Experiential Science Education Outside Classrooms and Barriers to Its Implementation

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Abstract
Experiential learning outside classrooms, e.g. field trips to such organizations as zoos, museums and conservation centres, offers numerous experiential learning opportunities for students in General Science and Biology classes in Grades 9-12. Field trips have been known to improve understanding of scientific concepts, biodiversity and environmental issues, although the literature shows there are barriers to a wider implementation of experiential learning opportunities by science teachers. The purpose of this research was to identify what outcomes high-school teachers in Ontario observe from their students participating in experiential learning activities at zoos, museums, and conservation centres, what barriers teachers identify, and how they overcome them. A qualitative approach based on semi-structured interviews was used. In teachers' opinion, outdoor experiential learning programs provide positive outcomes for students, but the success of those programs depends significantly on planning and preparatory work by teachers, proper trip management and collaboration between teachers, organizations' personnel and volunteers.

Keywords: Experiential learning, Environmental, Science, Secondary School

Introduction

Educational literature related to environmental education and experiential learning in science uses a variety of terms and concepts, often overlapping, which can be explained by a long history of both streams; many terms also arise from various environmental movements (Palmer, 1998). Experiential learning is viewed is a part of the naturalist current in environmental education which is based on human relationships with nature (Sauvé, 2005). Ontario Science Curriculum describes experiential learning as a learning which "enables students to apply the skills they have developed in the classroom to real-life activities in the world of science and innovation" (Ontario Ministry of Education, 2008a, p. 42). Outdoor learning is often not a part of the regular curriculum, is usually practiced short-term, and happens outside of the school, often at an external organization (Palmer, 1998).

This paper focuses on experiential learning in science education outside classrooms, which has been known to increase interest in science and environmental issues, reinforce scientific concepts, provide opportunities to connect to nature and allow the students to apply the skills they have developed in the classroom to real life activities (Dyment, 2005; Pedretti &

Nazir, 2014; Ravensbergen, 2012). Zoos, museums, and conservation centres offer numerous opportunities for students to gain positive learning experiences in science, learn to respect nature, increase the environmental consciousness, and to develop positive attitudes and understanding towards wildlife, biodiversity, and natural habitats (Davidson, Passmore, & Anderson, 2010; Graham, 2015; Packer & Ballantyne, 2010; Pedretti & Nazir, 2014; Ravensbergen, 2012; Skinner-Winslow, 2016).

While emphasizing the importance of experiential learning in science outside the classrooms, a number of authors point to a problem of various barriers to implementing experiential learning in teaching practice; those barriers include a shortage of support, lack of teacher knowledge, training and confidence in organizing visits or assigning projects in a setting outside the classroom, large class sizes, student safety concerns, and curriculum constraints including little flexibility and difficulties in adjusting education programs with curriculum expectations, especially in high school (Dyment, 2005; Kim & Fortner, 2006; Pedretti and Nazir, 2014; Ravensbergen, 2012). Current school science curricula encourage students to carry out hands-on and inquiry-based activities in class (Ontario Ministry of Education, 2008a, 2008b), but do not sufficiently cover the aspects of an outdoor science education.

The purpose of this research was to identify what outcomes high-school teachers in Ontario observe from their students participating in experiential learning activities at zoos, museums, conservation and science centres, what barriers to the wider implementation of experiential learning opportunities by science teachers exist, and how teachers overcome the known barriers. Learning from teachers' experience is important for a further implementation of experiential learning opportunities outside the classrooms in science education in Ontario at the senior school level.

Methodology

For this research study, a qualitative approach based on semi-structured interviews was used. Qualitative interviews have been widely applied in education (Brinkmann & Kyale, 2015; Flick, 2009; Olson, 2011). According to Brinkmann and Kvale, the "qualitative research interview attempts to understand the world from the subject's points of view" and to describe and "unfold the meaning of their experiences" (2015, p. 3). The interviewer always has an opportunity to clarify or extend the statements expressed by the person who is interviewed. A number of researchers carrying out their study in the field of science education point at the importance of semi-structured interviews in obtaining more detailed data on the subjects' experiences and perceptions in regard to environmental education (Pedretti &Nazir, 2014), out-of-school learning (Power, Taylor, Rees, & Jones, 2009), and science and technology education (Bencze, 2001). The use of semi-structured interviews allows the subjects to express more openly their viewpoints and focus more directly on certain topics (Flick, 2009). "In-vivo coding" is used in this work to capture the participants' exact words and phrases, with the subsequent categorizing of the main themes (Saldaña, 2014).

Selection of the participants of the study was carried out using the purposeful selection approach of the interviewees who could give in-depth insight into the area studied (Reybold, Lammert, & Stribling, 2012). In order to participate in the study, the interviewees had to meet the following criteria:

1. High school science teachers, preferably in Grades 11 and 12. In Grades 11 and 12 curricula are very dense; teachers can hardly find time to plan activities that prepare students for the trip and follow-up activities and to develop assessments and evaluations which incorporate questions related to the trip, which is why it is important to learn about experiences of those teachers.

2. Teaching General Science/Biology for at least five years. Experienced teachers have a good understanding of the curriculum's structure and planning, and of the amount of time required to teach each of its sections and units; they know what to focus on in each unit and which assignments and assessments each unit contains.

3. Teachers have a significant experience of implementing outdoor experiential learning programs in biology/science (e.g., at zoos, museums, conservation or science centres, and other organizations and sites). Ideally, the teacher has organized several trips, which means the teacher has an experience in their planning, and developing tasks, activities and evaluations based on what students learned during the trip.

4. Teaching in Ontario. This research is based on the Ontario Science curriculum which the author of this research is familiar with, as well as familiar with the education opportunities offered by various organizations (e.g., the Toronto Zoo, conservations centres in the Greater Toronto Area, and the Ontario Science Centre).

Two teachers, Jessy and John, who teach science and biology in Grades 9-12 and have an experience of organizing field trips to the Toronto Zoo, Ontario Science Centre and conservation areas agreed to participate in the research. Jessy has been teaching General Science and Chemistry for over 15 years. John has a background in evolutionary biology, and has been teaching Biology and General Science at high school for seven years. In the time frame for this project it was not possible to find and interview more participants, but selection criteria of both teachers fully satisfied the criteria required for the qualitative study, which are to provide information-rich cases and in-depth understanding of the subject researched (Reybold, Lammert, & Stribling, 2012); the analysis of the interviews with Jessy and John gave insightful answers to research questions of this study.

Findings

Teachers' Assertions

Teachers' perceptions on experiential learning touched on the following assertions that will be further elaborated separately in the next sections:

1. It has been found that outdoor experiential learning programs provide positive outcomes for students, such as improved learning, short-term and long-term outcomes, by creating more dynamic learning, forming associations with what students learn, and providing a real-life perspective on what is taught in class.

2. To achieve better outcomes, the teacher has to ensure proper planning and preparatory work.

3. Proper field trip management is important for the trip success, especially with large groups of students.

4. Collaboration of teachers, personnel of the organizations where the trip activities take place and of volunteers is important for the trip success.

The Importance and Outcomes of Field Trips

Participants of the study emphasized the benefits of real-life learning during the field trips which provide students with opportunities to connect to natural environments, develop understanding of such areas as biodiversity, climate change and water quality issues, and create learning experiences that often cannot be reproduced in the classroom. As John explained, at the zoo the "animal is right there", students "have a living example" in front of them, can "look at an actual living animal from a different perspective", and can "go and find examples of certain adaptive forms". On a field trip organized by Jessy to a neighborhood creek to check water quality and identify water organisms, students also got new learning skills which they cannot gain through the activities and evaluations they normally have in the classrooms; students were "more responsible" and "had good discussions about what organisms they had found".

The real-life relevance of an outdoor education is a common finding throughout the literature. As shown in the study by Pedretti and Nazir (2014), many teachers "view outdoor education as an intrinsic component of environmental education" (p. 278), where students get to experience life and environment, connect with real-life situations outside the classroom, and understand their role in an ecosystem. Similar findings were described by Davidson, Passmore, and Anderson (2010) in their study of the goals, expectations and perceived outcomes of the zoo trips.

In this study, teachers confirmed that on zoo trips students have an advantage to see live animals and have a real experience, rather than read about animals in a book or search on the Internet. Learning in a natural setting is also valued by the students, because "they are getting out of class, they are not just sitting down and looking at the slideshow or having a discussion", they "are more relaxed, and have happy faces". As shown by Wurdinger and Rudolph (2009), students are most excited about learning when they are applying in real world settings – such as fieldwork – the information they learned in the classroom.

Although the literature studied suggests that one of the outcomes of field trips is student's improved learning through connecting to natural environments, the literature does not provide extensive details of how students learn during the trips. Both participants of this study observed that field trips improved student learning, but, more specifically, students could "see a dynamic example of concepts" studied in class, and "form an association between what they learn and what they remember". Also, going on a field trip helped students "get an immediate sense of what the concept is". Both participants emphasized that teaching science should be extended beyond the classrooms, which allows not only to follow the required curriculum, but also provides opportunities for its enhancement. As Jessy explained, during field trips students learn about concepts they were not aware of, for example, climate change issues. Besides, "they go home and train their parents on how to reduce, reuse and recycle".

In addition to the short-term benefits of learning on field trips, the results of this study indicate that outdoor learning has important long-term benefits. In John's opinion, students who visited the zoo remembered the examples they saw at the zoo weeks and months after the trip, and included them in their answers to the questions on tests and assignments which were even not directly related to the zoo trip. Moreover, as the analysis of the literature suggests (Davidson, Passmore, & Anderson, 2010; Tofield et al., 2003), confirmed by results of this study, the

outcomes of a field trip can be enhanced by pre-planning and structured learning activities before, during and after trip, which will be discussed in further sections of this paper.

Proper planning and preparatory work as a key for a successful field trip

As Wurdinger (2009) noted about active learning approach, "for those that have relied on lecturing as their primary teaching format, this approach may appear rather risky" (p. 8). Indeed, as confirmed by a number of other authors, many teachers said they were not feeling confident to bring their classes on a field trip, explaining it by safety concerns, lack of training to organize field trips, and large class sizes (Dyment, 2005; Ravensbergen, 2012; Wurdinger & Rudolph, 2009). Both participants of this study argued that the benefits of taking students on each of the field trips overweighed any difficulties related to the organization of the trips, because of the proper planning and preliminary work done by the teacher before the trip.

According to the participants, proper preparatory work for the trip also allowed their students to demonstrate better learning outcomes. For example, preparation to the zoo trip made it more meaningful for the students, as they came to the zoo "not just to watch a monkey swinging on the trees or a fish swimming around in the tank, but look at some physical features or physical characteristics that are indicative of the traits and habitat, and adaptations to different kinds of life histories". When planning a trip to the local creek, "it is important to plan the trip in advance, go to the site, and see what learning experiences this place can offer to students". Before visiting a zoo or museum, "spend the time ahead of time arranging the track that the trip is going to take, so that you have specific displays in mind", and that "you know exactly where you are going to go, and what you are going to do at each one of the stations that you are visiting, and it is less spontaneous". For example, planning the trip to the zoo, the teacher can prepare the students:

> I want to illustrate this evolutionary concept, so I am going to stop at the polar bears display, or for this aspect we are going to take a tour through the America's pavilion where we can see a lot of camouflage amphibians and talk about different kinds of adaptations that serve to either provide camouflage to a predator or to a prey species.

As shown by the literature, setting clear learning goals before the trip, development of assessments related to the trip and of the post-trip activities ensures stronger outcomes of the outdoor learning (Davidson, 2010; Tofield, Coll, Vyle, & Bolstad, 2003). As mentioned by the participants, discussing examples and lecturing on the topic before the field trip, working on review worksheets, and explaining the expectations to the students makes learning experience interesting and enriching both for the students and the teacher.

According to both teachers, field trip preparation requires a lot of time, but, when planned properly, the trip is always rewarding for the students. The key to a successful trip is investing teacher's time before the trip. As Jessy said, "It is your personal time and planning, and if we put in more time and planning, the things do not follow apart, it smooths". Visiting the site before the trip and careful planning of the activities are important contributors to the trip success. As shown by literature (Tofield et al., 2003) and this research, in comparison to informal learning which mostly happens when students are not specifically prepared for the trip, planning of the activities and display visits enhance student learning and provide significant short- and long-term learning outcomes for them.

Field trip management

In addition to the findings outlined in the previous section, the participants also found that the use of certain strategies during the trip may play an important role in achieving best outcomes. Both participants discussed difficulties in organizing field trips with large group of students; planning a self-directed and organized class visit managed by one teacher can be a significant challenge. A solution to this, as suggested by the teachers, could be splitting up the large group into several smaller groups of students and sending them to a display to do an observational self-directed assignment or answer questions of the worksheets provided. In larger groups, the tour "would probably be more like a surface tour, while more enriching visits require more efforts, knowledge and efficient management during the tour". At the same time, as John noted, students who are already planning their future career in science are more interested during the trip and "are more likely to take it seriously". Also, "making the trip exciting for the students keeps them motivated".

As found by both participants, breaking up the class into small groups in many cases still requires supervision, because teacher's attention is split up amongst all of the small groups. A solution to this challenge, as suggested by both participants, is to have volunteers, such as zoo volunteers or another teacher coming with the class. Participants' concerns regarding large class sizes are supported by the literature. As found by Wurdinger and Rudolph (2009), participants of their research indicated the large class size as one of the factors that might limit the quality of learning outcomes for the students. They also suggested that large classes can be divided into small groups, each group can be given problems to solve, and then all groups would report to the entire class on their solutions.

Both participants also develop follow-up activities for their students, such as writing reflection on what they learned during the field trip, or answering questions related to the trip on the unit test or the midterm exam. This approach demonstrated by the participants in organizing a student-directed, but at the same time teacher-guided learning, aligns with the work of other educators (Crawford, 2000), and stimulates knowledge building by the students.

The role of collaboration

As mentioned in the previous section, help of volunteers, such as zoo or museum volunteers, or other teacher coming with the class improves the trip's success. As John explained, teachers need to "have a volunteer from the organization who knows the displays," and have to split up the class in smaller groups supervised by other adults.

When planning the trip, Jessy and John talk to other teachers and administration, collect the information from teachers' conferences, workshops and exhibitions, and contact ahead of time the organization they want to visit, to get the information required for the trip. An important role of collaboration and support by the organizations' personnel has also been discussed in the literature (Griffin, Glasscock, Schwertner, Atchley, & Tarpley, 2016; Skinner-Winslow, 2016).

Summary and Implications

This study provided several important insights, such as on positive outcomes of real-life learning during field trips and on how students learn – through forming an association between what they learn during the trip and what they remember from the material taught in the

classroom. Both teachers emphasized the role of planning ahead, communicating to students clear goals for field trips and developing pre- and post-trip activities. They also noted on the importance of field trip management and inquiry-based tasks and assignments during the trip. Finally, both participants commented on the important role of collaboration and support by other teachers and volunteers.

There are important implications of this study to the literature and practice. Results of the study improve understanding of the outcomes of experiential learning activities outside classroom for students. Strategies and experiences shared by both participants on how they overcome the barriers outlined in literature may help other teachers to include meaningful and safe field trips in their curricula, for example, trips to conservation areas, the Toronto Zoo and Ripley's Aquarium. To address the issue of the lack of teacher knowledge and training, teachers can ask help from the zoo or museum personnel. As a solution to the problem of large class sizes, classes can be divided into smaller groups provided with self-directed assignments to be performed during the trip, while the teacher's role is to observe and guide students. To address student safety concerns, both participants suggested going on a trip with volunteers (e.g., parents) and other teachers. They also emphasized the importance of visiting the site or organization ahead and planning in advance the activities that students are going to do or displays they are going to visit during the trip. As both participants also explained, keeping students motivated and making the trip exciting for them increases trip success.

Finally, this study also addresses teachers' concern identified in the literature as curriculum constraints in high school, but, as mentioned by John, the entire units of Grade 11 and 12 Biology could be built around field trips. Indeed, the analysis of the Ontario Science Curriculum performed by the author of this research suggests that all or almost all expectations of the curriculum can be covered in the pre-trip activities, the work done by students during the trip and in the post-trip assignments, and the entire units can be built around field trips. For example, such units as biodiversity and evolution could be taught in a zoo or aquarium setting. The Toronto Zoo already offers zoo-based summer high-school credits. This and other aspects can be further researched based on learning from teachers' experiences, curriculum analysis, and displays and activities offered by various organizations providing outdoor learning experiences in Ontario.

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