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Factors Related to Students' Perception of Learning During Outdoor Science Lessons in Schools' Immediate Surroundings

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ABSTRACT

The research presented in this paper answers the question: What factors are most related to students' perception of learning during outdoor science lessons occurring in schools' immediate surroundings? Twenty-six science teachers, as well as 71 classes of seventh (51 classes) and eighth (20 classes) graders participated in our study (n = 2007). All 26 teachers agreed to plan and carry out five outdoor lessons in their schools' immediate surroundings for each class they decided to include in the study. The 11 influencing factors we examined in this quantitative study were: the duration of the outdoor lesson, the students' level of preparation, the students' opportunity to make choices, the outdoor environment, the position in the lesson sequence, the presence of a laboratory technician, the scientific discipline, the grouping of the students, the teacher's outdoor teaching experience, the type of activity, and the weather conditions. To identify the factors most related to students' perception of learning, we ran a bivariate correlation analysis and then used a three-level hierarchical linear model (HLM) with the significant factors from the bivariate correlation. Our results showed that students' perception of learning was significantly and positively correlated with the factors listening to scientific explanations, being grouped with the entire class, students' level of preparation, and students' opportunity to make choices, and negatively correlated with observing. We conclude this paper by arguing that students' perception of learning is really a perception that is based on their anticipated success on school assessments.

Keywords: contextualization, middle school, outdoor science, perception of learning, science education

INTRODUCTION

What Is Outdoor Science Education in Schools' Immediate Surroundings?

Over the past decade, there has been an increasing amount of research on practices associated with teaching and learning science outdoors. Outdoor education can refer to many locations, such as field study centres, gardens, farms, or nature centres (Rickinson et al., 2004). Although these places are often located far from the school, outdoor education in a formal context can also take place in a school's immediate surroundings. In addition to being familiar to students, these sites have the advantage of being accessible during regular school periods (Fančovičová & Prokop, 2011; Lustick, 2009), even when the periods are as short as those in secondary school. This educational context, which is often underrepresented in the scientific literature on outdoor education, requires more attention from researchers in order to better understand the factors that optimize students' learning in science. Research efforts on education in schools' immediate surroundings have been concentrated in three fields: outdoor education, environmental education, and science education (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017).

In the field of outdoor education, authors generally consider outdoor education as a pretext for conducting activities with students in a school's immediate surroundings. For instance, the objective of Fägerstam's (2014, p. 56) research was "to explore how teachers from different disciplines experienced regular school-based outdoor teaching and learning," while Hovardas's (2016, p. 238) study was aimed "at investigating varying levels of teacher leadership in informal networks of primary school teachers who implement outdoor education." Essentially, authors in the field of outdoor education encourage conducting outdoor activities as frequently as possible.

In the field of environmental education, outdoor science is generally "considered as a vehicle for achieving environmental aims" (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017, p. 5348). The pedagogical interventions that are studied often focus on interdisciplinary knowledge acquisition (e.g., Skamp & Bergmann, 2001) or changes in attitudes or behaviours (e.g. Carrier, 2009). For instance, Ballantyne and Packer's (2009, p. 245) research objective was "identifying the specific teaching strategies or pedagogies that are most effective in bringing about desired learning outcomes in the context of learning in natural environments," and Carrier Martin (2003, p. 53) aimed "to examine the effects of participation in regular outdoor schoolyard environmental education activities on environmental knowledge, attitudes, behaviours, and comfort levels of fourth- and fifth-grade students." According to Sauvé (1997), because educational activities associated with the outdoor environment education movement necessarily take place in the outdoor environment, the outdoor environment therefore constitutes an additional resource for learning. Overall, the body of research presenting empirical results about environmental education shows that the outdoors offers the potential to contextualize various kinds of environmental activities.

The body of research about outdoor science in the field of science education has grown rapidly during the last few years. The scientific articles about outdoor science teaching and learning "focus on science learning objectives during a studied intervention" (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017, p. 5348). In contrast to studies in the field of outdoor education—where science education only provides a pretext for going outdoors—in the field of science education, the outdoors is used when it represents the best context, or added value, for achieving science learning objectives. For example, Glackin's (2016, p. 409)2016 research aimed to explore "the relationship between secondary science teachers' beliefs and their pedagogical practices during a two-year professional development programme" on outdoor learning, while Dhanapal and Lim (2013, pp. 3–4) asked the following research questions: "How does indoor and outdoor learning impact students' academic performance in science?" and "What are students' perceptions about incorporating indoor and outdoor learning in science?" These two studies share an explicit desire to put the outdoor environment at the service of science learning.

Most of the research we have identified in these three fields of study does not define what outdoor means in the context of education. Since a clear definition is needed to operationalize research about education in such places, in a previous scientific article, we relied on a literature review of the fields of outdoor education, environmental education, and science education to define the characteristics of a school's immediate surroundings in a school science context:

> places for learning that (a) are outside of the school building(s), which excludes classrooms and school laboratories; (b) allow the contextualization of learning in context; (c) are easily accessible during a regular science lesson; (d) can support activities that are complementary to other learning activities that take place inside the school; and (e) can directly target the goals of the science curriculum (Ayotte-Beaudet, Potvin, & Riopel, 2019, p. 16).

These characteristics allow us to qualify/disqualify certain environments for the purpose of our study.

Challenges and Benefits of Outdoor Science Education for Students' Learning

Many articles have identified challenges to introducing outdoor science in formal educational contexts, such as national assessments that do not require the use of outdoor learning environments (Dillon et al., 2006; Fisher, 2001), a lack of teacher expertise in teaching outdoors (Lustick, 2009; Skamp & Bergmann, 2001), and unpredictable weather (Dyment, 2005; Glackin & Jones, 2012). In most recent publications in the field of outdoor science education in schools' immediate surroundings, the research questions focus less on identifying challenges and more on studying the benefits of concrete outdoor pedagogical interventions.

The increased research over the last decade on outdoor science in schools' immediate surroundings reflects a desire to study a learning environment that is generally underused in schools but can contribute to the achievement of science learning objectives. One of the most frequently mentioned benefits is that outdoor science offers the opportunity to contextualize scientific concepts in authentic settings (e.g., Fägerstam & Blom, 2013; Lustick, 2009), which allows "their relevance to become immediately obvious" (Sahrakhiz, Harring, & Witte, 2018, p. 223). In the outdoors, students can also develop scientific field skills (Glackin, 2016; Glowinski & Bayrhuber, 2011)2016; Glowinski & Bayrhuber, 2011 that might not necessarily be developed in a classroom or laboratory (James & Williams, 2017; Lavie Alon & Tal, 2017). Moreover, schools' immediate surroundings provide various environments for developing competencies in deploying science learning in new contexts, that is, transferring students' learning from one situation to another (Chen & Cowie, 2013; Glackin, 2016)2016. Overall, the scientific work in recent years has demonstrated that outdoor environments are more than ordinary learning boosters; they are rich contexts that can lead to quality, meaningful, and authentic science learning for many students.

The main outcomes that have been investigated in scientific articles examining the benefits of outdoor science education include: (1) learning related to ecology (e.g., Ben-Zvi Assaraf & Orion, 2009; Fisher-Maltese & Zimmerman, 2015) or environmental education (e.g., Carrier, 2009; Hyseni Spahiu, Korca, & Lindemann-Matthies, 2014), (2) development of students' attitudes/motivations/interest (e.g. Bølling, Hartmeyer, & Bentsen, 2019; Dettweiler, Lauterbach, Becker, & Simon, 2017) Becker, & Simon, 2017, (3) teachers' positive perceptions regarding outdoor learning (e.g. Borsos, Patocskai, & Boric, 2018; Glackin, 2016)2016, and (4) students' positive perceptions of outdoor learning (e.g., Carrier, Thomson, Tugurian, & Stevenson, 2014; Dhanapal & Lim, 2013). However, in a previous meta-synthesis, we concluded that "students do not necessarily perceive a clear connection between the outdoor learning they perform and its scientific value" (Ayotte-Beaudet, Potvin, Lapierre, & Glackin, 2017, p. 5351). The research we present in this article therefore aims to shed light on the benefits of outdoor science education for middle-school students by studying their general perceptions of learning in their schools' immediate surroundings.

Perception of Learning

In general, school can be considered to be governed by what Carrier et al. (2014) call the testing dilemma: anything that is not useful for academic assessment is generally not a priority. Since the school science curriculum does not generally require the use of schools' immediate surroundings (Dyment, 2005), the learning environments used to ensure students' successful science achievement in school are usually indoor environments, either classrooms or laboratories. In a study conducted with 148 undergraduate pre-service elementary school teachers, many of them mentioned that outdoor education would be easier if schools would "stop focusing so much on test taking" (Blatt & Patrick, 2014, p. 2255). The emphasis on testing leads many teachers to use a more "traditional (transmissive) science instructional approach" to secure good grades for their students (Carrier, Tugurian, & Thomson, 2013, p. 2063). For this reason, we believe that students' perception of science learning at school will tend to be associated with their success on assessments.

For example, consider a teacher who conducts lessons about the diversity of life forms. During one of these lessons, to illustrate physical adaptations of animals, he presents different shapes of bird beaks as being adapted to their respective feeding habits (e.g., grain eating, aerial fishing, raptorial feeding). For the final exam, students will have to associate the shapes of bird beaks with their feeding mode. To ensure that they are successful, the students might complete exercises in a workbook, believing this will help them succeed on the exam. However, engaging in such academically focused activities about physical adaptations of animals does not necessarily mean that students will be competent at transferring this knowledge to outside-of-school contexts.

To help students transfer such knowledge, another teacher might decide to exploit her school's immediate surroundings. She could ask her students to identify the birds that live in this environment, to describe the beak shapes of these species, and to connect these observations to the available food sources. It is reasonable to expect that her students will develop better ecological competencies than those in the other group. For example, they might be more likely to ask themselves relevant questions about the shapes of bird beaks that can be found in different environments or attempt to make predictions about the shapes of the beaks of birds that live in environments where such-and-such resources are available.

However, it must be acknowledged that the outdoor activity will not necessarily lead students to perform better on academic knowledge tests (which are generally considered to be valuable measures of learning). Indeed, these tests are often aligned very well with previous practice (exercises), which favours optimal performance. It can therefore be hypothesized that some students will perceive the outdoor activity as less useful than the traditional way of learning or simply not worthwhile. This illustrates why it is essential to better understand students' perceptions of learning during outdoor science lessons.

In this study, students' perception of learning will refer to how much students' feel they have learnt during a science lesson, in accordance with their personal vision of what learning is.

Most studies interested in students' learning collect data about their effective (genuine) learning. However, as is generally the case with the construct of self-concept, we find that the perceptions that students cultivate are more decisive for further learning than actual learning. Only a few studies in the last few years have focused on students' perceptions of learning in science. We have identified different data collection strategies in this regard, such as interviews (Roberts et al., 2018), reflection forms completed by students (Roberts et al., 2018), questionnaires (Jones, 2017; Sample McMeeking et al., 2016) and Likert-scale items (Aljaloud et al., 2019; Jeong et al., 2016), which seem to be the most promising strategy. For example, to study students' perceptions of learning in a science classroom, Jeong, González-Gómez, & Cañada-Cañada (2016, p. 751) used five-point Likert-scale items (e.g., "The instruction methodology used in this course helped me to understand easily scientific contents"; "The course as a whole was a valuable learning experience"), and in research aiming to understand how a smartphone clicker app can impact learning performance in a computer science class, Aljaloud et al. (2019, p. 91) developed an online survey with Likert-scale items to measure students' perceptions of their learning performance (e.g., "Using the smartphone clicker app helped to improve my ability to comprehend the concepts in this module"). After exploring the different data collection strategies, we concluded that the use of Likert-scale items seems to be an effective and sufficient strategy for collecting data on perceptions of learning. They are also well adapted for larger studies that aim to verify hypotheses.

Research Problem and Question

Considering that (a) current research about schools' immediate surroundings appears to focus on studying the benefits of outdoor concrete pedagogical interventions, rather than their challenges (or shortcomings), and profiting from this; (b) it is important to better understand students' perceptions of science learning in this educational context in order to maximize its potential; and (c) we found no empirical studies in scientific journals that focus on factors that might be related to students' perception of learning in our research context, we ask the following research question: What factors are most related to students' perceptions of learning during outdoor science lessons occurring in their schools' immediate surroundings?

METHODS

Participants and Procedures

This study was conducted in connection with another study aiming to identify the factors that are most related to middle-school students' situational interest during outdoor science lessons occurring in their schools' immediate surroundings (for theoretical background for situational interest, see Ayotte-Beaudet, Potvin, & Riopel, 2019). The participants were students in the seventh and eighth grades in the province of Québec, Canada, who share the same curriculum, which includes five scientific fields: astronomy, biology, chemistry, biology, and physics. This curriculum does not explicitly stipulate that teachers should conduct lessons in their schools' immediate outdoor surroundings.

Twenty-six French-speaking science teachers (14 women and 12 men) and 71 classes of French-speaking seventh (51 classes) and eighth (20 classes) graders participated in our study (n = 2007). We recruited the teachers with the help of school directors, academic advisors, and our own professional network, as well as teacher groups on Facebook. Among the teachers, 15 worked in public schools and 11 in private schools. The teachers carried out their lessons in 19 schools (nine schools with one participant each, seven with two participants, and one with three participants) in various administrative regions of the province of Québec that reflect a certain diversity (urban, peri-urban, and rural areas). Only one of the 26 teachers participating in the study had fewer than five years' experience teaching science.

All 26 teachers agreed to plan and carry out five outdoor lessons in their schools' immediate surroundings for each class they decided to include in the study (a maximum of seven classes per teacher) during the 2015–2016 school year. They were asked to plan each outdoor lesson following the existing science curriculum and in line with our interpretation of what counts as science education in schools' immediate outdoor surroundings, which we presented in the earlier section, "What Is Outdoor Science Education in Schools' Immediate Surroundings?". Participating teachers also had to show a short video to their students explaining their involvement in the project (https://www.youtube.com/watch?v=uC-zOsxF9iA).

The teachers were asked to schedule five minutes at the end of each outdoor lesson during which the students would be asked to fill out a short questionnaire regarding their perception of learning in the outdoor science lesson they had just experienced. The teachers were also asked to select one student from each class who would be responsible for collecting the anonymous questionnaires, putting them in a pre-stamped envelope, and bringing them directly to the school secretary. We also requested that all 26 teachers fill out a short online questionnaire at the end of every outdoor lesson to help identify the precise characteristics of the factors under study.

To answer our research question, we selected 11 factors from our literature review related to students' situational interest in science in their school's immediate surroundings. For the sake of brevity, we refer readers to our previous article for the rationale behind our choice of factors to be studied (Ayotte-Beaudet, Potvin, & Riopel, 2019). Nine experts (four professors and five graduate students from our research team) validated the 11 factors, which were (a) the type of activity, (b) the outdoor environment, (c) the teacher's outdoor teaching experience, (d) the presence of a laboratory technician (a possible addition to the adult teacher in schools in the province of

Québec), (e) the scientific discipline, (f) the position in the lesson sequence, (g) the grouping of the students, (h) the weather conditions, (i) the duration of the outdoor lesson, (j) the students' opportunity to make choices, and (k) the students' level of preparation.

Instruments

We used a quantitative approach to answer our research question. We collected data about (a) students' perception of learning and (b) the eleven studied factors. We designed a measure with four Likert-scale items that was validated by a panel of experts to measure students' perception of learning at the end of each outdoor lesson. Two of the items were positively worded, and the other two were negatively worded. We chose to use an even scale ranging from 1 (strongly disagree) to 6 (strongly agree), and to secure the hypothesis of equidistance between the values, no qualifiers were associated with the values 2 through 5. The items, which were written in French on the questionnaire, were (1) "During this outdoor lesson, I experienced useful scientific learning," (2) "During this outdoor lesson, I did not learn much," (3) "I would probably have learned more by staying indoors today," and (4) "I would learn more by going outdoors more often."

This questionnaire was also used to gather data on two of the 11 situational interest factors we were studying. One factor (positive) was used to measure the students' level of preparation: "I was well prepared for this outdoor lesson." Another factor (negative) was used to measure students' opportunity to make choices: "During the outdoor lesson, I did not have the opportunity to make choices."

We asked the teachers to fill out an online questionnaire that collected data on nine of the 11 factors we were studying within 24 hrs of conducting their outdoor lessons. In the first section of the questionnaire, we also asked them about their outdoor teaching experience ("never taught outdoors before the research," "very rarely taught outdoors before the research," "frequently taught outdoors before the research"), where the lesson was positioned within their lesson sequence (first outdoor lesson, second outdoor lesson, etc.), how long the outdoor lesson lasted (in minutes), and whether a lab technician was present (yes/no). We then used a Likert-scale item with the same values as we described previously for the students' situational interest questionnaire to collect data about the weather conditions during the lesson: "The weather conditions were in all respects favourable for achieving the learning objectives of this outdoor lesson." Finally, the teachers were asked to select the options that applied to the outdoor lesson for each of the following four factors: type of activity (listening to scientific explanations, listening to instructions, identifying a scientific problem, making assumptions, experimenting, observing, modelling), outdoor environment (wooded area, schoolyard, park, watercourse, neighbourhood), scientific discipline/topic (astronomy, biology, chemistry, geology, physics, scientific method), and student grouping (alone, in pairs, teams of three, teams of four, other groupings, entire class). As there could be more than one option for the same outdoor lesson, the teachers also had to select the relative weighting for each choice (0%, 25%, 50%, 75%, 100%).

Analysis

The goal of the analysis phase was to identify the factors (independent variables) that correlated the most with the middle-school students' perception of learning (dependent variable) when science lessons were conducted outdoors in their schools' immediate surroundings. In order to validate our perception-of-learning questionnaire, we conducted a principal axis factor analysis. We used Cronbach's alpha to test the internal consistency. The unit of analysis for the variable students' perception of learning was the event of a single outdoor lesson. First, we averaged the items that were valid (a maximum of four) for each questionnaire. Second, we averaged each student's mean scores for every outdoor lesson. This allowed us to calculate an average score for students' perception of learning for each outdoor lesson. Seven of the 11 studied factors were nominal variables (type of activity, outdoor environment, teacher's outdoor teaching experience, presence of a laboratory technician, scientific discipline, position in lesson sequence, and student grouping), and four were discrete variables (weather conditions, duration of the outdoor lesson, students' opportunity to make choices, and students' level of preparation). We conducted the data analysis in two steps: First, we ran a bivariate correlation analysis to identify the factors for which there was a clear correlation with students' declared perception of learning (the dependent variable). We then used a three-level hierarchical linear model (HLM) with the significant factors from the bivariate correlation. The HML allowed us to simultaneously take into account the hierarchy between the teacher, the group, and the lesson in the analysis.

Ethics

An ethics certificate was obtained for this study in December 2014 from the Comité pour l'évaluation des projets étudiants impliquant de la recherche avec des êtres humains (CÉRPÉ) des facultés des sciences et des sciences de l'éducation de l'Université du Québec à Montréal.

RESULTS

Overview of the Outdoor Lessons

The 26 teachers involved in the study conducted outdoor lessons for 51 groups of seventh graders, as well as 20 groups of eighth graders during the 2015-2016 school year. The 71 groups each participated in up to 5 outdoor science lessons (11 classes participated in 1 lesson, 13 classes participated in 2 lessons, 9 classes participated in 3 lessons, 11 classes participated in 4 lessons, and 27 classes participated in 5 lessons).

Descriptive statistics for the students' perception of learning variable for all lessons are: min = 2.90, max = 5.48, M = 4.11, SD = .50.

167 of the 243 outdoor lessons were conducted alone by the teacher, whereas for 76 of the lessons the teacher was accompanied by another person.

Several of the outdoor lessons involved knowledge pertaining to more than one scientific subject. 14.4% of the outdoor lessons were related to astronomy, 45.6% were related to biology, 6,6% were related to chemistry, 19.3% were related to geology, and 20.6% were related to physics. 53.1% of the outdoor lessons involved the scientific method.

The teachers used several different learning environments in their school's immediate surroundings: 28.4% of the lessons were conducted partially or entirely in a wooded area, 63% were conducted in the schoolyard, 11.9% were conducted in a park, 9.9% were conducted near a watercourse, 6.6% were conducted in the neighborhood, and 4.1% were conducted in another environment.

In 17.3% of the outdoor lessons, students were instructed to work alone at least once. In 48.1% of the outdoor lessons they were put into pairs. In 28.8% of the outdoor lessons the students were put into teams of 3. In 32.1% of the outdoor lessons they were put into groups of 4. The entire class was involved in 11.1% of the classes, and teams of 5, 6, 8, or 9 were made in 9.5% of the outdoor lessons.

During any outdoor lesson, the teachers were allowed to use several different types of activities. 21.8% of the outdoor lessons included listening to scientific explanations. 22.6% of the outdoor lessons included listening to instructions. 0.8% of the outdoor lessons included identifying a scientific problem. 10.9% of the outdoor lessons included making assumptions. 36.6% of the outdoor lessons included collecting data. 25% of the outdoor lessons included experimenting. 74.1% of the outdoor lessons included observation. 7% of the outdoor lessons included modeling, and 2.5% of them included a different type of activity such as moving from one place to another or collecting specimens, waste.

All the teachers involved in the study were asked to assess their level of experience teaching science lessons outdoors. This information allowed us to determine that 34.2% of the outdoor lessons were conducted by teachers who had no experience teaching outdoors prior to our study, 56% were conducted by teachers who had rarely taught outdoors, and 9.9% were conducted by teachers who taught outdoors frequently.

The teachers involved in the study were asked to report the duration of each outdoor lesson.

We measured the level of agreement at the end of each lesson using 3 factors on a scale ranging from 1 (strongly disagree) to 6 (strongly agree). No qualifiers were associated with the values 2 through 5.

Each teacher reported their level of agreement through a statement relating to the weather conditions:" The weather conditions were favorable in order to achieve the learning objectives of this outdoor science lesson".

Students reported their perception of the opportunity they were given to make choices with one item: "I did not have the opportunity to make choices during this outdoor lesson".

Finally, students reported their perception of the level of preparation they had with one item: "I was well prepared for this outdoor lesson".

In order to illustrate the total information that we collected about an outdoor lesson in the online questionnaire, we provided an example. We asked teachers to report what they asked students to do and what the targeted learning in line with the science curriculum was. In February, in the middle of winter in the province of Quebec, one teacher conducted an outdoor lesson during which he asked students to take pictures of observations they made about the natural changes that have occurred during this season in an ecosystem next to the school. He stated that he wanted to target a learning objective related to life sciences in the science curriculum, which was to name the characteristics that define a habitat (e.g. climate, flora, fauna). This outdoor lesson was conducted alone by the teacher. 100% of the lesson was oriented towards the development of scientific method skills. 100% of the lesson took place in a wooded area near the school. Students were asked to work in teams of four during 100% of the lesson. The lesson involved instructions 25% of the time and observation 75% of the time. The duration of the lesson was 65 minutes. The teacher reported a level of agreement of 6 with the statement related to weather conditions. The students reported a mean level of agreement of 3.32 with the statement related to the opportunity to make choices, and the students reported a mean level of agreement of 2.64 with the statement related to the level of preparation.

To better discern the meaning of our resulting data, we also provided five examples of what students could have been asked to do during an outdoor lesson: (a) identify species of trees near the school ground, (b) listen to scientific explanations about natural energy sources, (c) make a diagram to illustrate forces and movements in the schoolyard, (d) collect snow samples to compare their properties, and (e) study the different types of rocks near a coastline.

Psychometric Properties of the Perception-of-Learning Questionnaire

We used the perception-of-learning questionnaires from all first outdoor lessons (n = 2007) to test the psychometric properties of the perception-of-learning questionnaire. The correlation matrix for the four items used in the questionnaire showed that all p-values were less than .001 (see Appendix). The Kaiser-Meyer-Olkin measure verified the sampling adequacy, KMO = .644, which is above the acceptable limit of .5 (Field, 2013). Bartlett's test of sphericity, X = 1482.79, df = 6, p < 0.001, showed that the sample was adequate. The confirmatory principal axis factor analysis showed that our four-item Likert scale questionnaire measured only one factor, students' perception of learning, which explained 52.96% of the variance. All four items met the criterion of having a factor loading of at least .4 (Steven, 2009). The Cronbach alpha coefficient value (α = .759) was judged reliable, as it was above the acceptable threshold of .7 (Field, 2013). According to the psychometric properties, the perception-of-learning questionnaire showed good internal validity and reliability. Table 1 presents the summary of the confirmatory principal axis factor analysis.

Factors Related to Students' Perception of Learning

As the first step of our analysis, we computed a bilateral correlation analysis that showed which factors were significantly correlated with students' perceptions of learning. The factors with a significance level less than .05 were: listening to scientific explanations (r = .228, p < .001), listening to instructions (r = .180, p = .005), making assumptions (r = .147, p = .022), observing (r = -.154, p = .017), schoolyard (r = -.216, p = .001), watercourse (r = .236, p < .001), teacher's outdoor experience (r = .318, p < .001), presence of a laboratory technician (r = .362, p < .001), geology (r = .143, p = .026), scientific method (r = -.205, p = .001), students grouped in pairs (r = -.256, p < .001), entire class (r = .262, p < .001), duration of the outdoor lesson (r = .416, p < .001), students' opportunity to make choices (r = .179, p = .005), and students' level of preparation (r = .469, p < .001). All results for this first step are presented in Table 2.

Table 1. Summary of confirmatory factor analysis results for the students' perception-of-learning questionnaire (n = 2007)

Items	SSI
During this outdoor lesson, I did not learn much.	**.757**
During this outdoor lesson, I experienced useful science learning.	**.733**
I would probably have learned more by staying indoors today.	**.732**
I would learn more by going outdoors more often.	**.686**
Eigenvalue	
% of variance	52.96
Cronbach's α	.759

Note. Factor loadings over .40 appear in bold.

For the second step of our analysis, we ran a three-level HLM with the significant factors from the bilateral correlation analysis, using the SAS 9.4 software's MIXED procedure. We calculated the standardized coefficient with Hox's (2010) formula. The factors that most positively correlated with middle-school students' perception of learning during outdoor science lessons in their schools' immediate surroundings were listening to scientific explanations (ß = .209, p < .001), entire class (ß = .128, p = .022), students' opportunity to make choices (ß = .152, p = .002), and students' level of preparation (ß = .425, p < .001). The results show a significant negative correlation with students' perception of learning when teachers had them observing (ß = -.161, p < .001). Finally, there was a positive correlation with duration of the outdoor lesson (ß = .091, p = .082), but the correlation was not significant (p < .1). The pseudo-R^2 (Hox, 2010) was .474. Our data collection strategies allow us to reasonably presume that these results were consistent across the outdoor lessons. The results from the three-level HLM are presented in Table 3.

The intraclass correlation coefficient indicated that 21.9% of the variance was due to the outdoor lessons (level 1), 64.6% to the groupings (level 2), and 13.5% to the teachers (level 3). These results indicate that the three levels had an effect on students' perception of learning.

DISCUSSION

Factors Related to Students' Perception of Learning

The purpose of this study was to identify the factors that are most related to students' perception of learning during outdoor science lessons that occur in their schools' immediate surroundings. Our study was exploratory, since we did not have any preliminary hypothesis based on the scientific literature. Still, we found interactions that appear important to highlight for further research.

Our results show that students' perception of learning

Table 2. Correlations between students' perception of learning and studied factors (n = 243)

Factors	Pearson correlation	Sig. (2-tailed)
Type of activity		
Listening to scientific explanations	.228	.000***
Listening to instructions	.180	.005**
Identifying a scientific problem	-.031	.630
Making assumptions	.147	.022*
Collecting data	-.012	.858
Experimenting	-.026	.691
Observing	-.154	.017*
Modelling	-.025	.700
Outdoor environment		
Wooded area	-.023	.721
Schoolyard	-.216	.001**
Park	.020	.754
Watercourse	.236	.000***
Neighbourhood	.036	.578
Teacher's outdoor experience	.318	.000***
Presence of a laboratory technician	.362	.000***
Scientific discipline		
Astronomy	-.017	.791
Biology	.076	.236
Chemistry	.018	.774
Geology	.143	.026*
Physics	.027	.675
Scientific method	-.205	.001**
Position in lesson sequence	-.008	.896
Student grouping		
Alone	-.043	.508
In pairs	-.256	.000***
Teams of three	-.044	.493
Teams of four	-.020	.754
Entire class	.262	.000***
Weather conditions	.083	.198
Duration of the outdoor lesson	.416	.000***
Students' opportunity to make choices	.179	.005**
Students' level of preparation	.469	.000***

Note. $^{+}$ *p* < .1. * *p* < .05. ** *p* < .01. *** *p* < .001.

is significantly correlated with the factors listening to scientific explanations and entire class. Although most research on outdoor science education promotes the use of more active pedagogical approaches, the perception of learning among the students who participated in our research was correlated with factors related to a more magisterial and passive pedagogical approach. Our results echo those of a recent study conducted during an introductory college physics courses that concluded that "students' perception of their own learning can be anticorrelated with their actual learning under well-controlled implementations of active learning versus passive lectures" (Deslauriers, McCarty, Miller, Callaghan, & Kestin, 2019, p. 6). Such results illustrate a central tension surrounding outdoor science learning in formal education. At school, students are generally taught with the aim of succeeding on assessments (Kapon et al., 2018) disciplinary authenticity, and common school science as three perspectives that entail different educational goals. Based on an analysis of the literature, we identify five facets of the tensions: content fidelity, content coverage, language and discursive norms, epistemic structure and standards, and significance. We then explore the manifestations of these facets in two different examples of the instruction and learning of physics at the advanced high school level in Israel and Italy. Our analysis suggests that (1. The format of science assessments, which generally remains standard, encourages teachers to focus their teaching on the most effective pedagogical approaches that enable students to perform well on assessments. Most of the time, interventions that students perceive as effective for assessments are limited to the "teacher lecture, textbook reading, laboratory experiments, and interactive discussion" (James & Williams, 2017, p. 59). This well-documented phenomenon of "teaching to the test" (Jennings & Bearak, 2014) causes students to develop a clear vision of what learning in school is, namely, learning that will help them succeed on an assessment. Like Lavie Alon and Tal (2017, p. 238), we believe that "we still lack the tools to adequately assess" outdoor science learning. After conducting a study to identify challenges in outdoor classrooms in the early years, Davies and Hamilton (2018, p. 117) concluded that "assessing children in the outdoors is not used to its potential." In these circumstances, it is reasonable to ask whether assessments are adapted to outdoor science learning. Thus, despite the fact that teachers who integrate outdoor science education generally wish to develop more meaningful and authentic learning that students can make use of beyond school assessments, we may suspect that students do not always perceive this type of learning as useful for success on assessments. Therefore, we believe that students'

Table 3. Results from the three-level hierarchical linear model

Factors	B	SE B	ß	df	t	p
Listening to scientific explanations	.559	.129	.209	153	4.32	$< .001^{***}$
Listening to instructions	.204	.133	.068	153	1.53	.128
Making assumptions	.190	.204	.039	153	.93	.354
Observing	-.229	.066	-.161	153	-3.50	$< .001^{***}$
Schoolyard	-.052	.051	-.049	153	-1.03	.307
Watercourse	-.105	.092	-.049	153	-1.15	.253
Teacher's outdoor experience	.140	.087	.172	153	1.60	.111
Presence of a laboratory technician	-.006	.058	-.006	153	-.11	.916
Geology	-.060	.081	-.032	153	-.74	.462
Scientific method	-.081	.065	-.058	153	-1.26	.211
In pairs	.058	.049	.051	153	1.19	.236
Entire class	.232	.100	.128	153	2.32	$.022^{*}$
Duration of the outdoor lesson	.001	.001	.091	153	1.75	$.082^{+}$
Students' opportunity to make choices	.127	.040	.152	153	3.20	$.002^{**}$
Students' level of preparation	.374	.044	.425	153	8.53	$< .001^{***}$

Note. $^{+}p < .1$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

perception of learning is rather a perception based on their anticipated success on assessments.

Our results also show a positive correlation between students' level of preparation and their perception of learning during outdoor science lessons. This finding is consistent with the conclusions of many researchers, such as Rickinson et al. (2004, p. 7), who stressed the importance of "well-designed preparatory and follow-up work" for outdoor learning in general. After conducting empirical research on learning opportunities in outdoor schools, Sahrakhiz et al. (2018, p. 223) also stressed the particular importance of planning for maximizing the "potential of the outdoor school." In a study conducted with secondary science teachers, Glackin (2016)2016 concluded that the most successful teachers in the outdoor environment were those who considered planning to be essential. It also seems important to add that we found a positive correlation between students' level of preparation and their situational interest in schools' immediate surroundings during the research conducted in parallel with the present research (Ayotte-Beaudet, Potvin, & Riopel, 2019). While some research has already highlighted the importance of student preparation for outdoor activities, the specific contribution of our research is that it further suggests that good preparation is positively associated with students' perception of learning during outdoor science lessons in their schools' immediate surroundings.

The last positive correlation we found in this study is a correlation between students' opportunity to make choices and their perception of learning during outdoor science lessons. This result is reflected in some other studies that have different contexts. For instance, Dettweiler et al. (2017, p. 15)we searched into the satisfaction of basic psychological needs (BPN, who studied basic psychological needs satisfaction through outdoor learning—but not in a science education context—found that the freedom experienced by students during outdoor sessions "is highly valued by the students." As another example, after conducting a study of the impact of field trips to natural environments on student learning outcomes, Lavie Alon & Tal (2017, p. 250) recommended "less structured, didactic teaching and more active learning that encourage the students to observe and explore the environment themselves, allowing more free choice time and opportunities for direct experience with nature." This observation seems to be in line with Glackin's (2016)2016 conclusion in which she stressed the importance of providing students with flexibility for more successful enactments during outdoor science lessons. Finally, in our research conducted in parallel with the present research (Ayotte-Beaudet, Potvin, & Riopel, 2019), we also found a positive correlation between students' opportunity to make choices and their situational interest. Therefore, it seems that giving students the opportunity to make choices during periods of outdoor science education can lead to many benefits. Our results and the research related to these allow us to conclude with confidence that giving students the opportunity to make choices in outdoor classrooms should be strongly considered by teachers planning science lessons in their schools' immediate surroundings.

Since making observations is an important activity for scientists in conducting scientific investigations (Lee & Butler, 2003), we were surprised to find a significant negative correlation between perceptions of learning and the outdoor lessons that required students to observe. In fact, some research has emphasized the benefits of observation for science learning. For instance, one research study on learning in an outdoor classroom found that the students "pointed out the importance of direct experiences and observing real organisms in their real environments" (Sjöblom & Svens, 2018, p. 8). Moreover, Lavie Alon & Tal (2017, p. 250) recommend that in natural environments, teachers should "encourage the students to observe and explore the environment themselves." A possible explanation to better interpret the negative correlation we found in our results might be that students perceive outdoor observation as a mere waste of time compared to the acquisition of new scientific knowledge for their exams. Another possible explanation could be Auer's (2008) observation that "surface learners" are not necessarily capable of in-depth comprehension of their outdoor observations. Since students are not used to making formal observations in their schools' immediate surroundings, it is reasonable to believe that they do not perceive their value. Perhaps the negative correlation between observation and students' perception of learning can be explained by the fact that they are simply not used to making scientific observations. Ultimately, we believe that the negative correlation we found between students' perception of learning and their observations highlights the importance of explaining to students how observations contribute to science learning and scientific investigations.

To conclude this discussion, we presented a broader reflection of our results. Perhaps the most distinctive features of our research design were that (1) we allowed all participating teachers the freedom to conduct the activities of their choice, which led to a wide variety of outdoor lessons, but also that (2) many students had never experienced outdoor science lessons before our research.

It is in this context that we aimed to identify the factors most related to students' perceptions of learning during outdoor science lessons occurring in their schools' immediate surroundings. Our results showed that certain factors that most influenced the perception of learning were related to a certain passivity among the students (listening to scientific explanations with the entire class), while others were associated with a more active participation by the student (opportunity to make choices and a good level of preparation).

At first glance, these results might seem contradictory. In our opinion, they might actually reflect two predominant beliefs concerning the phenomenon of learning, as identified by Glackin (2016)2016, among teachers who teach science outdoors: social constructivist beliefs and traditional beliefs. In her article, Glackin (2016)2016 argues that teachers with social constructivist beliefs about learning are more likely to provide authentic learning opportunities. Since students are used to more teacher-directed approaches in the classroom, it is normal that they might feel more inclined to learn when they encounter such conditions, regardless of whether or not it is the case. We therefore believe that is must be kept in mind that, for most of these students, it was the first time that they had science lessons outdoors. It therefore might be a rather radical change in their reality as students, and a few outdoor lessons might not be enough to transform their perception of learning in such a context. It can be expected that these students' perception of learning will eventually evolve if they experience outdoor learning on a more regular basis, especially if their teachers use activities that are aligned with social constructivist beliefs about learning.

Study Limitations and Further Directions

Some limitations of our study should be mentioned for further research directions. First, we preferred an ecological research design, in the sense that we allowed the teachers to make their own pedagogical choices, as long as their lessons met our definition of outdoor science in a school's immediate surroundings. Given this design, some factors that were under consideration were underrepresented in the study, such as knowledge related to chemistry, learning environments near watercourses or in the school's neighbourhood, and activities such as identifying a scientific problem and modelling. Second, our results were obtained strictly from quantitative data. To further investigate the results, it would be essential to use more interpretive data collection strategies. In particular, future research should try to better explain why students' perception of learning was positively correlated to a passive form of learning outdoors and negatively correlated to observation. Third, it is important to bear in mind that although some factors did not appear to be significant in our study, it does not follow that they are not at all significant. Since the significance score for the duration of the outdoor lesson was .082, for example, it is difficult to conclude with confidence that this factor has no real effect on the perception of learning. Fourth, our results are, obviously, restricted to the factors we selected, and other factors might be examined as well. Fifth, it should be remembered that our results are exploratory correlations and not causalities. Further research is needed to validate the correlations we found.

Despite the limitations mentioned, we have no reason to question the validity of the significant results we obtained. They should therefore serve as a strong basis for formulating new research questions and testing research hypotheses related to outdoor science in schools' immediate surroundings.

CONCLUSION

The increasing amount of research on practices associated with teaching and learning science outdoors reflects a desire to change practices among both researchers and educational practitioners. For such a transformation of practices to be successful, it is essential that teachers and students explicitly revise their vision of what school science learning is all about. That is why we considered it crucial to gain a better understanding of the factors that are most correlated with students' perceptions of learning when science lessons occur in their schools' immediate surroundings. Our results show that our middle-school student participants were more likely to have the impression of learning when they found themselves in more passive learning roles, despite the fact that many teachers use the outdoors to place students in an active learning position. In our opinion, this shows the strength of the belief that learning is associated with traditional teaching. To change students' beliefs, teachers would certainly benefit from explicitly communicating their learning objectives to their students so that they are fully aware of the (sometimes) different nature of learning science outdoors. In parallel, we also urge researchers to explore more research questions related to assessment strategies that respect both the nature of the scientific learning that takes place outdoors in schools' immediate surroundings and the requirements of the school science curriculum. If there is a key message to learn from this research, we argue that in order for students to be aware of the (frequently) different nature of the science learning they can achieve outdoors—as compared to indoor learning—it is crucial to transform their perception of what learning in science involves. Otherwise, students may not be aware of the richness of the learning objectives that are set by science teachers outdoors and therefore may not achieve them.

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Appendix. Correlation matrix of the perception of learning questionnaire

		1	2	3	4
1. Item 1	r	1			
	n	1974			
2. Item 2	r	.530***	1		
	n	1926	1957		
3. Item 3	r	.277***	.370***	1	
	n	1926	1912	1957	
4. Item 4	r	.302***	.257***	.472***	1
	n	1930	1912	1915	1959

Note. *** *p* < *.001.*