations to what exists in the outdoor environment in different geographic areas, but with some innovation it is worth exploring the possibilities and opportunities to observe and investigate earth materials outside the classroom. This research has illuminated the need for me to continue refining the workbook in order to have an inspiring and efficient tool to guide future workshops. My research will continue in this regard based on ongoing feedback from teachers and colleagues, as well as including further enhancements such as maps, drawings and figures once proper permission has been obtained.

**Integrating Field-based Learning**

I felt the teachers had limited knowledge in rock identification and were uncertain about sedimentary processes with regard to erosion and weathering. This shortcoming may have been mitigated somewhat had I provided the workbook information prior to the workshop. However, I made the decision not to in order to be able to capture the teachers’ views without knowledge of the learning tools that would be provided at the workshop. I felt the information in the workbook would have influenced their views of field trips by knowing the content and aims of the field trip. My decision was substantiated by my expectation that the teachers would have had experience teaching earth science in the classroom and thus had a reasonable level of knowledge. As such, the opportunity to increase their knowledge and allow them to become familiar with the field trip was not provided. This negatively impacted the effectiveness of the workshop. Future workshops will, therefore, always include an information package that will be disseminated prior to the workshop so teachers can prepare ahead of time.
In addition to conducting regularly scheduled workshops, as suggested earlier, other ideas to assist teachers with integrating field-based learning in the curriculum is to offer classroom visits to facilitate with the pre- and post-field trip activities and to accompany the class when the teacher conducts the field trip. A recent example to assist schools with their earth science curriculum was a university-based museum that continued to provide on-going support throughout the school year to teachers following a teachers’ professional development program (Pickering et al., 2016). Approaches they used included: two follow-up workshops; digital resources; consultations with Museum staff; a social networking site which contained up-to-date information on earth science lectures; notice of events at the Museum and affiliated professional organizations; and access to a large variety of classroom resources. This is a type of commitment that not all informal education institutions (e.g. the Museum) are capable of doing, but serves as an excellent example of the ways that earth science professionals can get involved with schools to sustain a level of earth science knowledge and strive to improve with time. There are also approaches the teachers could take. They could reach out to stay connected with the earth science community and there is certainly opportunity where they could partner with the geoscientists to combine their teaching perspectives and knowledge in their area of expertise as a complement to the science.

Additional ideas to consider are two other aspects of integrating field-based learning. One would be to incorporate one or more groups of people that included pre- and in-service teachers, school administrators and government staff in both the development and implementation of the field-based learning initiatives. Having different perspectives represented could provide ownership and pride in developing an effective program to which they contributed that may result in a greater potential for success and sustainability. The second aspect would be to use a
systems-thinking approach and integrating other science curricula such as physics, chemistry, biology and social studies or arts-based curriculum into the field-based learning. Practicing inquiry from many different perspectives, as opposed to focusing on one specific facet of inquiry, could offer a variety of scenarios for problem solving and result in a deeper interdisciplinary understanding across a multitude of content areas. These examples would require a collaborative effort from teachers using several different curricula components that may not have been integrated previously and teachers may have limited knowledge of the other curricula. As such, it may require circumstances where there are shared goals and a long-term commitment to make changes.
CONCLUSIONS

Research Questions

Question 1

What are teachers’ views of field trips and are they altered after the workshop?

The teachers’ responses to the pre- and post-field trip questions showed an increase in their confidence and comfort with teaching earth sciences in a field setting suggesting that the workshop had a positive affect on their views of field trips. The teachers all felt that the workshop increased their knowledge in earth sciences and that they learned instructional strategies with how to teach in a field setting. However, in comparing all their responses, there was slightly lower agreement on how to guide students with observation, interpretation and analysing, suggesting they would have benefited from more guidance in focussing the learning on how to think geologically. Confidence in these earth science-specific field skills is difficult to achieve on a one-day workshop considering the teachers are learning new knowledge at the same time as trying to understand how to teach this new knowledge in a field setting. Overall, teachers’ views of field trips, after the workshop, appear to be very positive based on the four pre-field trip responses.

Question 2

What are the views of an expert panel of field trips and how do they compare to the teachers?

Generally, the expert panel “agree” to “strongly agree” on their views when asked about instructional strategies, grade specific curriculum topics, confidence level teaching in a field setting, the workshop planning and success, field trip activities, earth science knowledge, and building relationships with other teachers. They had slightly stronger agreement that workshops increased earth science knowledge, introduce teachers to relevant field activities, and provide
opportunity to build relationships with other teachers and experts. Their responses had slightly lower agreement (i.e. included some “neutral” responses) to statements related to the workshop providing activities that were curriculum relevant and that met grade-specific curriculum requirements in comparison to the teachers’ views (i.e. included “agree” to “strongly agree” responses).

Most of the teachers “strongly agreed” that the workshop was well planned and organized, and overall successful. In contrast, the expert panel responses were split between “agree” and “strongly agree” to the same topics; however, in fairness, the expert panel were not present during the field trip. The expert panel comments are theoretical rather than applied and are not from the experience of the teachers that participated in the field trip. In addition, it is difficult to make a definitive statement on views due to the small number of participants. The impression I am left with is that more work is needed to improve the workshop to be more effective. Therefore, those conducting workshops in the future must continue to strive by soliciting feedback before, after and during the field trip so they can address and overcome any challenges or difficulties they may face.

The qualitative data collected from the expert panel provided valuable insights and emphasized key aspects such as ensuring the workshop: is well planned and organized; includes relevant and practical hands-on activities; gives opportunity for scientific inquiry and problem solving; and enhances the teachers’ knowledge of earth science processes and concepts. The teachers commented on similar topics to the expert panel, with most noting hands-on activities and increasing their knowledge in earth science as key characteristics of the workshop they attended.
The similarity in views between the expert panel and teachers in the quantitative and qualitative data suggests that the workshop experienced by the teachers was analogous to most other workshops conducted by other geoscientists. Therefore, it is reasonable to speculate that the findings of this study represent teachers’ general views on field-based learning which is that they are effective in increasing the knowledge of earth science and improving teachers’ confidence in teaching earth science in the field.

Questions 3 and 4

*How effective was the workshop and what techniques worked best?*

The workshop was effective in several areas including: providing practical hands-on activities to do in the field; learning about glaciers and glacial landscapes; learning rock identification strategies; introducing the teachers to a reflection activity as a way to connect to nature; and providing resources such as field supplies and a digital copy of the workbook. The concept of having a subject matter expert conducting the workshop is a technique that works well. I was very comfortable explaining the glacial environment and provided answers with confidence based on my background in Quaternary geology. Other techniques that worked well and that were essential in providing an effective field trip was having a well planned and organized field trip. Prior to the workshop, the bus rental was confirmed, the Museum classroom was booked for the entire day, and each site was visited beforehand to review the activities, assess accessibility and meet with the landowner to confirm all was okay to access the site on the day of the field trip. Lastly, the approach to learn by doing was by far the most important element to the field trip. This was a workshop that improved teachers’ knowledge of earth science, but more importantly, it was an experience where they gained confidence knowing that they could teach earth science in the field.
Research Objective

My research objective of gaining a better understanding of how to effectively integrate field-based learning into the curriculum was met. Developing the workbook and conducting the workshop provided me with invaluable first-hand experience and a much wider perspective of the many facets that need to be considered for an effective field-based learning program. The comments from the teachers and expert panel, analysis of the teachers’ workbooks and my personal observations have provided a wealth of information.

I received a tremendous amount of support and encouragement from everyone I spoke to about my project, especially teachers. This tells me that there is a need to improve the level of earth science understanding in schools and that teachers are receptive to learning more. The most important insights I gained from doing this research are two-fold. First, is that an understanding of earth science processes and concept necessitates learning skills such as temporal and spatial thinking that are not commonly learned in the other sciences. Second, is that I need to learn how to be more engaged with the teachers in order to more effectively guide them through their inquiry. For instance, I will consider asking the teachers better questions and explaining in greater detail to provide additional guidance while they are completing the field activities.

It was a significant challenge to attract teachers for the workshops, but this has not discouraged me from persevering and continuing to conduct workshops in the future. The teachers who attended the workshop were enthusiastic, keen to learn, and appreciative of the opportunity to increase their knowledge and gain confidence in teaching earth science, especially with regard to conducting a field trip. I am eager to reach out to more teachers.

I realized that my workshop is just the beginning of my growth as an environmental educator. I wanted to be able to provide some emphasis on the fact that there is a vital connection
between earth science knowledge and understanding climate change and other environmental issues. Unfortunately, this was a shortcoming primarily because of the time and effort that was spent on developing and conducting my first teachers’ workshop. My work is not complete and hence, I will endeavour to contribute my expertise to help teachers, who are the influencers in making a difference and encouraging young minds to be curious about the Earth they need to sustain.
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APPENDICES
A. Teacher Questionnaire
Teacher Questionnaire

Demographic Information
1. At which school(s) are you currently teaching?

2. What grade level(s) and subject(s) are you currently teaching?

3. How many years have you been teaching?

4. What education and training have you completed?

These are Pre-Workshop questions on the topic of Earth Sciences.
Please indicate the degree you agree or disagree with the following statements.

5. I know how to plan and organize a field trip focused on earth sciences for my students.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

6. I am confident guiding my students on an earth science field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

7. I am comfortable providing guidance and feedback to my students as they analyze and interpret grade-specific, earth science related curriculum topics in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>
8. I am comfortable guiding my students to make relevant grade-specific, earth science related curriculum observations in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

These are Pre-Workshop questions on the topic of Social Studies

Please indicate the degree you agree or disagree with the following statements.

9. I know how to plan and organize a field trip focused on social studies for my students.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

10. I am confident guiding my students on social studies topics in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

11. I am comfortable providing guidance and feedback to my students as they analyze and interpret grade-specific, social studies related curriculum topics in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

12. I am comfortable guiding my students to make relevant grade-specific, social studies related curriculum observations in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>
These are Post-Workshop questions on the topic of Earth Sciences.

*Please indicate the degree you agree or disagree with the following statements since attending this field workshop.*

13. I now know better how to plan and organize a field trip focused on earth sciences for my students.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
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</table>

14. I am more confident guiding my students on an earth science field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

15. I am more comfortable providing guidance and feedback to my students as they analyze and interpret grade-specific, earth science related curriculum topics in a field setting.

<table>
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<tr>
<th>1-Strongly Disagree</th>
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<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

16. I am more comfortable guiding their students to make relevant grade-specific, earth science related curriculum observations in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

These are Post-Workshop questions on the topic of Social Studies

*Please indicate the degree you agree or disagree with the following statements since attending this field workshop.*

17. I now know how to better plan and organize a field trip focused on social studies for my students.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

18. I am more confident guiding my students on social studies topics in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
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</thead>
</table>

19. I am more comfortable providing guidance and feedback to my students as they analyze and interpret grade-specific, social studies related curriculum topics in a field setting.

<table>
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<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
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</table>

20. I am more comfortable guiding my students to make relevant grade-specific, social studies related curriculum observations in a field setting.

<table>
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<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

These are Post-Workshop questions on the conduct of the Workshop

*Please indicate the degree you agree or disagree with the following statements.*

21. I am more informed about some instructional strategies for conducting a field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
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</table>

22. The curriculum topics contained in the field trip were relevant to the grade level(s) I teach.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

23. My confidence in teaching earth science material in a field setting has increased as a function of attending this workshop.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>
24. My confidence in teaching social studies material in a field setting has increased as a function of attending this workshop.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

25. The workshop reflected careful planning and organization.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
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</table>

26. I was provided with activities that I will be able to use to lead my students on a field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

27. I increased my knowledge in earth sciences.

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<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
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</table>

28. The workshop met the curricular and grade-specific topics for earth sciences.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

29. The workshop met the curricular and grade-specific topics for social studies.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

30. Overall, I thought this was a successful workshop.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
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</table>
31. The workshop was an excellent opportunity to build relationships with other participating teachers and experts.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
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</table>

Post-Workshop Open-Ended Questions
32. What were your expectations for this workshop? Please provide some specific examples of expectations and how they were and/or were not met.

33. What do you feel were the most important characteristics of the field trip you experienced?
34. What important characteristics do you think should have been included in the field trip?

35. Now that you have experienced the workshop, are there any changes or new topics you would like to see for future workshops? If so, what?
36. Do you have any other comments about the workshop that you would like to share?
B. Expert Panel Questionnaire
Expert Panel Questionnaire

Demographic Information
1. How many years have you been/were you involved in outreach activities?

2. What is/was your role(s) in providing the outreach activities?

3. What are the grade levels of the teachers that normally participate/participated in your outreach activities?

4. What percentage of the outreach activities for teachers that you are (and/or have been) involved with are/were conducted in a field setting?

Answer the following questions based on your opinion of the teachers after they have participated in a workshop. Questions on the topic of Earth Sciences
Please indicate the degree you agree or disagree with the following statements.

1. Field workshops help most teachers learn how to plan and organize a field trip focused on earth sciences for their students.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

2. Field workshops enhance most teachers’ confidence in guiding their students on an earth science field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

3. Field workshops increase the confidence of most teachers in providing guidance and feedback to their students as they analyze and interpret grade-specific, earth science related curriculum topics in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>
4. Field workshops increase the comfort level of most teachers in guiding their students to make relevant grade-specific, earth science related curriculum observations in a field setting.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

Answer the following questions based on your opinion of the teachers after they have completed a workshop. Questions on the workshop success

Please indicate the degree you agree or disagree with the following statements.

1. Teachers feel more informed about instructional strategies for conducting a field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

2. Teachers feel the curriculum topics contained in the field trip were relevant to the grade level(s) they teach.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

3. Teachers feel their confidence in teaching earth science material in a field setting has increased as a function of attending the workshop.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

4. Teachers feel the workshop reflected careful planning and organization.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>

5. Teachers feel they were provided with activities that they will be able to use to lead their students on a field trip.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
</table>
6. Teachers feel they increased their knowledge in earth sciences.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
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</tbody>
</table>

7. Teachers feel the workshop met the curricular and grade-specific topics for earth sciences.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
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</table>

8. Overall, teachers thought the workshop was successful.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
<th>5-Strongly Agree</th>
</tr>
</thead>
<tbody>
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</tbody>
</table>

9. Teachers feel the workshop was an excellent opportunity to build relationships with other participating teachers and experts.

<table>
<thead>
<tr>
<th>1-Strongly Disagree</th>
<th>2-Disagree</th>
<th>3-Neutral</th>
<th>4-Agree</th>
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</thead>
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</tbody>
</table>

**General Questions on Workshops**

6. What are the most important aspects teachers gain by attending your professional development activities that are conducted in a field setting?

   

7. What are you, or your organization, aiming to achieve by conducting your professional development activities in a field setting?

   

8. What are the key elements that lead to an effective professional development in a field setting?

   

9. What are the main barriers/constraints/challenges teachers face with trying to provide both themselves and their student’s opportunities to learn in a field setting?


10. What additional information and advice would you like to offer?

