LOOK ACADEMIC PUBLISHERS
OPEN ACCESS

INTERNATIONAL JOURNAL OF ENVIRONMENTAL & SCIENCE EDUCATION
e-ISSN: 1306-3065
2019, Vol. 14, No. 1, 13-32

Factors Related to Middle-school Students' Situational Interest in Science in Outdoor Lessons in their Schools' Immediate Surroundings

Jean-Philippe Ayotte-Beaudet [1*], Patrice Potvin [2], Martin Riopel [2]

[1] *Université de Sherbrooke, CANADA*
[2] *Université du Québec à Montréal, CANADA*

* CORRESPONDENCE: Jean-Philippe.Ayotte-Beaudet@USherbrooke.ca

ABSTRACT

Drawing on a mixed-methods convergent parallel design, this article presents the results of a study aimed at identifying the factors that are most related to middle school students' situational interest during outdoor science lessons in their schools' immediate surroundings. The study involved 26 French-speaking science teachers and 2007 students from 71 classes of French-speaking seventh (51 classes) and eighth (20 classes) graders in the province of Québec, Canada. The teachers were asked to plan and conduct five outdoor lessons in their school's immediate surroundings in line with the existing provincial science program. The eleven influencing factors that were considered in the quantitative analysis were: the duration of the outdoor lesson, the students' level of preparation, the 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' situational interest, we first ran a bivariate correlation analysis and then used a three-level hierarchical linear model (HLM) with the significant factors from the bivariate correlation. We also conducted in-depth interviews with teachers, which allowed us to highlight convergences and divergences with the quantitative results. The results suggest that students' level of preparation, an opportunity to make choices, putting students into action, and conducting a reasonably difficult outdoor activity were positively related to students' situational interest, while grouping students in pairs and the position in the lesson sequence were negatively related to students' situational interest. This article closes with possible implications for teaching practices and suggestions for further research, including underexplored aspects of outdoor science education in formal educational contexts.

Keywords: contextualization, middle school, outdoor science, situational interest, science education

CONTEXT

Interest in Science

Over the course of the last three decades of the 20th century, many researchers developed or proposed theories to conceptualize and describe the concept of interest and its influences (for a review, see Potvin & Hasni, 2014a; Osborne et al., 2003). In the education field, this concept is important because, among other

Article History: Received 2 December 2018 ◆ Revised 14 December 2018 ◆ Accepted 14 December 2018

things, it is widely recognized as correlated with learning (Renninger & Hidi 2011; Schmidt & Rotgans 2017). Indeed, it has been argued that one of the most important questions in education is how interest is generated at school (Renninger & Hidi, 2011). Nevertheless, in recent years, many researchers have pointed to the problem of a decline in students' interest in school science (Potvin & Hasni, 2014b; Barmby et al., 2008; Bennett & Hogarth 2009; Turner & Ireson 2010). With the exception of a very small number of divergent results (e.g., Vedder-Weiss & Fortus 2011, 2012), most of the scientific literature from the past 15 years that we reviewed led us to conclude that the interest students declare regarding school science generally tends to decrease from primary to middle school and that the transition from primary to middle school is a critical moment in this decline.

Researchers have also found that students' interest in school science compares unfavorably with their interest in out-of-school science, when science is not explicitly linked to school (Bennett & Hogarth, 2009; Osborne et al., 2003). For example, in a study conducted in the province of Québec, Canada, based on linear regressions with more than two thousand students in grades 5 through 11, Potvin & Hasni (2014b, p. 796) judged that "(...) as children grow older, their interest in out-of-school S&T *increases*, while their interest [toward] in-school S&T *declines* considerably". This has led researchers such as Braund and Reiss (2006, p. 1373) to assert that "science education is . . . in crisis."

Given the conclusion that schools might benefit from paying more attention to students' interest in school science itself, researchers have tried to identify the best ways to generate student interest (Krapp and Prenzel 2011). A great number of empirical studies during the last 10 years have identified factors affecting students' relationship to school science. We retrieved a large number of factors related to students' interest in school science from these studies: cognitive challenges (Chen & Cowie, 2013; Logan & Skamp, 2013; Tsai, Kunter, Lüdtke, Trautwein, & Ryan, 2008), contextualization (Barmby. Kind, & Jones, 2008; Osborne, Simon, & Collins, 2003; Uitto, Juuti, Lavonen, Byman, & Meisalo, 2011; Zoldosova & Prokop, 2006), curriculum (Potvin & Hasni, 2014b; Häussler & Hoffmann, 2000; Krapp & Prenzel, 2011), gender (Allaire-Duquette, Charland, & Riopel, 2014; Krapp & Prenzel, 2011; Osborne et al., 2003), learning environment (Glowinski & Bayrhuber, 2011; Renninger & Hidi, 2011), novelty effect (Abrahams, 2009; Palmer, Dixon, & Archer, 2016; Renninger & Hidi, 2011), pedagogical strategy (Potvin & Hasni, 2014a; Christidou, 2011; Häussler, Hoffman, Langeheine, Rost, & Sievers, 1998; Krapp & Prenzel, 2011), scientific topic (Potvin & Hasni, 2014a; Häussler & Hoffmann, 2000; Uitto et al., 2011), social interaction (Ayar, 2015; Loukomies, Juuti, & Lavonen, 2015; Raes, Schellens, & De Wever, 2014), and teacher (Logan & Skamp, 2013; Osborne et al., 2003; Rotgans & Schmidt, 2011).

Situational Interest

Renninger and Hidi (2011, p. 169) have identified five main attributes of the concept of *interest*: (a) "interest is content or object specific," (b) "interest involves a particular relation between a person and the environment and is sustained through interaction," (c) "interest has both cognitive and affective components," (d) "a person is not always aware of his or her interest during engagement," and (e) "interest has a physiological/neurological basis." The conceptualization of interest generally distinguishes between individual interest and situational interest. Individual interest is characterized by a stable predisposition over time and does not require external factors for stimulation (Ainley et al., 2002; Hidi & Renninger 2006; Krapp, 2007). In contrast, situational interest is a temporary situation generated by external conditions, and it may or may not lead to the development of an individual interest (Ainley et al., 2002; Hidi & Renninger 2006; Krapp, 2007). To exemplify the difference, consider a teacher who asks students to collect arthropods during an outdoor science activity. Some of these students might already have developed a prior persistent interest in arthropods before this outdoor lesson, and the positive feeling they experience during the activity might be rooted in this prior interest. It is, however, possible that other students who initially did not like arthropods or did not know anything about them might temporarily become interested in them during the activity. This interest would be qualified as situational. Two components of situational interest have frequently been identified: focused attention and affect (Ainley et al., 2002; Krapp & Prenzel, 2011; Renninger & Hidi, 2011; Schiefele, 2009). Given its characteristics, the concept of situational interest appears to be more appropriate than individual interest for qualifying students' experience during activities that have a limited time frame, such as a science lesson.

When Hidi and Renninger (2006) published their widely cited theoretical four-phase model of interest development, they argued that individual interest leads to more knowledge acquisition. However, Rotgans and Schmidt (2017, p. 363) recently found from empirical data that "situational interest is the mechanism that drives knowledge acquisition, whereas individual interest is the affective outcome of such learning. Knowledge

Table 1. Items used to measure students' situational interest in science

Authors	Items (*n*)	Scales (*n*)	Wording	Items
Gungor, Eryılmaz, & Fakıoglu, 2007	4	5	Positive & negative	• Our physics class is fun in this semester. • This semester I find the physics course interesting. • I actually look forward to going to physics class this semester. • This semester our physics class is dull.
Lin, Hong, & Chen, 2013	1	4	Question	• How much were you interested?
Moreno, 2009	4	10	Questions	• How interesting was it to learn about this material? • How entertaining was it to learn about this material? • If you had a chance to use this program with new environmental conditions, how eager would you be to do so? • How motivating was it to learn about this material?
Nieswandt, 2007	9	4	Positive	• When I learn something new in chemistry, I am willing to spend my free time on it. • I would love to have more class periods in chemistry. • I am looking forward to my chemistry class. • It is fun for me to work at a chemistry problem. • My chemistry class is the most important thing for me. • When I am working at a chemical problem it can happen that I do not realize how time flies. • It is personally meaningful for me to be a good chemist. • It is important for me to know a lot in my chemistry class. • It is important for me to remember the content learned in the chemistry class.
Palmer, 2009	1	5	Neutral	• I thought this part was: 1 (very boring); 2; 3 (in between); 4; 5 (very interesting)
Rotgans & Schmidt, 2011	6	5	Positive & negative	• I want to know more about today's topic • I will enjoy working on today's topic • I think today's topic is interesting • I expect to master today's topic well • I am fully focused in today's topic; I am not distracted by other things • Presently I feel bored
Tapola, Veermans, & Niemivirta, 2013	1	5	Neutral	• Working on these tasks seems to be… 1 (not at all interesting) to 5 (very interesting)
Tapola, Jaakkola, & Niemivirta, 2014	1	7	Neutral	• Working on these tasks seems to be… 1 (not at all interesting) to 7 (very interesting)

acquired is what connects both." Rotgans and Schmidt (2018, p. 536) confirmed these results in another paper in which they concluded that situational interest influences knowledge acquisition while individual interest does "not directly influence subsequent knowledge acquisition." According to these recent empirical findings, to support greater knowledge gains during science lessons—and, it is to be hoped, ultimately enhance students' individual interest—instructional intervention should focus on situational interest arousal. This is why the concept of situational interest is at the core of our study.

To better understand the nature of the instruments that are most frequently used to measure situational interest, we reviewed the literature. We found 30 ERIC-indexed articles about situational interest in science that present empirical studies and that mention at least one data collection instrument (May 23, 2017). Most of these articles ($n = 22$) mention use of a Likert-scale questionnaire; however, only eight of the articles present the questionnaire. For the sake of synthesis, **Table 1** provides an overview of the items used in these questionnaires. Four of the eight Likert-scale questionnaires had only one item (Lin et al., 2013; Palmer, 2009; Tapola et al., 2013, 2014), which is usually considered insufficient to lead to conclusive results about situational interest. Of the remaining four articles, Rotgans and Schmidt's (2011, p. 39) six-item situational interest questionnaire was the only one that conformed to the previously described logic of the situational interest concept and referred to a specific situation that was limited in time (e.g., "I want to know more about today's topic"; "I think today's topic is interesting").

Contextualization of Learning

It has been suggested—and supported by evidence—that contextualization of learning in science can significantly enhance students' interest in science (Potvin & Hasni, 2014b; Barmby et al. 2008; Chen & Cowie 2013; Glowinsky & Bayrhuber, 2011; Häussler & Hoffmann, 2000; Logan & Skamp, 2013; Sadler, 2009; Uitto et al., 2011) and their achievements (Amos & Reiss 2012; Chen & Cowie 2013; Lee & Songer 2003; Rivera Maulucci et al., 2014; Rivet & Krajcik, 2008). Learning can be contextualized when a teacher uses a situation or an event to introduce, motivate, and guide the presentation of scientific knowledge (Rivet & Krajcik, 2008). Giamellaro (2014) identified four assumptions inherent to the contextualization of learning: (a) there is learning to contextualize, (b) learning is intrinsically linked to a context, (c) each context produces a different effect on each student, and (d) without a context, knowledge is incomplete and of limited use.

We identify four common challenges related to the implementation of contextualization in scientific learning. First, contextualization of science learning *with* a context, compared to contextualization *in* a context—to use Giamellaro's (2014) expression—does not necessarily give students direct contact with situations in which the scientific knowledge is mobilized. Second, contextualizing school science learning requires more teacher preparation time. Third, even when a curriculum may require contextualization of learning, national assessment formats might at least in part explain why many science teachers decide to maintain more traditional in-class (non-context-based) approaches. Fourth, teachers who did not adequately learn during their training how to use contextualized learning situations may find it more difficult to perceive the added value. These four challenges may explain why school science often appears to be decontextualized from students' realities and why teachers who do contextualize scientific learning do it with difficulty.

Contextualization of School Science Outdoors in Schools' Immediate Surroundings

One of the methods that teachers can use to enhance students' situational interest and facilitate the contextualization of science learning is to conduct activities in environments that are familiar to students (Ayotte-Beaudet, Potvin, & Riopel, 2017; Hasni et al., 2016). To this end, several authors have suggested using schools' immediate surroundings (e.g., Bølling et al., 2017; Carrier et al., 2013; Fägerstam & Blom 2013). In addition to being familiar to students, these environments have the advantage of being accessible during regular teaching periods (Fančovičová & Prokop 2011; Lustick, 2009), even when the teaching periods are as short as those that prevail in middle school.

The literature did not provide us with a satisfying definition of a *school's immediate surroundings* that would allow us to qualify/disqualify certain environments, such as far-away museums or school laboratories. Therefore, for the purposes of our study and in accordance with one of the objectives that our research program pursues—which is to support the development of middle school teaching in regular school settings—we have identified a school's immediate surroundings as 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. These attributes provide an arbitrary yet clearer set of criteria that allow us to frame the conclusions of the present study.

Through contextualization in schools' immediate surroundings, science teachers can help students (a) develop a conception of the scientific activity that is not limited to stereotypes such as laboratory activities and (b) use their scientific learning beyond the school's walls. For example, to contextualize learning about the problem of the emerald ash borer, an invasive insect species that decimates the ash population in North America, a teacher might ask students to collect data to study the population of ash trees in the immediate neighborhood. It is reasonable to believe that these students will be able to better understand the work of field scientists and to transfer their learning more easily to nonacademic contexts than students who have been limited to reading a text describing this issue in a classroom.

Several studies have identified obstacles to contextualization of science education in the school's immediate surroundings, as perceived by teachers: curricula generally do not explicitly encourage outdoor learning activities (Lock, 2010; Lustick, 2009; Rickinson et al., 2004); students' achievement on standardized national assessments does not require field activities (Dyment, 2005; Fisher, 2001; Lustick, 2009; Rickinson et al., 2004); the presence of laboratories in high schools encourages a representation of the scientific activity that is confined to the indoors (Braund & Reiss, 2006, Fägerstam, 2014; Reiss & Braund, 2004); teachers have a low level of expertise in teaching in environments that extend outside of their classrooms or school laboratories

(Dyment, 2005; Glackin, 2016; Rickinson et al., 2004); the time that is dedicated to science lessons at school is too limited (Dillon et al., 2006; Fisher, 2001; Hyseni Spahiu et al., 2014; Lock, 2010; Rickinson et al., 2004); outdoor group management presents different challenges than indoor group management (Fägerstam, 2014; Glackin & Jones, 2012; Hyseni Spahiu et al., 2014); outdoor lessons might entail a financial cost (Braund & Reiss, 2006; Glackin & Jones, 2012; Rickinson et al., 2004); achievement of learning objectives could be compromised by unpredictable weather conditions (Dyment, 2005; Glackin & Jones, 2012); and some teachers do not recognize the educational potential of their schools' immediate surroundings (Amos & Reiss, 2012; Ben-Zvi Assaraf & Orion, 2009; Glackin, 2016).

These obstacles seem to discourage teachers from using schools' immediate surroundings for learning, so that many of them stick to the classroom and school laboratories alone. Nevertheless, the obstacles do not call into question the strong potential of contextualization of science learning in these places.

Research Question

We formulated our research question based on the observations that (a) individual interest can be aroused by learning activities that stimulate situational interest, yet the factors that are most related to situational interest remain understudied, (b) contextualization is a means to encourage students' interest in school science, but science learning is often decontextualized or teachers can only contextualize it with difficulty, and (c) teachers should adopt strategies to contextualize scientific learning in schools' immediate surroundings to generate situational interest in school science, yet multiple challenges discourage teachers from teaching outdoors. Our research question was also formulated to consider that (d) very little empirical research has been devoted to effective formal science teaching in schools' immediate surroundings (Ayotte-Beaudet, Potvin, & Riopel, 2017), (e) we found no empirical studies published in scientific journals that studied all the factors that might be related to students' situational interest in their schools' immediate surroundings, and (f) research must help teachers to overcome some of the challenges to formal outdoor education in schools' immediate surroundings.

Therefore, our research question was: *Which factors are most related to middle-school students' situational interest during outdoor science lessons occurring in their schools' immediate surroundings?*

METHODS

Participants and Procedures

We conducted our study with students in the seventh and eighth grades, which form a transition level between primary and middle school and are a critical moment in the decline of students' interest in school science. In the province of Québec, the seventh and eighth grades share the same science program, which integrates five scientific fields (astronomy, biology, chemistry, geology, and physics). It is also important to point out that this program does not explicitly encourage teachers to use their school's immediate outdoor surroundings.

The participants included 26 French-speaking science teachers (14 women and 12 men) and 71 classes of French-speaking seventh (51 classes) and eighth (20 classes) graders (n = 2007). The teachers were recruited with the help of our professional network, school directors, academic advisors, and groups of teachers on the social network Facebook®. Fifteen of the teachers worked in public schools and the other 11 in private schools. They taught in 19 schools (nine schools with one participant each, seven schools with two participants each, and one school with three participants) in different administrative regions of the province of Québec, reflecting a certain diversity (urban, peri-urban, and rural areas). All participating teachers except for one had at least five years of experience in science teaching.

All teachers voluntarily agreed to plan and conduct five outdoor lessons during the 2015–2016 school year in their school's immediate outdoor surroundings for each class that they decided to include in the study (one to seven classes per teacher). We asked them to plan each outdoor lesson in line with the existing science curriculum and in accordance with our vision of what counts as *science education in a school's immediate surroundings* (presented in the section "Contextualization of School Science Outdoors in Schools' Immediate Surroundings"). The teachers were also instructed to show their students a short video describing their involvement in the project (https://www.youtube.com/watch?v=uC-zOsxF9iA).

We asked the teachers to plan on five minutes at the end of each outdoor lesson during which the students could complete a short situational interest questionnaire about the outdoor science lesson they had just experienced. One student from each class was in charge of collecting the anonymous questionnaires, placing them in a pre-stamped envelope, and giving the envelope to the school secretary. The teachers were also asked to fill out an online questionnaire at the end of each outdoor lesson in order to identify the characteristics of the factors under study. The teachers were also all asked to participate in an individual interview at the end of the school year to discuss the factors they believed to be related to students' situational interest in science in their school's immediate surroundings.

To answer our research question, we selected eleven factors from our literature review that might be related to students' situational interest in science in their school's immediate surroundings. These factors were validated by a panel of nine experts (four professors and five graduate students from our research team). The eleven studied factors 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.

Data Instruments

We used mixed methods to answer our research question. We collected data about (a) students' situational interest in science in their schools' immediate surroundings and (b) the eleven studied factors.

To measure *students' situational interest* at the end of each outdoor lesson, we designed an eight-item Likert-scale questionnaire that was validated by a panel of experts. Four of the items were positively worded and the other four 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 qualifier was associated with the values 2 through 5. Our eight items were inspired by two frequently cited components of situational interest—focused attention and an affective dimension—and the six items on Rotgans and Schmidt's (2011) questionnaire (see **Table 1**). The items, which were written in French on the questionnaire, were (1) "I was very focused during this outdoor lesson," (2) "The outdoor lesson we just experienced did not interest me," (3) "I liked everything in this outdoor lesson," (4) "The outdoor lesson did not grab my attention," (5) "I would like to experience other outdoor lessons like this one," (6) "I think my friends did not like the outdoor lesson," (7) "The outdoor lesson we just experienced captivated me," and (8) "This outdoor lesson was boring."

We also used this questionnaire to collect data about two of the eleven studied situational interest factors. One item (positive) was used to measure the *students' level of preparation*: "I was well prepared for this outdoor lesson." Another item (negative) was used to measure the *opportunity to make choices*: "During the outdoor lesson, I did not have the opportunity to make choices."

The teachers were asked to fill out an online questionnaire that collected data about nine of the eleven studied factors within the 24 hours following each lesson. In the first section, we collected data on the *teacher's outdoor teaching experience* ("never taught outdoors before the research," "very rarely taught outdoors before the research," "frequently taught outdoors before the research"), the *lesson's position in the lesson sequence* (first outdoor lesson, second outdoor lesson, etc.), the *duration of the outdoor lesson* (in minutes), and the *presence of a laboratory technician* (yes, no). Then we used a Likert-scale item with the same values as previously described for the students' situational interest questionnaire to collect data about the *weather conditions*: "The weather conditions were in all respects favorable for achieving the learning objectives of this outdoor lesson." Finally, teachers had to select the options for each of the following four factors that applied to the outdoor lesson: *type of activity* (listening to scientific explanations, listening to instructions, identifying a scientific problem, making assumptions, experimenting, observing, modeling), *outdoor environment* (wooded area, schoolyard, park, watercourse, neighborhood), *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). Since there could be more than one choice for the same outdoor lesson, teachers also had to specify the relative weighting for each choice (0%, 25%, 50%, 75%, 100%).

Finally, we generated data through semistructured interviews in which teachers discussed their interpretations of the factors that most related to students' situational interest in science in their school's immediate surroundings. During the interviews, teachers were not questioned specifically about the eleven studied factors; rather, they were free to refer to the factors of their choice, for spontaneity. All interviews were conducted by telephone by the principal researcher and were audio recorded and transcribed. **Table 2**

Table 2. Questions addressed to teachers during the individual interviews

Individual interview questions
• *At the end of each outdoor lesson, do you think that you were able to properly assess students' level of interest?*
• *In general, what were the most influential factors for students' interest regarding the object studied during the outdoor lessons?*
• *Did you notice differences between your classes*? [for teachers who had more than one class involved in the study]
• *Did you plan any outdoor lesson that you were not able to carry out? If yes, why not?*
• *In your opinion, does the inclusion of outdoor lessons give you an opportunity to generate interest in a new way?*
• *To sum up your point of view, what are the factors that most benefit students' interest in school science during a lesson in their school's immediate surroundings?*

lists the questions presented to the participant teachers regarding the factors that they believed to be related to students' situational interest in science in their school's immediate surroundings (other questions related to outdoor science learning and challenges were also raised, but we do not discuss them in this paper).

Analysis

This study followed a mixed methods convergent parallel design (Creswell and Plano Clark, 2011) in which both quantitative and qualitative data were collected during the same phase and analyzed independently. The convergences and divergences between the quantitative and qualitative results are highlighted in the discussion that follows.

The objective of the analysis phase for the *quantitative data* was to identify the factors (independent variables) that were most correlated with middle-school students' situational interest (dependent variable) during outdoor science lessons occurring in the schools' immediate surroundings. To assess the validity of our situational interest questionnaire, we computed a principal axis factor analysis. To test the internal consistency, we used Cronbach's alpha. The unit of analysis for the variable *students' situational interest* was the event of a single outdoor lesson. First, we averaged the valid items (with a maximum of eight) for every situational interest questionnaire. Second, for each outdoor lesson, we averaged the mean scores for each student. This allowed us to obtain an average score for situational interest reported by the students for each outdoor lesson. The eleven studied factors included seven 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 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 significant correlation with students' declared situational interest (the dependent variable). Second, we 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.

The objective of the analysis phase for the *qualitative data* was also to answer our research question, this time according to teachers' perceptions. To analyze the written transcriptions of the semistructured interviews, we used thematic content analysis. We created our own list of codes with the eleven studied factors and four emergent factors (presented in the results section) identified by two researchers after several iterations of coding. After we set our final list of codes, the written transcriptions were coded by a graduate research assistant. At the end of the first coding phase, the principal researcher revised all of the units of analysis for each code and synthesized all of the material, and the research assistant then reread the synthesis for validation purposes.

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

During the 2015–2016 school year, the 26 teachers involved in the study conducted outdoor lessons for a total of 51 classes of seventh graders and 20 classes of eighth graders ($n = 2007$). Each of the 71 classes participated in one to five outdoor science lessons ($n = 243$; one lesson: 11 classes, two lessons: 13 classes, three lessons: 9 classes, four lessons: 11 classes, five lessons: 27 classes).

The descriptive statistics for the variable *students' situational interest* for the 243 outdoor lessons are: min = 2.94, max = 5.61, $M = 4.37$, $SD = .51$.

Of the 243 outdoor lessons, 167 were conducted by the teacher alone, while the teacher was *accompanied* by another person during 76 of the lessons.

Many of the outdoor lessons involved knowledge related to more than one *scientific topic*. By the end of the school year, 14.4% of the outdoor lessons involved astronomy, 46.5% biology, 6.6% chemistry, 19.3% geology, and 20.6% physics, and 53.1% included the scientific method.

Teachers used various *learning environments* in their school's immediate surroundings, with 28.4% of the outdoor lessons occurring entirely or partially in a wooded area, 63% in the schoolyard, 11.9% in a park, 9.9% near a watercourse, 6.6% in the neighborhood, and 4.1% in another environment.

Students were asked to work alone at least once in 17.3% of the outdoor lessons, in pairs in 48.1%, in teams of three in 28.8%, in teams of four in 32.1%, with the entire class in 11.1%, and in another student grouping (teams of five, six, eight, or nine) in 9.5%.

Teachers were free to use more than one *type of activity* during any outdoor lesson. By the end of the school year, 21.8% of the outdoor lessons involved listening to scientific explanations, 22.6% listening to instructions, 0.8% identifying a scientific problem, 10.9% making assumptions, 36.6% collecting data, 25% experimenting, 74.1% observing, 7% modeling, and 2.5% another type of activity (moving from one place to another or collecting waste).

We asked teachers to assess their *level of experience* in teaching science outdoors. This allowed us to determine that 34.2% of the outdoor lessons were taught by teachers who had never taught outdoors before our study, 56% by teachers who had not taught outdoors very often, and 9.9% by teachers who frequently taught outdoors.

The teachers reported the *duration* of each outdoor lesson (min = 10, max = 240, $M = 41.27$, $SD = 37.61$).

At the end of each outdoor lesson, we measured the level of agreement with the last three factors on a scale ranging from 1 (*strongly disagree*) to 6 (*strongly agree*), with no qualifiers associated with the values 2 through 5.

Teachers reported their level of agreement with a statement related to *the weather conditions*: "The weather conditions were in all respects favorable for achieving the learning objectives of this outdoor lesson" (min = 1, max = 6, $M = 4.73$, $SD = 1.47$).

Students reported their perception regarding their *opportunity to make choices* with one item: "During the outdoor lesson, I did not have any opportunity to make choices" (min = 2.59, max = 5.66, $M = 4.43$, $SD = .60$).

Students finally reported their perception regarding their *level of preparation* with one item: "I was well prepared for this outdoor lesson" (min = 2.57, max = 5.52, $M = 4.06$, $SD = .57$).

To illustrate the total information that we collected about an outdoor lesson in the online questionnaire, we provide 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, one teacher conducted an outdoor lesson during which he asked students to take measures of the time of day with a sundial that the students had previously made indoors. He stated that he wanted to target a learning objective related to astronomy in the science curriculum, which is to explain "different phenomena using the properties of light (cycles of day and night, seasons, phases of the Moon, eclipses)" (Gouvernement du Québec, 2011, p. 33). This outdoor lesson was conducted by the teacher alone, 100% of the outdoor lesson involved astronomy, 100% of the lesson took place in the schoolyard, students were asked to work in pairs during 100% of the lesson, the lesson involved listening to instructions 25% of the time and observing 75% of the time, the duration was 25 minutes, the teacher reported a level of agreement of 3 with the statement related to the weather conditions, the students reported

Table 3. Summary of confirmatory axis factor analysis results for situational interest as declared by students on the questionnaire (n = 2007)

Item	SSI
The outdoor lesson we just experienced captivated me.	**.801**
I liked everything in this outdoor lesson.	**.795**
This outdoor lesson was boring.	**.793**
I would like to experience other outdoor lessons like this one.	**.759**
The outdoor lesson we just experienced did not interest me.	**.717**
This outdoor lesson did not grab my attention.	**.712**
I think my friends did not like the outdoor lesson.	**.647**
I was very focused during this outdoor lesson.	**.528**
Eigenvalue	
% of variance	52.47
α	.885

Note. Factor loadings over .4 appear in bold face.

a mean level of agreement of 3.78 with the statement related to the opportunity to make choices, and the students reported a mean level of agreement of 4.44 with the statement related to the level of preparation.

To better discern the meaning of our resulting data, we also provide five examples of what students could have been asked to do during an outdoor lesson: (a) collect producers, consumers, and decomposers to design and manufacture a terrarium, (b) measure the surface temperature of materials to study urban heat effects, (c) listen to scientific explanations about rocks and erosion during a walk along the Saint Lawrence River, (d) collect soil samples to compare their properties, and (e) take pictures of three living things and three nonliving things.

Psychometric Properties of the Situational Interest Questionnaire

A Q-Q plot and the Shapiro-Wilk test of normality allowed us to conclude that normality of the distribution for the variable *situational interest declared by students* can be assumed. We used the situational interest questionnaires from all first outdoor lessons to run a correlation matrix, and all *p*-values were less than .001. We computed a confirmatory principal axis factor analysis of the unidimensionality of the eight items measuring situational interest declared by students on all questionnaires (n = 2007) filled out during the first outdoor lesson. The scree plot showed that we had only one factor, which is *situational interest*. The Kaiser–Meyer–Olkin measure verified the sampling adequacy, KMO = .91 (which can be qualified as *marvellous*, according to Hutcheson and Sofroniou 1999). Bartlett's test of sphericity, $X = 5387.38$, $df = 28$, $p < 0.001$, indicated that the sample was adequate. We found only one factor that explained 52.47% of the variance, suggesting that the eight items represented the factor *situational interest declared by students*—all eight items met the criterion of having a factor loading of at least .4 (Steven 2009). The Cronbach alpha coefficient value ($\alpha = .885$) was judged reliable. These psychometric properties allowed us to conclude that the situational interest questionnaire showed good internal validity and reliability. **Table 3** presents a summary of the exploratory factor analysis results.

Factors Related to Students' Situational Interest as Declared by Students

First, a bilateral correlational analysis allowed us to identify factors for which there was a significant correlation with the situational interest declared by students. **Table 4** presents the correlations between situational interest as declared by students and the studied factors. We only retained factors for which the significance level was less than .05: observing ($r = .146$, $p = .023$), watercourse ($r = .154$, $p = .017$), teacher's outdoor teaching experience ($r = .129$, $p = .044$), presence of a lab technician ($r = .203$, $p = .001$), physics ($r = .129$, $p = .044$), position in lesson sequence ($r = -.136$, $p = .034$), in pairs ($r = -.256$, $p < .001$), duration of the outdoor lesson ($r = .177$, $p = .006$), students' opportunity to make choices ($r = .461$, $p < .001$), students' level of preparation ($r = .539$, $p < .001$).

Table 4. Correlations between situational interest as declared by students and studied factors (n = 243)

Factors	Pearson correlation	Sig. (2-tailed)
Type of activity		
Listening to scientific explanations	-.046	.478
Listening to instructions	.052	.419
Identifying a scientific problem	-.051	.425
Making assumptions	.063	.331
Collecting data	-.047	.464
Experimenting	-.124	$.053^{+}$
Observing	.146	$.023^{*}$
Modeling	.041	.528
Outdoor environment		
Wooded area	-.086	.180
Schoolyard	-.093	.147
Park	.013	.844
Watercourse	.154	$.017^{*}$
Neighborhood	.022	.729
Teacher's outdoor teaching experience	.129	$.044^{*}$
Presence of a laboratory technician	.203	$.001^{**}$
Scientific discipline/topic		
Astronomy	-.122	$.057^{+}$
Biology	-.001	.987
Chemistry	.118	$.066^{+}$
Geology	.038	.557
Physics	.129	$.044^{*}$
Scientific method	-.063	.328
Position in lessons sequence	-.136	$.034^{*}$
Student grouping		
Alone	.039	.542
In pairs	-.256	$.000^{***}$
Teams of three	.071	.269
Teams of four	.052	.418
Entire class	.046	.473
Weather conditions	.075	.248
Duration of the outdoor lesson	.177	$.006^{**}$
Opportunity to make choices	.461	$.000^{***}$
Students' level of preparation	.539	$.000^{***}$

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

Second, we used the significant factors from the bilateral correlation analysis to run a three-level hierarchical linear model to identify the factors that most correlated with middle-school students' situational interest during outdoor science lessons in their schools' immediate surroundings. We also calculated the standardized coefficient using Hox's (2010) formula. We ran the analysis using the MIXED procedure of the SAS 9.4 software. **Table 5**, which summarizes the results from the three-level hierarchical linear model, indicates that the significant factors that positively correlated with middle-school students' situational interest during outdoor science lessons in their schools' immediate surroundings were *students' level of preparation* (.428) and *students' opportunity to make choices* (.182). However, the results show a significant negative correlation with situational interest when the teachers grouped the students *in pairs* (-.129) and for the *position in the lesson sequence* (-.032). It should be noted that the positive correlations of the *presence of physics in teaching* (.147) and the *teacher's outdoor teaching experience* (.148) were not significant, as $p < .1$ for these factors. The pseudo-R^2 (Hox 2010) is .427. According to our quantitative analysis strategies, we can reasonably presume that the significant factors were consistent across the outdoor lessons.

Table 5. Results from the three-level hierarchical linear model

Factors	*B*	*SE B*	*ß*	*df*	*t*	*p*
Observing	-.015	.065	-.011	158	-.23	.816
Watercourse	-.058	.092	-.027	158	-.62	.533
Teacher's outdoor teaching experience	.148	.089	.180	158	1.67	.097^{+}
Presence of a lab technician	.066	.057	.060	158	1.15	.253
Physics	.147	.080	.070	158	1.84	.068^{+}
Position in lesson sequence	-.032	.015	-.087	158	-2.13	.035*
In pairs	-.129	.050	-.112	158	-2.59	.011*
Duration	-.0001	.001	-.006	158	-.11	.913
Opportunity to make choices	.182	.042	.214	158	4.35	< .001***
Students' level of preparation	.428	.044	.479	158	9.66	< .001***

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

The intraclass correlation coefficient indicated that 27.9% of the variance was due to the outdoor lessons (level 1), 58.8% to the groupings (level 2), and 13.3% to the teachers (level 3). These results indicate that the three levels had an effect on students' situational interest.

Factors Related to Students' Situational Interest According to Teachers

Of the 26 science teachers involved in this study, 23 took part in an individual semistructured interview about the factors related to students' situational interest in science in their school's immediate surroundings. This section presents teachers' perceptions regarding the eleven studied students' situational interest factors and four other factors that were mentioned during the interviews. The number of teachers who mentioned each factor is indicated in parentheses. We selected (and translated from French to English) statements that allow us, based on our interpretation, to report the main ideas expressed by teachers—who are anonymized by four-letter pseudonyms.

Weather conditions. During the individual interviews, weather conditions were the most spontaneously cited factor (unsolicited; 16/23). Representing a widely shared view, *Flor* said that "it was obvious that when the weather was good, the students all wanted to go outdoors." *Lara* also explained that "when the weather was not very nice, if there was rain, students did not like to go outdoors." In general, the teachers believed that favorable weather conditions increased students' situational interest, while unfavorable weather conditions appeared to decrease their situational interest. However, one teacher mentioned that even when the weather conditions were not the most favorable, the students still preferred to go outdoors.

Students' level of preparation. Many teachers mentioned that students' preparation for an outdoor lesson could be related to the students' situational interest (10/23). We identified three dimensions of preparation. According to *Cora*, "the teacher's planning must be clear." *Zita* thought that "outdoor learning should be in line with what students are learning indoors so that it is meaningful for them." *Tina* said that to arouse students' interest, "instructions should be clear." These quotations illustrate the following three dimensions of the student's level of preparation: (a) the teacher's preparation, (b) the students' prior learning preparation, and (c) instructions to be followed during the outdoor lesson. The interviews also revealed that the students' level of preparation plays an important role in their situational interest; a lack of preparation can lead to idleness and weaker comprehension of the learning objective of the outdoor lesson.

Position in the lesson sequence. Many teachers talked about the lesson's position in the lesson sequence (10/23). For *Zita*, "students appreciated the novelty, because they felt that it was a privilege compared to other classes." On the other hand, she mentioned that "when some outdoor lessons took place close together, the interest was completely lost." *Roxy* found that her students "were ready to do anything that would take them out of the classroom." In general, teachers who spoke about the position in the lesson sequence all referred to the positive effect of novelty on students' situational interest.

Opportunity to make choices. Many teachers reported that providing an opportunity to make choices related to the science activities positively affected students' situational interest during outdoor lessons (8/23). For instance, *Anna* suggested that it is more interesting for students when "they collect data by themselves instead of using samples prepared by their teacher in a lab." According to *Phil*, "outdoors, students have the freedom to walk, to search, or to experiment by themselves rather than simply listening to a presentation." It appears from the interviews that students expect to make more decisions when they learn outdoors.

Student grouping. Teachers mentioned that student grouping could be related to students' situational interest (5/23). According to the teachers, working in a team rather than alone can be positively or negatively related to students' situational interest. *Flor* observed that "it is important for students to work in teams rather than work alone." *Mado* noted that when "there is a group with a lazy student, it can be more difficult for the others to be interested." According to *Dino*, "when everyone knew what their task was, students were able to manage themselves." While student grouping was related to students' situational interest, our interviews did not allow us to draw a clear conclusion regarding the best way to do this.

Presence of a laboratory technician. Some teachers mentioned that the presence of an additional person during outdoor lessons contributed to enhancing students' situational interest (5/23). For *Otto*, "this factor was probably the most influential." *Dino* explained that having some help from a laboratory technician helped him "to answer students' questions quickly." As the presence of a laboratory technician helped some teachers supervise their class better, it can be suspected that these evocations are conditional on the quality of the support.

Type of activity. The type of activity during a lesson could also be related to students' situational interest, according to some teachers (4/23). For each of these teachers, collecting samples was the most interesting activity for students. *Luca* explained that "it is like experimenting in the lab without feeling the formal school context." The teachers explained that collecting samples may be interesting because students are put into action. In contrast, according to these teachers, students seemed less interested when an activity did not put them into action.

Scientific discipline. Three teachers believed that the scientific discipline affected students' situational interest (3/23). *Lara* mentioned that some scientific knowledge could be more interesting to learn outdoors. She said that "rocks and minerals are not the most interesting topics of scientific knowledge. However, when students see them in their local environment, this triggers their interest." We did not identify any consensus about the most interesting scientific discipline to learn outdoors, but some types of scientific knowledge seemed to generate more favorable reactions.

Outdoor environment. Two teachers referred to the outdoor environment (2/23). Both had access to only their schoolyard, and they would have appreciated having access to more outdoor environments. It seems impossible to draw any conclusion about the effect of the outdoor environment on students' situational interest based on these statements.

Duration of the outdoor lesson. Only one teacher alluded to the duration of the outdoor lesson during the individual interviews (1/23). *Dino* would have liked to offer outdoor lessons that are longer than a regular period.

Teacher's outdoor teaching experience. No teacher referred to the teacher's outdoor teaching experience (0/23).

During the interviews, teachers also referred to four other factors not included in our list of eleven studied factors.

Putting students into action. Putting students into action was the most frequently cited factor that teachers recognized as related to students' situational interest that was not included in our list at the beginning of the study (11/23). For example, in *Gigi*'s opinion, "the most important factor for students is having an activity in which they have an active role to play." *Jade* felt that "there was more interest when students were working." According to *Zita*, "students must be put into action. No action, it does not work. You really need action." All of the teachers who mentioned putting the students into action noted that this increased students' situational interest in science in the school's immediate surroundings. Some of these teachers believed that it was the most influential factor.

Contextualization. Many teachers mentioned the possible influence of the contextualization of learning (8/23). For example, outdoors, *Brad* tried "to make links with notions that students learned indoors." *Cora* noticed that when she organized a birdwatching activity, "the motivation was greater because students had to identify birds for real." These two quotations illustrate the two general ideas expressed by these eight teachers, that contextualizing science learning outdoors in schools' immediate surroundings makes learning scientific concepts more meaningful and that it gives students an opportunity to identify contexts in which scientific concepts can be used. They all mentioned that the contextualization of learning generally enhanced students' situational interest.

Level of difficulty of the activity. Some teachers judged that the level of difficulty of an outdoor activity could affect students' situational interest (6/23). These teachers seemed to agree that outdoor activities should involve a certain level of challenge. *Nina* expressed their general point of view well, saying that for her, an interesting activity should involve "a challenge considered quite difficult by students, but possible to address." Therefore, to maintain students' situational interest, they should feel confident about completing the activity.

Time of day. Only one teacher said that the time of day could affect students' situational interest (1/23). *Adam* noticed that a single activity could generate different levels of situational interest depending on when it happened, e.g., "if it is the first or the last period of the day."

DISCUSSION

Factors Related to Students' Situational Interest

Since we chose to adopt a mixed methods convergent parallel design to conduct this study, it seems important to highlight the convergences and divergences between the quantitative and qualitative results.

The most compelling result of this study might be that, according to both the quantitative and the qualitative results, *students' level of preparation* for an outdoor lesson can be positively related to their situational interest. Our results are similar to Rickinson et al.'s (2004, p. 47) observation that "*preparatory work* [emphasis added] prior to outdoor learning is [a] factor well evidenced in the literature." Our interviews showed that teachers distinguish three kinds of preparation: (a) the teacher's preparation, (b) the students' prior learning preparation, and (c) instructions to be followed during an outdoor lesson. Given the importance of these multiple dimensions, it appears essential for teachers to concentrate their effort on prior preparation for outdoor lessons.

The *opportunity to make choices* was also positively related to students' situational interest, according to both the quantitative and the qualitative results. The importance assigned to this factor in our results supports the conclusions of other studies that offering a cognitive challenge (Chen & Cowie, 2013; Logan & Skamp, 2013), providing cognitive autonomy (Tsai et al., 2008), and letting students make decisions (Potvin & Hasni, 2014a) generally have positive effects on students' interest.

Our results did not allow us to draw clear conclusions about the effect of *students' grouping* on their situational interest. The quantitative results showed that students were less interested during outdoor lessons when they were grouped in pairs. These results are not consistent with the results of Ayar (2015), who found that students' interest—in Ayar's case, however, undergraduates—increased when they were paired to solve robotics problems. On the other hand, some teachers suggested during our interviews that working in teams rather than alone was more beneficial for students' situational interest. These comments echo the findings of some researchers who have concluded that cooperative learning can increase students' interest (e.g., Loukomies et al., 2015; Raes et al., 2014). In light of these divergences, it seems crucial to gain a better understanding of how students' groupings might affect their situational interest during an outdoor science lesson in their school's immediate surroundings. One hypothesis might be that the way in which the groups are formed is important. Indeed, people usually do not like it when teams are imposed, and even less if pairings possibly involve ordinary animosity.

Since many researchers have published results regarding biology in the context of outdoor education in schools' immediate surroundings (e.g., Ben-Zvi Assaraf & Orion, 2009; Fančovičová & Prokop, 2011; Magntorn & Helldén, 2007), we expected to find in our study that biology would be the most interesting discipline for students. However, our results do not allow us to identify a specific *scientific discipline* related to students' situational interest. Nonetheless, because many studies have identified significant issues regarding students' interest in physics (e.g., Owen et al., 2008; Pickens & Eick, 2009), it is interesting to note that physics was present in teaching at almost the significance threshold. Considering that a major issue that has been identified is that physics is not sufficiently contextualized at school (Allaire-Duquette, Charland, & Riopel, 2014; Häussler & Hoffmann, 2002; Kerger et al., 2011), our results may suggest that contextualizing teaching in physics might enhance students' situational interest more than in other sciences. This hypothesis appears to be relevant for investigation in further research.

Weather conditions did not significantly correlate with students' declared situational interest, but this is the factor that teachers mentioned the most during the individual interviews. Like some of our participants, Dyment (2005) has affirmed that Canada's difficult and unpredictable weather conditions may be detrimental for outdoor lesson activities. One teacher (n = 20) reported the same in a study that took place in the UK

(Glackin & Jones 2012). It seems reasonable to believe that weather conditions would be of greater concern for teachers in regions with variable climates than for those in regions with more stable climates. This could explain why weather conditions were such an important factor for the teachers in our study. However, it is possible that weather conditions did not appear in the quantitative results because teachers were able to choose more appropriate days for conducting their outdoor lessons. Thus, they might have favored weather-friendly moments, thereby reducing the variability of the weather factor and thus methodologically minimizing its effect on students' interest.

Our two-step quantitative data analysis did not reveal any significant relationship between the *presence of a supportive laboratory technician* and students' declared situational interest. When we designed this study, we selected this factor because of concerns about outdoor group management stressed by other researchers (Glackin & Jones, 2012; Hyseni Spahiu et al., 2014; Skamp & Bergmann, 2001). Even if the presence of a laboratory technician did not seem to be related to students' situational interest in our study, some teachers suggested during the interviews that students could benefit from greater supervision outdoors, in particular in terms of improving the quality of their learning. We believe further investigations should study this observation made by some of our participating teachers.

Neither the qualitative data nor the quantitative data allowed us to identify a *type of activity* that was significantly related to students' declared situational interest. At first glance, this result does not corroborate the results in some other articles (Christidou, 2011; Krapp & Prenzel, 2011; Häussler et al., 1998; Logan & Skamp, 2013; Turner & Ireson, 2010; Zoldosova & Prokop, 2006). However, we believe that the type of classification we used may explain the absence of this effect. It emerged from the interviews that *putting students into action* could be related to their situational interest. A classification that considers this factor would take into account research concluding that practical activities that put students into action are related to students' interest (Abrahams, 2009; Barmby et al., 2008; Bergin, 1999; Logan & Skamp, 2013). Several teachers also stated that an outdoor activity's *level of difficulty* could be related to students' situational interest, suggesting that outdoor activities that are neither too easy nor too difficult should be used. This result is reminiscent of Vygotsky's (1978) concept of the zone of proximal development, within which a student can learn with the help of peers or educators. Future research studying students' situational interest outdoors should therefore consider these two factors that emerged from the interviews.

Neither our results regarding students' situational interest nor the teacher interviews allowed us to identify a particular type of *learning environment* to favor (wooded area, schoolyard, park, watercourse, or neighborhood). However, considering that more than half of the 243 outdoor lessons took place in the schoolyard, our results suggest that teachers do not necessarily need extraordinary learning environments such as wooded areas or watercourses to carry out outdoor learning activities. This observation may provide encouragement to teachers who believe that their school's immediate surroundings are inappropriate for outdoor science lessons, as reported by some participants in other studies (Borsos et al., 2018; Glackin & Jones, 2012; Hyseni Spahiu et al., 2014).

Given both the qualitative and the quantitative data, we cannot conclude that the *duration of an outdoor lesson* is related to students' situational interest. Tying this result in with the existing scientific literature in the field of outdoor science education, it seems important to emphasize that most research has taken place in out-of-school contexts (e.g., Amos & Reiss, 2012; Zoldosova & Prokop, 2006). Our results therefore suggest that it is possible to generate situational interest during a shorter period of time. In our opinion, future research should investigate the relation between the duration of an outdoor lesson and other factors, such as teachers' preparation.

We were slightly surprised to find that a *teacher's outdoor teaching experience* was not related to students' situational interest, given that other scientific articles have found that a lack of outdoor teaching experience could discourage teachers from making use of outdoor teaching environments (Ben-Zvi Assaraf & Orion, 2009; Dyment, 2005; Ernst, 2014). Our observed results can be interpreted as strong but not significant. Maybe the effect differs from one teacher to another—that is, some teachers benefit from previous experience, but some do not. We can also suspect that the relationship between students' situational interest and teachers' outdoor teaching experience might not vary linearly. In any case, it is essential to investigate this relationship further and not to presume the existence of a linear relationship.

Our quantitative results allow us to conclude that the lesson's *position in the lesson sequence* (first outdoor lesson, second outdoor lesson, etc.) is related to students' situational interest. During the interviews, many of our participants also mentioned that the *novelty effect* could be related to students' situational interest when lessons occur in a school's immediate surroundings. Our results are in line with other studies that have concluded that the mere presence of novelty can generate situational interest (e.g. Abrahams, 2009; Glowinski & Bayrhuber, 2011; Palmer et al., 2016). What is noteworthy about our results is that we recorded a novelty effect that declined over the course of no more than five outdoor lessons. Therefore, we believe that outdoor lessons should probably not be expected to have lasting effects on students' situational interest. We believe that our results suggest instead that the *particular ways* in which teachers design their outdoor lessons are more important to student interest than the mere fact of going outside. Our results also suggest that further research efforts might take novelty effects into account or control for them in the study design, either by having participants experience a large enough number of lessons to accustom them to the targeted activity until something like boredom sets in or by recording, as we did, the number (or order/position) of novel activities in a teacher's weekly/monthly planning.

Also, one teacher mentioned that the *time of day* could be related to his students' situational interest. When we designed this study, we did not include this factor because we considered that teachers would not be able to control it. We still do not consider it a priority for further research.

About one third of the interviewed teachers discussed the *contextualization of science learning* in their school's immediate surroundings. Most of them reported that such learning environments often offer better opportunities to link science concepts to environments that are familiar to students. This observation supports the premise of this study—that using schools' immediate surroundings allows the contextualization of science learning—and should support conducting further research in this field of study.

Study Limitations and Further Directions

Since our study was developed in light of previous research efforts, some limitations should be taken into account for additional research. First, despite the fact that we had a large sample of outdoor lessons, some factors were underrepresented: knowledge related to chemistry, learning environments near a watercourse or in the school's neighborhood, and activities such as identifying a scientific problem and modeling. Second, our data collection from the students was limited to quantitative date. We believe that qualitative data—for example, interviews with students—would contribute to more in-depth comprehension of the factors related to students' situational interest. Third, regarding the study's procedures, it is important to note that we only established correlations between situational interest and the studied significant factors, and not causalities. Fourth, because we did not retrieve any studies that examined factors related to students' interest in school science during outdoor lessons in their schools' immediate surroundings, our results are limited to the factors we selected. Nevertheless, our results should help researchers to make and test assumptions and to study potential interaction effects between factors.

CONCLUSIONS AND IMPLICATIONS

In this research, we aimed to identify the factors that are most related to middle-school students' situational interest during outdoor science lessons in the schools' immediate surroundings. Our study used inferential statistics to compare data gathered from a large sample of students and in-depth interviews with teachers, allowing us to highlight convergences and divergences between these. The findings from both the quantitative and the qualitative data suggest that students' level of preparation and their opportunity to make choices were positively related to students' situational interest and that the first outdoor lesson could produce a novelty effect. Our quantitative results show that grouping students in pairs had a negative effect on situational interest. Our interviews with teachers also revealed that putting students into action and conducting outdoor activities that are neither too easy nor too difficult might be positively related to students' situational interest.

The results published in this paper can help teachers address one of the most important challenges teachers face, which is their low level of expertise in outdoor teaching. Our results show that teachers should give the highest priority to preparation of their students prior to an outdoor lesson and to the possibility of allowing students to make choices in the specific context of a science lesson in their school's immediate surroundings. For instance, teachers who would like to conduct their first outdoor lessons should be well prepared, in that they should clearly determine their science learning objectives and make all their decisions accordingly. We recommend that these teachers prepare their students well by clearly explaining the purpose of each outdoor lesson and what will be expected of the students when they are outdoors. To generate students' situational interest, it also seems well advised to provide students with an opportunity to make some choices to enable them to feel more involved in their learning and possibly help them to make their science learning more meaningful. In addition, teachers should keep in mind that the novelty effect could mean that students will show less situational interest after a few outdoor lessons. To take this effect into consideration, we suggest that teachers plan outdoor lessons that directly target the goals of the science curriculum, which should be the main reason for using the school's immediate surroundings, rather than simply trying to generate interest. To help teachers better contextualize their science teaching, we also believe that teachers should learn how to use outdoor learning environments during their initial teacher training.

Our results can also help us reconsider a challenge frequently mentioned by teachers, namely, that their school's immediate surroundings do not have any educational potential. Indeed, in our study, we did not find any type of activity, outdoor environment, or scientific discipline/topic that was significantly related to students' situational interest during outdoor science lessons in the schools' immediate surroundings. If statistical reasons do not explain these nonsignificant results, they should convince teachers that their schools' immediate surroundings might have the potential for outdoor science lessons despite their own negative perceptions.

As little research has focused on outdoor science education in schools' immediate surroundings, we believe that our study contributes to shedding new light on this topic. We strongly encourage researchers to continue to identify a network of problems related to this field of research. In the future, research should try to better understand the potential of outdoor places not only for enhancing students' situational interest, but also for their learning in the area of science. In order for outdoor environments to be considered more seriously, it also seems essential for research to focus on their possible contribution to ensuring a quality science education in the school context, a topic that has been rather underexplored until now.

Disclosure statement

No potential conflict of interest was reported by the authors.

Notes on contributors

Jean-Philippe Ayotte-Beaudet – Université de Sherbrooke, Canada.

Patrice Potvin – Université du Québec à Montréal, Canada.

Martin Riopel – Université du Québec à Montréal, Canada.

REFERENCES

Abrahams, I. (2009). Does practical work really motivate? A study of the affective value of practical work in secondary school science. *International Journal of Science Education, 31*(17), 2335–2353. https://doi.org/10.1080/09500690802342836

Ainley, M., Hidi, S., & Berndorff, D. (2002). Interest, learning and the psychological processes that mediate their relationship. *Journal of Educational Psychology, 94*(3), 545–561. https://doi.org/10.1037/0022-0663.94.3.545

Allaire-Duquette, G., Charland, P., & Riopel, M. (2014). At the Very Root of the Development of Interest: Using Human Body Contexts to Improve Women's Emotional Engagement in Introductory Physics. *European Journal of Physics Education*, *5*(2), 31-48. https://doi.org/10.20308/ejpe.93516

Amos, R., & Reiss, M. (2012). The benefits of residential fieldwork for school science: Insights from a five-year initiative for inner-city students in the UK. *International Journal of Science Education, 34*(4), 485–511. https://doi.org/10.1080/09500693.2011.585476

Ayar, M. C. (2015). First-hand experience with engineering design and career interest in engineering: An informal STEM education case study. *Educational Sciences: Theory and Practice, 15(*6), 1655–1675. https://doi.org/10.12738/estp.2015.6.0134

Ayotte-Beaudet, J.-P., Potvin, P., & Riopel, M. (2017). Teaching and Learning Science Outdoors in Schools' Immediate Surroundings at K-12 Levels: A Meta-Synthesis. *EURASIA Journal of Mathematics Science and Technology Education*, *13*(9), 5343-5363. https://doi.org/10.12973/eurasia.2017.00833a

Barmby, P., Kind, P. M., & Jones, K. (2008). Examining changing attitudes in secondary school science. *International Journal of Science Education, 30*(8), 1075–1093. https://doi.org/10.1080/09500690701344966

Bennett, J., & Hogarth, S. (2009). Would you want to talk to a scientist at a party? High school students' attitudes to school science and to science. *International Journal of Science Education, 31*(14), 1975–1998. https://doi.org/10.1080/09500690802425581

Ben-Zvi Assaraf, O., & Orion, N. (2009). A design based research of an earth systems based environmental curriculum. *Eurasia Journal of Mathematics, Science and Technology Education, 5*(1), 47–62. https://doi.org/10.12973/ejmste/75256

Bergin, D. A. (1999). Influences on classroom interest. *Educational Psychologist, 34*(2), 87–98. https://doi.org/10.1207/s15326985ep3402_2

Bølling, M., Hartmeyer, R., & Bentsen, P. (2017). Seven place-conscious methods to stimulate situational interest in science teaching in urban environments. *Education* 3-13, 14 pages.

Borsos, E., Patocskai, M., & Boric, E. (2018). Teaching in nature? Naturally! *Journal of Biological Education*, 11 pages.

Braund, M., & Reiss, M. (2006). Towards a more authentic science curriculum: The contribution of out-of-school learning. *International Journal of Science Education, 28*(12), 1373–1388. https://doi.org/10.1080/09500690500498419

Carrier, S. J., Tugurian, L. P., & Thomson, M. M. (2013). Elementary science indoors and out: Teachers, time, and testing. *Research in Science Education, 43*(5), 2059–2083. https://doi.org/10.1007/s11165-012-9347-5

Chen, J., & Cowie, B. (2013). Engaging primary students in learning about New Zealand birds: A socially relevant context. *International Journal of Science Education, 35*(8), 1344–1366. https://doi.org/10.1080/09500693.2012.763194

Christidou, V. (2011). Interest, attitudes and images related to science: Science, teachers, and popular science. *International Journal of Environmental and Science Education, 6*(2), 141–159.

Creswell, J. W., & Plano Clark, V. L. (2011). *Designing and conducting mixed methods research* (2nd ed.). Thousand Oaks: Sage.

Dillon, J., Rickinson, M., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2006). The value of outdoor learning: Evidence from research in the UK and elsewhere. *School Science Review, 87*(320), 107–111.

Dyment, J. E. (2005). Green school grounds as sites for outdoor learning: Barriers and opportunities. *International Research in Geographical and Environmental Education, 14*(1), 28–45. https://doi.org/10.1080/09500790508668328

Ernst, J. (2014). Early childhood educators' use of natural outdoor settings as learning environments: an exploratory study of beliefs, practices, and barriers. *Environmental Education Research, 20*(6), 735–752. https://doi.org/10.1080/13504622.2013.833596

Fägerstam, E. (2014). High school teachers' experience of the educational potential of outdoor teaching and learning. *Journal of Adventure Education and Outdoor Learning, 14*(1), 56–81. https://doi.org/10.1080/14729679.2013.769887

Fägerstam, E., & Blom, J. (2013). Learning biology and mathematics outdoors: effects and attitudes in a Swedish high school context. *Journal of Adventure Education and Outdoor Learning, 13*(1), 56–75. https://doi.org/10.1080/14729679.2011.647432

Fančovičová, J., & Prokop, P. (2011). Plants have a chance: outdoor educational programmes alter students' knowledge and attitudes towards plants. *Environmental Education Research, 17*(4), 537–551. https://doi.org/10.1080/13504622.2010.545874

Fisher, J. A. (2001). The Demise of Fieldwork as an Integral Part of Science Education in United Kingdom Schools: a victim of cultural change and political pressure? *Pedagogy, Culture and Society, 9*(1), 75–96. https://doi.org/10.1080/14681360100200104

Giamellaro, M. (2014). Primary contextualization of science learning through immersion in content-rich settings. *International Journal of Science Education, 36*(17), 2848–2871. https://doi.org/10.1080/09500693.2014.937787

Glackin, M. (2016). 'Risky fun' or 'Authentic science'? How teachers' beliefs influence their practice during a professional development programme on outdoor learning. *International Journal of Science Education, 38*(3), 409–433. https://doi.org/10.1080/09500693.2016.1145368

Glackin, M., & Jones, B. (2012). Park and learn: improving opportunities for learning in local open spaces. *School Science Review, 93*(344), 105–113.

Glowinski, I., & Bayrhuber, H. (2011). Student labs on a university campus as a type of out-of-school learning environment: Assessing the potential to promote students' interest in science. *International Journal of Environmental and Science Education, 6*(4), 371–392.

Gouvernement du Québec. (2011). *Quebec education program: Progression of learning in secondary school; Science and Technology Cycle One, Science and Technology Cycle Two, Environmental Science and Technology*. Québec: Gouvernement du Québec.

Gungor, A., Eryılmaz, A., & Fakıoglu, T. (2007). The relationship of freshmen's physics achievement and their related affective characteristics. *Journal of Research in Science Teaching, 44*(8), 1036–1056. https://doi.org/10.1002/tea.20200

Hasni, A., Bousadra, F., Belletête, V., Benabdallah, A., Nicole, M.-C., & Dumais, N. (2016). Trends in research on project-based science and technology teaching and learning at K–12 levels: A systematic review. *Studies in Science Education, 52*(2), 199–231. https://doi.org/10.1080/03057267.2016.1226573

Häussler, P., & Hoffmann, L. (2000). A curricular frame for physics education: Development, comparison with students' interests, and impact on students' achievement and self-concept. *Science education, 84*(6), 689–705. https://doi.org/10.1002/1098-237X(200011)84:6<689::AID-SCE1>3.0.CO;2-L

Häussler, P., & Hoffmann, L. (2002). An intervention study to enhance girls' interest, self-concept, and achievement in physics classes. *Journal of Research in Science Teaching, 39*(9), 870–888. https://doi.org/10.1002/tea.10048

Häussler, P., Hoffman, L., Langeheine, R., Rost, J., & Sievers, K. (1998). A typology of students' interest in physics and the distribution of gender and age within each type. *International Journal of Science Education, 20*(2), 223–238. https://doi.org/10.1080/0950069980200207

Hidi, S., & Renninger, K. A. (2006). The four-phase model of interest development. *Educational Psychologist, 41*(2), 111–127. https://doi.org/10.1207/s15326985ep4102_4

Hox, J. J. (2010). *Multilevel analysis: Techniques and applications* (2nd ed.). New York: Routledge. https://doi.org/10.4324/9780203852279

Hutcheson, G., & Sofroniou, N. (1999). *The multivariate social scientist*. London: Sage. https://doi.org/10.4135/9780857028075

Hyseni Spahiu, M., Korcab, B., & Lindemann-Matthies, P. (2014). Environmental education in high schools in Kosovo–A teachers' perspective. *International Journal of Science Education, 36*(16), 2750–2771. https://doi.org/10.1080/09500693.2014.933366

Kerger, S., Martin, R., & Brunner, M. (2011). How can we enhance girls' interest in scientific topics? *British Journal of Educational Psychology, 81*(4), 606–628. https://doi.org/10.1111/j.2044-8279.2011.02019.x

Krapp, A. (2007). An educational–psychological conceptualization of interest. *International Journal of Educational and Vocational Guidance, 7*, 5–21. https://doi.org/10.1007/s10775-007-9113-9

Krapp, A., & Prenzel, M. (2011). Research on interest in science: Theories, methods, and findings. *International Journal of Science Education, 33*(1), 27–50. https://doi.org/10.1080/09500693.2010.518645

Lee, H.-S., & Songer, N. B. (2003). Making authentic science accessible to students. *International Journal of Science Education, 25*(8), 923–948. https://doi.org/10.1080/09500690305023

Lin, H.-S., Hong, Z.-R., & Chen, Y.-C. (2013). Exploring the development of college students' situational interest in learning science. *International Journal of Science Education, 35*(13), 2152–2173. https://doi.org/10.1080/09500693.2013.818261

Lock, R. (2010). Biology fieldwork in schools and colleges in the UK: an analysis of empirical research from 1963 to 2009. *Journal of Biology Education, 44*(2), 58–64. https://doi.org/10.1080/00219266.2010.9656195

Logan, M. R., & Skamp, K. R. (2013). The impact of teachers and their science teaching on students' 'science interest': A four-year study. *International Journal of Science Education, 35*(17), 2879–2904. https://doi.org/10.1080/09500693.2012.667167

Loukomies, A., Juuti, K., & Lavonen, J. (2015). Investigating situational interest in primary science lessons. *International Journal of Science Education, 37*(18), 3015–3037. https://doi.org/10.1080/09500693.2015.1119909

Lustick, D. (2009). The failure of inquiry: Preparing science teachers with an authentic Investigation. *Journal of Science Teacher Education, 20*(6), 583–604. https://doi.org/10.1007/s10972-009-9149-4

Magntorn, O., & Helldén, G. (2007). Reading nature from a 'bottom-up' perspective. *Journal of Biology Education, 41*(2), 68–75. https://doi.org/10.1080/00219266.2007.9656065

Moreno, R. (2009). Constructing knowledge with an agent-based instructional program: A comparison of cooperative and individual meaning making. *Learning and Instruction, 19*(5), 433–444. https://doi.org/10.1016/j.learninstruc.2009.02.018

Nieswandt, M. (2007). Student affect and conceptual understanding in learning chemistry. *Journal of Research in Science Teaching, 44*(7), 908–937. https://doi.org/10.1002/tea.20169

Osborne, J., Simon, S., & Collins, S. (2003). Attitudes towards science: A review of the literature and its implications. *International Journal of Science Education, 25*(9), 1049–1079. https://doi.org/10.1080/0950069032000032199

Owen, S., Dickson, D., Stanisstreet, M., & Boyes, E. (2008). Teaching physics: Students' attitudes towards different learning activities. *Research in Science and Technological Education, 26*(2), 113–128. https://doi.org/10.1080/02635140802036734

Palmer, D. H. (2009). Student interest generated during an inquiry skills lesson. *Journal of Research in Science Teaching, 46*(2), 147–165. https://doi.org/10.1002/tea.20263

Palmer, D. H., Dixon, J., & Archer, J. (2016). Identifying underlying causes of situational interest in a science course for preservice elementary teachers. *Science Education, 100*(6), 1039–1061. https://doi.org/10.1002/sce.21244

Pickens, M., & Eick, C. J. (2009). Studying Motivational Strategies Used by Two Teachers in Differently Tracked Science Courses. *Journal of Educational Research, 102*(5), 349–362. https://doi.org/10.3200/JOER.102.5.349-362

Potvin, P., & Hasni, A. (2014a). Interest, motivation and attitude towards science and technology at K-12 levels: a systematic review of 12 years of educational research. *Studies in Science Education, 50*(1), 85–129. https://doi.org/10.1080/03057267.2014.881626

Potvin, P., & Hasni, A. (2014b). Analysis of the decline in interest towards school science and technology from grades 5 through 11. *Journal of Science Education and Technology, 23*(6), 784–802. https://doi.org/10.1007/s10956-014-9512-x

Raes, A. Schellens, T., & De Wever, B. (2014). Web-based collaborative inquiry to bridge gaps in secondary science education. *Journal of the Learning Sciences, 23*(3), 316–347. https://doi.org/10.1080/10508406.2013.836656

Reiss, M., & Braund, M. (2004). Managing learning outside the classroom. In M. Braund, and M. Reiss (Eds.), *Learning Science Outside the Classroom* (pp. 225–234). New York: Routledge Farmer.

Renninger, K. A., & Hidi, S. (2011). Revisiting the conceptualization, measurement, and generation of interest. *Educational Psychologist, 46*(3), 168–184. https://doi.org/10.1080/00461520.2011.587723

Rickinson, M., Dillon, J., Teamey, K., Morris, M., Choi, M. Y., Sanders, D., & Benefield, P. (2004). *A review of research on outdoor learning*. Shrewsbury: Field Studies Council.

Rivera Maulucci, M. S., Brown, B. A., Grey, S. T., & Sullivan, S. (2014). Urban middle school students' reflections on authentic science inquiry. *Journal of Research in Science Teaching, 51*(9), 1119–1149. https://doi.org/10.1002/tea.21167

Rivet, A. E., & Krajcik, J. S. (2008). Contextualizing instruction: Leveraging students' prior knowledge and experiences to foster understanding of middle school science. *Journal of Research in Science Teaching, 45*(1), 79–100. https://doi.org/10.1002/tea.20203

Rotgans, J. I., & Schmidt, H. G. (2011). The role of teachers in facilitating situational interest in an active-learning classroom. *Teaching and Teacher Education, 27*(1), 37–42. https://doi.org/10.1016/j.tate.2010.06.025

Rotgans, J. I., & Schmidt, H. G. (2017). The relation between individual interest and knowledge acquisition. *British Educational Research Journal, 43*(2), 350–371. https://doi.org/10.1002/berj.3268

Rotgans, J. I., and Schmidt, H. G. (2018). How individual interest influences situational interest and how both are related to knowledge acquisition: A microanalytical investigation. The Journal of Educational Research, 111(5), 530–540. https://doi.org/10.1080/00220671.2017.1310710

Sadler, T. D. (2009). Situated learning in science education: socio-scientific issues as contexts for practice. Studies in Science Education, 45(1), 1–42. https://doi.org/10.1080/03057260802681839

Schiefele, U. (2009). Situational and individual interest. In K. Wentzel, and A. Wigfield (Eds.), Handbook of motivation at school (pp. 197–222). New York: Routledge.

Schmidt, H. G., & Rotgans, J. I. (2017). Like it or not: Individual interest is not a cause but a consequence of learning. Rejoinder to Hidi and Renninger (2017). *British Educational Research Journal, 43*(6), 1266–1268. https://doi.org/10.1002/berj.3307

Skamp, K., & Bergmann, I. (2001). Facilitating Learnscape Development, Maintenance and Use: teachers' perceptions and self-reported practices. *Environmental Education Research, 7*(4), 333–358. https://doi.org/10.1080/13504620120081241

Stevens, J. P. (2009). *Applied multivariate statistics for the social sciences* (5th ed.). New York: Routledge.

Tapola, A., Jaakkola, T., & Niemivirta, M. (2014). The influence of achievement goal orientations and task concreteness on situational interest. *The Journal of Experimental Education, 82*(4), 455–479. https://doi.org/10.1080/00220973.2013.813370

Tapola, A., Veermans, M., & Niemivirta, M. (2013). Predictors and outcomes of situational interest during a science learning task. *Instructional Science, 41*(6), 1047–1067. https://doi.org/10.1007/s11251-013-9273-6

Tsai, Y.-M., Kunter, M., Lüdtke, O., Trautwein, U., & Ryan, R. M. (2008). What makes lessons interesting? The role of situational and individual factors in three school subjects. *Journal of Educational Psychology, 100*(2), 460–472. https://doi.org/10.1037/0022-0663.100.2.460

Turner, S., & Ireson, G. (2010). Fifteen pupils' positive approach to primary school science: when does it decline? *Educational Studies, 36*(2), 119–141. https://doi.org/10.1080/03055690903148662

Uitto, A., Juuti, K., Lavonen, J., Byman, R., and Meisalo, V. (2011). Secondary school students' interests, attitudes and values concerning school science related to environmental issues in Finland. Environmental Education Research, 17(2), 167–186. https://doi.org/10.1080/13504622.2010.522703

Vedder-Weiss, D., & Fortus, D. (2011). Adolescents' declining motivation to learn science: Inevitable or not? *Journal of Research in Science Teaching, 48*(2), 199–216. https://doi.org/10.1002/tea.20398

Vedder-Weiss, D., & Fortus, D. (2012). Adolescents' declining motivation to learn science: A Follow-Up Study. *Journal of Research in Science Teaching, 49*(9), 1057–1095. https://doi.org/10.1002/tea.21049

Vygotsky, L. S. (1978). *Mind in society: The development of higher mental process*. Cambridge: Harvard University Press.

Zoldosova, K., & Prokop, P. (2006). Education in the field influences children's ideas and interest toward science. *Journal of Science Education and Technology, 15*(3), 304–313. https://doi.org/10.1007/s10956-006-9017-3