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Learning outdoors or with a computer: the contribution of the learning setting to learning and to environmental perceptions

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ABSTRACT

Background: Outdoor learning and computer-based learning are two different alternatives to in-class conventional teacher-centered learning.

Purpose: This study compares the outdoor learning setting with computer-based learning in class. It examines the influence of the two different learning settings on academic achievements, the learning experience, and pro-environmental perceptions.

Sample: A total of 90 elementary school students (third and fourth-grade classes) participated in the study.

Design and methods: The academic knowledge of the study participants was tested through identical exams for both learning settings. In addition, in each group the students' perceptions were examined by means of a questionnaire about environmental values and the learning experience.

Results: The study demonstrates that academic achievements in the two settings were similar, but the students expressed more enthusiasm about the outdoor learning experience than about in-class learning. In addition, the outdoor learning setting contributed more to promoting positive environmental perceptions even though students did not learn directly about environmental issues and sustainability.

Conclusions: These findings suggest that learning in the natural environment is valuable: Alongside the fostering of computerized learning, it is also important to promoteoutdoor learning settings and integrate both settings by implementing mobile technologies in the outdoor teaching.

KEYWORDS

Outdoor learning; computer setting; learning experience; environmental perceptions

Introduction

Two distinct central trends in education, each of which reflects worldwide social processes, are technological development and environmental sustainability. This study compared two learning settings that each reflect one of these trends and that constitute alternatives to in-class conventional teacher-centered learning – namely, a computerized setting and outdoor learning in the natural surroundings (Jeronen, Palmberg, and Yli-Panula 2017).

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In the computerized setting, the student is fixed in one place, facing a changing screen that offers plentiful options of virtual tasks, information and video experiences. The outdoor study setting takes place in outdoor surroundings and is experiential and based on interdisciplinary content (Tal, Lavie-Alon, and Morag 2014). The first setting engages computer skills and only some of the senses, while the second connects the student to nature and the ecological environment while activating psychomotor activity and skills of self-exploration.

Many studies compare each of these settings to in-class traditional teacher-centered learning (Diamond and Irwin 2013; Cheung and Slavin 2013; Smetana and Bell 2012; Dhanapal, Lim, and Cheng 2013), but it is difficult to find studies that directly compare the effectiveness of outdoor learning with computer-based learning in promoting science learning and environmental perceptions among young children.

Why is it important to compare these two learning settings? This is primarily related to the differences in the education system's attitude toward each of them. Computer technology continues to occupy a central place in the classroom, and is the subject of massive monetary investment, as well as comprehensive planning by educational institutions world-wide. Much has been written about the contributions of computers to education, and programs for computer-based learning are increasingly replacing various curricula (Naicker 2011; Pierce and Cleary 2016). By contrast, outdoor learning receives far less attention. Leaving the classroom to explore the tangible outside world has commonly been regarded as a waste of educational resources, time and money (Rios and Brewer 2014; Orion and Hofstein 1994).

Comparison of these two learning settings will help to provide a better understanding of the distinct contribution of each one. Moreover, this comparison can help to further advance teaching development, by combining mobile technologies with outdoor instruction and thus utilizing the advantages of each setting.

This study compared the respective impacts of these two settings on academic achievement (the subject matter was the interaction between living organisms and their environment) and on the students' learning experience. In addition, the students' environmental perceptions were examined in the context of each learning setting. Studies have shown that outdoor-learning activities and experiences in nature may promote environmental values, even if no emphasis is placed on ecological or sustainability issues in the subject matter itself (Palmberg and Kuru 2000; Farmer, Knapp, and Benton 2007; Hattie et al. 1997). These studies served as the basis for examining students' environmental perceptions. Each variable in our study shed light on a different dimension and thus the evaluation of all of them together offers a broader understanding of the respective influences of the two learning settings from the perspective of the students.

The study setting and learning

The most common learning setting is indoor learning in the classroom, where the teacher is dominant and presents a variety of subjects to the whole class. Researchers criticize this setting, claiming that it offers the students little say in terms of the content, pace, and nature of the studies, which are dictated mainly by the teacher (Dhanapal, Lim, and Cheng 2013). Students in the classroom setting often show little interest in

school and even develop negative attitudes toward their studies, thereby failing to realize their academic capabilities (Ryan, Carlton, and Ali 1999; Harun and Salamuddin 2014). Shih, Chuang, and Hwang (2010) point out that traditional teacher-centered learning places little emphasis on the student-centered inquiry process of learning and as a result reduces the enthusiasm to learn and explore. Others emphasized that the excessive rustle effect of noise within the classroom setting may indirectly impair the students' concentration in the long term (Jackman, Beaver, and Wyatt 2014). Indoor classrooms are limited by their size and do not possess natural components. Thus indoor learning activities may not be sufficient for vivacious students to explore the world around them, and this may limit their opportunities to apply their scientific skills (Jackman, Beaver, and Wyatt 2014). When compared to other learning environments, most studies find that the alternative out-of-class learning setting offers advantages in the academic and social dimensions (Becker et al. 2017).

Other learning settings, such as outdoor learning (Harun and Salamuddin 2013) and e-learning (Amaury and Snyder 2008–9; Brocato, Bonanno, and Ulbig 2015) have been studied and found to have a direct influence on students' learning outcomes. The outcomes affected include cognitive achievements such as knowledge, understanding, thinking, and reasoning abilities, as well as emotional achievements such as interest and motivation to learn. Learning setting also affected behavioral achievements, such as active participation in study, the development of attitudes toward learning (Haertel, Walberg, and Haertel 1981), and social-moral values (Harun and Salamuddin 2013; Brocato, Bonanno, and Ulbig 2015). Even the physical structure of school surroundings and the seating arrangement of students can promote interest in learning (Weinstein 1979; Lei 2010). This explains the constant search for alternatives and diverse learning settings that can make up for the shortcomings of the traditional learning setting in the classroom. Two common alternatives are outdoor learning and computerized learning – the settings examined in this study.

The outdoor learning setting

The outdoor learning setting aims to expose children to a wide variety of environments and experiences. It is holistic and is situated outside the classroom. Teaching in this setting employs methods that use the outdoor surroundings to enact experiential learning that widens and deepens theoretical contents that are learnt in other settings (Harun and Salamuddin 2013). The physical setting may be located in a schoolyard, where a greenhouse or an animal enclosure could be built (Graham et al. 2005), or outside the school premises, through field trips, camps, and other outdoor nature activities (Hattie et al. 1997).

In support of outdoor learning, researchers claim that active learning that allows students use all their senses and explore the subject matter tangibly, in addition to lectures and theoretical explanations or animations, improves the level of knowledge and the motivation to learn and fosters a positive attitude toward learning (Ernst 2007). When properly planned and performed, outdoor activities such as field trips, school gardening, camping or museum visits may all contribute to high achievements and encourage active participation and interactivity and the generation of a more positive attitude to the study subjects (Jeronen, Palmberg, and Yli-Panula 2017).

One of the main characteristics that is typical to the outdoor learning setting is the idea of active participation and learning in the natural environment (Tal, Lavie-Alon, and Morag 2014). Such self-activism of the student is found to promote not only knowledge and academic achievements, but also positive attitudes and behaviors, ecoliteracy, and physical activity (Ratcliffe et al. 2011).

Experiential learning in the outdoor setting is first-hand and sensory based. In the outdoor learning activities students may explore, touch, listen, watch, move things, dissemble, and reassemble. Students on field trips, for example, sharpen their skills of observation and perception by utilizing all their senses (Behrendt and Franklin 2014). In school gardening, children also may eat and enjoy the fruit of their work (Ratcliffe et al. 2011; Graham et al. 2005).

Tal, Lavie-Alon, and Morag (2014) observed 62 fieldtrips to natural environments by students aged 10–14 and interviewed the participants – students, teachers, and professional guides – in order to investigate the quality of those trips in terms of their context (the physical environment, the characteristics of the group and guides, etc.) and their learned contents. They found that in high quality activities students became active and highly engaged learners. They reported on their meaningful learning experiences and affective and social outcomes. The researchers also found evidence of better social bonding, meeting physical challenges, and even building one's own identity in the high quality field trips experience. Students claimed that the adventure and physical experiences yielded many benefits in the cognitive, affective, and social aspects.

Other researchers claim that outdoor learning served to improve students' self-confidence, as well as social skills (Campbell and Jane 2012; D'Amato and Krasny 2011) such as group work and moral judgements (Cooley, Burns, and Cumming 2015; Palmberg and Kuru 2000). Outdoor field trips provide an opportunity for students to develop increased perception, a greater vocabulary, and an increased interest in the outdoors (Behrendt and Franklin 2014).

The examination of students' perceptions regarding their outdoor learning experience reveals that they expressed more positive responses than in the case of indoor science learning (Dhanapal, Lim, and Cheng 2013). Their developing of a positive attitude to learning was based on their being motivated to develop connections between the theoretical concepts in the classroom and what they have experienced, and on the opportunity to experience and handle natural events that inspire their curiosity and motivation to learn (Feille 2013). Studies have suggested that developed interest stimulates curiosity, empowers students to ask questions, discuss observations, consider past experiences, or simply ponder the topic (Farmer, Knapp, and Benton 2007) and to inculcate environmental values and a sense of responsibility (Mehmet 2015; Feille 2013).

Environmental education is a closely related concept to outdoor learning that focuses on ecological and sustainability issues. According to Hart (2007), environmental education is any educational act that aspires to provide knowledge of the physical and human-social environment, to promote caring and respect for the environment and for others, and to develop skills for acting on their behalf (D'Amato and Krasny 2011). It has been claimed that these skills and values are promoted effectively through outdoor learning, due to the multifaceted engagement of the student in the learning process at the physical, intellectual, and emotional levels (Harun and Salamuddin 2014).

Similarly, Farmer, Knapp, and Benton (2007) found that a field trip promoted environmental perceptions in fourth graders and that students continued to express positive environmental perceptions, and even to initiate environmental activities, long after the trip was over. Although the students did not learn directly about ecological and sustainability issues during the field trip, the very fact of spending time in natural surroundings seemed to contribute to their positive environmental perceptions. A comprehensive review of 96 studies on outdoor learning (Hattie et al. 1997) found that study in natural settings affected some 40 social and emotional parameters, including taking a positive stand regarding the environment. The researchers suggested that the reason for this is that activities in natural settings are usually characterized by enjoyment, appreciation for the beauty of nature, and the development of a positive emotional perspective toward it. These factors encourage care for the environment and concern for its preservation.

Despite the advantages of the outdoor learning setting, particularly its integration of interaction with biotic elements, logistical limitations and the accelerated progress of urbanization limit its availability to teachers and students. It requires the planning and adaptation of lesson activities, as well as strict adherence to regulations and complex logistical arrangements (Jelmberg and Goodman 2008). Outdoor learning settings are also liable to include external attractions that may challenge the students' ability to listen and concentrate. Accordingly, proper preparation is vital in order to make the most of outdoor study and promote dialogue between the students and the environment (D'Amato and Krasny 2011).

The computerized learning setting

The computer technologies that were introduced into schools toward the end of the twentieth century guaranteed a dramatic influence on learning processes that cannot be obtained through other media (Wellington 2005). Computer technologies facilitate the gathering and processing of information; instead of memorization, the computer allows a focus on problem-solving processes, sharing, and thinking. Computer technologies also allow quick access to a wealth of information and the integration of different kinds of media – pictures, sound, text, and films (Pierce and Cleary 2016).

Evidence suggests that proper preparation and guidance lead to significant success with computer-aided study (Cheung and Slavin 2013). In the study of a foreign language, the achievements of those learning by computer exceeded those of students learning without computers (Macaro, Handley, and Walter 2012). Similar results were observed with respect to study of science (Smetana and Bell 2012) and mathematics (Hegedus, Dalton, and Tapper 2015; Cheung and Slavin 2013).

In contrast to these studies, others have shown that learning with a computer may not be more effective than traditional formal learning. Studies present various reasons for the partial realization of the hopes associated with the integration of computer technology into education. These include teachers' difficulties in implementing real pedagogical changes, technical problems, and the overabundance and endless variety of information sources that pose difficulties for the students (Moos and Azevedo 2009; Dawson 2008). Paradoxically, the growing number of students using computers, social networks and video games did not reinforce the computer's usefulness for learning, such as the ability to create Excel spreadsheets according to Moos and Azevedo (2009).

Computer applications designed for teaching, and especially programs intended to inculcate environmental values in students, are still being further developed (Diamond and Irwin 2013; Uzunboylu, Cavus, and Ercag 2009; Chang, Chen, and Hsu 2011; Lai et al. 2013). There is evidence suggesting the influence of computer-assisted learning on the development of social or emotional perspectives (Amaury and Snyder 2008–9). Diamond and Irwin (2013) defined four fields that must be developed in students to instill sustainability literacy (i.e. the development of the understanding, the skills, the perspectives, and the activities for preserving the environment). These are: awareness of the relevant concepts; personal and ethical identity; relevant skills; and confidence in the ability to apply all these to advancing the quality of the environment. Communication and collaboration between students followed the more flexible access to information that was made possible by e-learning tools (Pierce and Cleary 2016). By sharing opinions and publishing works via e-learning, students' confidence was improved and the learning experience became more powerful, resulting in the development of personal identities and skills of sustainability among the students (Aivazidis, Lazaridou, and Hellden 2006; Turan 2014).

Mobile technologies extend the learning possibilities and can serve as a bridge between outdoor learning and computer learning. Learning in nature and computer learning have traditionally appeared to be contradictory concepts. However, the high level of interest shown by young people in computer-based technologies have led an increasing number of teachers to integrate mobile technologies in out-of-class learning and to cope with the challenges these technologies present (Zimmerman et al. 2015; Jones, Scanlon, and Clough 2013). Researchers show how mobile technologies mediate learning in the natural world and change the students' knowledge during the course of field trips (Chang, Chen, and Hsu 2011). In addition, it has been reported that mobile technologies enhance a sense of identification with science and environmental awareness (Uzunboylu, Cavus, and Ercag 2009; Jones, Scanlon, and Clough 2013).

A key challenge in the integration of mobile technologies in outdoor learning is how to encourage the learner to concentrate on completing the tasks rather than on the device itself (Filippini-Fantoni and Bowen 2008). By facing this challenge, the direct contact with flora and fauna in nature, combined with the ability to prepare electronic lists, use digital field guides, and search for online information can make a significant contribution to nature learning (McClain and Zimmerman 2016).

In conclusion, it is important to emphasize that computerized technology is not merely an additional learning tool, but rather an integrated educational system, which takes the place of traditional teaching methodologies and tools. Faced with the increasing integration of such technology in schools, it is important to continue examining its characteristics.

Outdoor learning vs. computer-based learning

In order to better understand both kinds of learning settings that this research deals with (outdoor and computer-based), the following main characteristics are compared:

(a) Frequency: As computer and mobile technology became available to most students, these media have increasingly been replacing the informal learning environment (Uhls et al. 2014; Zimmerman et al. 2015). Outdoor setting education has

a long tradition in some countries (Lai et al. 2013), but it seems to be gradually losing its importance and role in the educational system, especially in Israel (Tal, Lavie-Alon, and Morag 2014). The integration of mobile technologies in outdoor education may reverse this trend.

(b) Availability and accessibility: Outdoor learning requires careful planning of activities and involves complex logistical planning (Jelmberg and Goodman 2008). In contrast, learning with a computer is usually pre-built and simpler to teach for experienced teachers. However, technical problems and inadequate teacher training are critical factors explaining the mixed success of teaching with technology (Smetana and Bell 2012).

(c) Communication and social skills: Researchers and educators are concerned with the growing amount of time that children and teenagers spend engaging with media and communicating using screens, at the expense of face-to-face communication and non-screen playtime (Uhls et al. 2014). Such a dramatic change may influence all aspects of social communication and skills, leading to possible emotional misunderstandings (Uhls et al. 2014). Accordingly, it has been suggested that the use of outdoor activities could help develop social skills (Uhls et al. 2014; Palmberg and Kuru 2000).

(d) Active learning: Both learning settings engage the students in active self-learning, albeit with different characteristics. For example, a dynamic outdoor environment provides meaningful contextual experiences that engage all five senses with less use of print and electronic media (Lai et al. 2013). Computerized technology activates only the students' senses of hearing and sight, but its information is not limited to any particular location. Mobile technology, such as smartphones or i-Pad, may easily serve as tools for outdoor education while also permitting multisensory learning (Lai et al. 2013; McClain and Zimmerman 2016).

(e) Learning experience: Interactive surroundings that may stimulate children's learning motivation are found in both the computerized and the outdoor settings (Lai et al. 2013; Smetana and Bell 2012; Hummel and Randler 2012). The three-dimensional outdoor experience surrounds the students directly, leading to personal transformations (D'Amato and Krasny 2011) such as stronger connection to nature among students (Braun and Dierkes 2017). Computer technologies offer a spectacular multimedia environment with many access to information, communication, and learning possibilities (Pierce and Cleary 2016).

(f) Academic achievements and environmental values: The research findings on the connections between academic achievement and computerized learning settings are inconclusive (Cheung and Slavin 2013; Moos and Azevedo 2009). In contrast, most of the studies on outdoor learning indicate progress in achievement and in awareness of sustainability values (Ernst 2007; D'Amato and Krasny 2011; Graham et al. 2005), although it is important to note that the number of studies on learning with technology is significantly higher.

The research questions

The objectives of the study presented here were to examine the influence of computer-based learning in class as compared to outdoor learning on three variables. The research questions were:

(1) How did each of the learning environments influence the students' academic achievements?
(2) How did the learning environment influence the students' learning experience?
(3) What contribution did each learning environment make to promoting environmental perceptions?

Research context

The present study deals with a subject occupying the attention of Israeli schools, which have a tradition of outdoor learning in elementary school. The outdoors learning in Israel that was highly integrated into science teaching until the 1990s, significantly decreased with the introduction of computerized technology. A national reform to incorporate computer technology into schools, which began in the first decade of the 21st century, seems to be at odds with outdoor learning – the natural setting, connected to the senses and emotions, versus an ingenious technological environment. A teacher in one such school wished to compare these two learning settings, serving as the basis of the current study. The teacher had 15 years of teaching experience in the sciences. She participated in the study as part of her studies for her Master's degree in scientific education, and all four of the classes she teaches were included in the study. It is important to emphasize that she had no personal preference for either of the learning settings: she considers them equally important and has similar experience teaching science in both.

Methodology

Participants

A total of 90 students from an elementary school in a small town in the south of Israel took part in the study. The students were from four classes: two third-grade classes (9-year-olds) and two fourth-grade classes (10-year-olds). In each learning setting, there was one class from each age group. A total of 45 students studied in each learning setting. The classes consisted of similar groups of students and were divided into learning settings at random. The classes were heterogeneous in terms of the students' academic level and most of the students had an intermediate socioeconomic background. The same teacher instructed all four classes.

The research process and tools

The study lasted two months. Each class received about 30 hours of study on the characteristics, structure, classification, and interactions between living organisms and their environment. The study subjects were drawn from the regular curriculum, with the third graders focusing on plants and the fourth graders concentrating on animals. A greenhouse and small farm corner were established in the vicinity of the school and the students who studied in the outdoor setting learned in these places. In the greenhouse, different activities took place, such as sowing, sprouting, planting, monitoring growth, and experiments for testing the effects of abiotic elements on the phenological stages of plant

life. In addition, the students harvested the crop and prepared dishes with the fruit and vegetables. At the farm, the students undertook observations of animals in their habitat and helped care for horses, cows, rabbits, guinea pigs, goats, chickens, snakes, and turtles. In their activities with plants or animals, the students made use of binoculars, magnifying glasses, microscopes, cameras, and structured tracking sheets.

In the computerized setting, the same subjects were studied mainly by means of the computer. A digital book ('Brainpop') was used, as well as computerized simulations, films from the internet, databases and computerized sites ('Ofek,' 'Galim'). The students chose a plant from the Brassicaceae or Faboideae family or an animal from one of the classes and studied all its features. The students produced presentations in Google Drive and shared them with the entire class.

After two months, the academic knowledge of the study participants was tested through identical exams for both learning settings according to age group. The tests were composed by the Israeli National Teachers' Center for Science and Technology in the Elementary Schools (available on the website: www.matar.tau.ac.il/?page_id=7837). The exams, which were compiled by the regional advisors for science in elementary schools, had content validated by many teachers, and are available to all elementary school science teachers in Israel. The third grade exam dealt with the definition of plants as living beings, knowledge of their needs for living, their division into groups, knowledge of the organs of the plant and their functions, and phonological stages in the life of the plant. The questions were of various types: multiple-choice questions, questions that required matching up different concepts, and analysis of situations and processes. The fourth grade test checked for knowledge of the variety of organisms in nature, interactions among the organisms and between them and their environment, and human involvement in the components of the environment.

In addition, in each group the students' perceptions were examined by means of a questionnaire about environmental values that was taken unchanged from an environmental literacy report on the Israeli educational system (Tal et al. 2007). The Likert scale questionnaire contained 24 statements regarding the student's perception of the environment and his/her personal impact on it. For example, 'We should buy less products whose production pollutes' or, 'If I recycle, it will improve the quality of the environment'. The students marked the extent of their agreement with each statement according to four levels: completely untrue, slightly true, moderately true, very true (the questionnaire appears as an appendix). The general reliability of the questionnaire was found to be high (Table 1, $\alpha = 0.82$).

In addition, the students were asked two open questions: 'A. What is the environmental issue that concerns you most on a personal level?' and 'B. Write about your learning experiences when you learn outside the classroom/when you learn with the computer.' We were aided in wording the first question by the questionnaire

Table 1. Achievements of the students from the two learning setting.

	Third-grade classes N = 45		Fourth-grade classes N = 45		All classes N = 90	
Learning setting	*M (SD)*	$t_{(43)}$	*M (SD)*	$t_{(43)}$	*M (SD)*	$t_{(88)}$
Computer setting	81.01 (13.42)	.28	81.04 (17.16)	1.26	81.02 (15.36)	1.13
Outdoor setting	82.60 (14.89)	$p > 0.05$	86.20 (10.96)	$p > 0.05$	84.40 (12.96)	$p > 0.05$

composed by Negev et al. (2008) which had been validated, and which included open questions regarding environmental problems. The second question was written by us and had its content approved by two veteran teachers. The purpose of this question is to examine what students will write about their experience studying in each of the settings, without outside direction. Before the students were asked to answer, the teacher explained the meaning of the open questions to them.

Data analysis

Factor analysis using the varimax method with orthogonal rotation divided the perceptions questionnaire into two categories with high internal reliability (Table 1). One category, called 'My environment', contained 12 statements ($\alpha = 0.77$) examining the students' perception of humans' influence on the environment. The second category was called 'The environment and me' and contained 10 statements ($\alpha = 0.81$). This category examined the students' perspectives about their personal impact on the environment.

t tests for independent samples were run to compare the students' perspectives and exam grades to the learning setting. The answers to the open questions were processed using content analysis, with the categories consolidated and set in accordance with the students' answers. In the first stage, each of the researchers separately sorted the students' answers into main categories. A comparison of the sorting results showed an agreement level of 80%. In the second stage, the researchers discussed the categories and agreed on a final division. The answers to the question 'What is the environmental issue that concerns you the most on a personal level?' were divided into six categories as detailed in Table 3. The descriptions of the learning experience were divided into three categories as shown in Table 5. A chi-squared distribution (χ^2) was carried out to estimate the variance between the students' answers in the various categories and the learning setting.

Findings and discussion

The students' knowledge achievements

An examination of the average grade on the tests according to the distribution of the learning settings shows that, among the students in the outdoor learning setting, the average grade was higher than that of the students who studied with computer integration (84.4 and 81.0, respectively). However, the difference was not found to be statistically significant, as may be seen in Table 1. This result was obtained when comparing each age group separately.

The average grade in both learning settings was quite high. It seems that the students in both settings were able to understand the aspects of the relationship between living organisms and their environment well. These findings support earlier reports on the effectiveness of studying with a computer (Aivazidis, Lazaridou, and Hellden 2006) or in an outdoor learning setting (Farmer, Knapp, and Benton 2007) for the promotion of knowledge acquisition, including on environmental issues (Aivazidis, Lazaridou, and Hellden 2006; Blair 2009; Graham et al. 2005).

The students' perceptions of the environment

Table 2 summarizes the environmental perceptions of all the students in this study. The students in both learning settings demonstrated positive perceptions and it is important to emphasize that this came about despite the fact that the students did not learn directly about subjects such as water or air pollution, recycling or other ecological issues. Table 2 shows that the average of the positive perceptions dealing with the student's perceptions of the environment ('My environment') is higher among the students as a whole than the average of the perceptions dealing with the student's ability to have an effect on the environment ('The environment and me'). The students in both learning settings clearly demonstrate positive perceptions toward the general need for a clean ecological environment, but were less inclined to see themselves as responsible or to play an active part in improving the quality of the environment.

An examination of the distribution of the perceptions' averages according to learning setting (Table 3) shows that the average of all the positive perceptions among the outdoor setting students was higher than that of their peers who studied with a computer (M = 3.35 and M = 3.04, respectively). This difference was found to be statistically significant (t = 3.10, $p < 0.05$) with medium effect size (d = 0.63). Statistically significant differences were also found in the division of the perceptions into the two categories 'My environment' and 'The environment and me'. The perceptions of the outdoor setting students in both categories were significantly more positive than the perceptions of the computer-integrated setting (Table 3). It seems that the outdoor students demonstrated a greater desire to change and improve their environment personally and also had a greater awareness of society's impact on the environment.

Table 2. The perceptions of all the students towards the environment (N = 90).

Category	No. of statements	Included statements	Representative statements	*M*	*SD*	*α*
All the perceptions	24	1–24		3.19	0.50	.82
My environment	12	2,5,6,9,10,11,14,19, 20,21,23,24	2. We should buy less products whose production pollutes. 6. It's necessary to produce clean electricity even if it's more expensive.	3.25	0.49	.77
The environment and me	10	3,4,7,8,12,15,16,17,18,22	8. If I recycle, it will improve the quality of the environment. 16. I'm willing to buy less in order to decrease damage to the environment.	3.13	0.63	.81

Statements 1 and 13 were found to be unsuitable for the categories in the table.

Table 3. Perceptions of the students according to learning settings.

	Computer-based setting N = 45		Outdoor setting N = 45			
Category	*M*	*SD*	*M*	*SD*	$t_{(88)}$	*Cohen's d*
All the perceptions	3.04	0.54	3.35	0.40	−3.10*	0.63
My environment	3.14	0.47	3.37	0.48	−2.27*	0.54
The environment and me	3.00	0.64	3.27	0.61	−2.20*	0.51

*$p < 0.05$.

The students who studied in the outdoor setting came into direct contact with plants and animals. Their learning was unmediated and required them to take initiative and personal responsibility for the safety and welfare of the plants and animals they followed. Learning in the natural environment in an outdoor learning setting involved activities incorporating physical exertion, such as movement in the farmyard and the greenhouses, holding, petting and feeding plants and animals. In addition to the senses of sight and hearing, which are utilized in the computer setting, the senses of touch, smell, and taste were also engaged. It appears that these factors in our study, as Graham et al. (2005) also emphasize, had a cumulative influence that developed the students' personal and direct regard for the subjects of their studies. According to Shih-Jang (2004), mere knowledge and awareness of environmental problems does not necessarily promote positive environmental perceptions. Rather, action-oriented instruction and participation in outdoor activities lead to the development of environmental literacy among young students.

When analyzing the direct influence of outdoor learning on the level of general, environmental and ecological long-term knowledge in students, Farmer, Knapp, and Benton (2007) point to the actions described by the students: 'walking, hiking, seeing, drawing, identifying, sucking (straws), poking holes, touching, hearing, monitoring, measuring…' (36–37). The researchers consider these actions a central theme in the perception of pro-environmental attitudes among elementary school children who attend a school field trip.

When computer-based learning was compared to a conventional traditional learning environment for inculcating environmental literacy, students were not found to have achieved better results using the computer medium (Wright 2008; Ruchter, Klar, and Geiger 2010). When the outdoor learning setting was compared to in-class conventional learning, the outdoor setting was often found to better develop pro-environmental attitudes (D'Amato and Krasny 2011; Jeronen, Palmberg, and Yli-Panula 2017). Since farms and nature are no longer accessible to most children, they may be brought to direct and active contact with natural phenomena through school gardening. Blair (2009) believes that 'active childhood involvement with plants may affect subsequent attitudes and behavior in adults' (18). Our findings also show that physical and social activities are of importance, and these are mainly available in an outdoor environment. We believe that the combination of physical activities with emotional contact, as well as direct contact with plants and animals were responsible for the development of more positive perceptions toward the general ecological habitat among students in an outdoor learning setting.

Environmental issues that concern the students

The open question 'What is the environmental issue that concerns you most on a personal level?' was answered by 85% of the students. Analysis of the students' answers showed four central issues of concern to them: Air and water pollution, the dirtying of the environment, recycling and water waste, and harm to plants and animals

Table 4. Answers analysis regarding the environmental issue that bothers the students.

Category	Students in the computer- based setting N = 45 (100%)	Students in the outdoor setting N = 45 (100%)	χ2	Selected quotes
Air and water pollution	16 (35%)	8 (18%)	4.24 $p < 0.05$	'Air pollution. I'm afraid most of the country will be polluted.'; 'Big factories don't think about the environment, only about how much money they'll earn.'
The dirtying of the environment	7 (15%)	8 (18%)	.03 $p > 0.05$	'In public places there are sometimes people who litter.'; 'People dirty the neighborhood.'
Recycling and water waste	2 (4%)	5 (11%)	1.33 $p > 0.05$	'Not everybody in the class separates their trash.'; 'People waste too much water.'
Harm of plants and animals	5 (11%)	10 (22%)	.17 $p > 0.05$	'Children wreck the ants' home.'; 'Sometimes people don't take care of the animals and they get hurt.'
There's no bothersome issue	7 (16%)	8 (18%)	.05 $p > 0.05$	'Nothing'
Didn't answer	8 (18%)	6 (13%)	.08 $p > 0.05$	

(Table 4). About 30% of the students in each learning setting wrote that no issue concerns them or did not answer the question.

The students were asked to write about the one issue that concerns them the most. An analysis of the results in Table 4 shows that there is significant statistical variance in their attitude toward air and water pollution. Students who studied with a computer put more emphasis on air and water pollution: 35% of computer setting students in comparison to just 18% of the outdoor setting students. A possible explanation for these findings is that more students in the outdoor setting chose to mention another issue that particularly bothered them, and this caused the significant differences. 22% of students studying outdoors put emphasis on harm to plants and animals as opposed to just 11% of students studying with a computer. Although there was no significant variance in the findings of this issue, this may explain the significant difference in the air and water pollution. In addition, while there were no statistically significant differences on this issue, it cannot be ignored that in the outdoor environment, over twice as many children chose harm to animals or plants as the issue that particularly bothered them. It is possible that a larger research population might have yielded statistically significant findings.

It can be surmised that personal responsibility for plants and animals drew them emotionally and intellectually closer to the subjects under their care. It is therefore possible that more students from the outdoor setting noted harm of animals or plant life as the issue of greatest concern to them. These results support earlier findings suggesting that outdoor learning enhances environmental consciousness and awareness (Kruse and Card 2004; Rios and Brewer 2014; Behrndt and Franklin 2014). Interest in the natural world and sensitivity to it are developed in students through natural environments learning experiences (Kruse and Card 2004; Hummel and Randler 2012; Ernst 2007; Ratcliffe et al. 2011).

The learning experience in the study setting

When we examine the students' answers regarding their learning experience in each of the settings, a significant difference between the two groups is evident. As Table 5 shows, most of the students who studied in the outdoor setting (73%) enjoyed the learning setting and were enthusiastic about it. By contrast, only 38% of the students who studied with a computer reported enjoying the learning. A chi-square test demonstrates a significant statistical difference of distribution in this matter ($\chi^2 = 7.80$, $p < 0.01$). The difference in the percentage of students who did not answer the question at all was also statistically significant: 29% of the students who studied with a computer failed to report at all on their learning experience, as compared to 11% of the students in the outdoor setting. The learning experience has a direct impact on learning and influences psychological and sociological aspects. Among other dimensions, enjoyment of learning enhances the motivation and interest in learning (Reuven, Klein and Tannenbaum 1991).

Our finding supports the conclusion of earlier studies that outdoor study has a positive effect on motivation for learning and the learning experience (Carrier et al. 2014; Hattie et al. 1997; Becker et al. 2017). The use of live animals in the classroom enhanced interest and intrinsic motivation among students when compared to students who studied the same subjects through film (Hummel and Randler 2012).

Students all over the world choose to spend many hours using computers for school-work and other non-work activities: obtaining information, communicating with friends, watching films and looking at pictures, playing games and doing creative activities (Khoo and Churchill 2013). Therefore, our finding that many students evaluated the

Table 5. Answers analysis regarding the learning experience.

Category	Students in the computer- based setting N = 45 (100%)	Students in the outdoor setting N = 45 (100%)	χ2	Selected quotes
Enjoyment of the learning setting	17 (38%)	33 (73%)	7.80 $p < 0.01$	Computer: 'It was fun and more comfortable for me to learn by computer.'; 'I liked it best when we studied with the computer because I understand the material better and it's more fun and more interesting.' outdoor: 'It was fun taking care of the animals. An amazing experience.'; 'On the farm I learned about all the classes of animals and now I know more.'
Didn't enjoy or would have preferred the other learning setting	15 (33%)	7 (16%)	7.80 $p < 0.01$	Computer: 'It was annoying. I would have preferred to be on the farm.'; 'I'd rather have studied on the animal farm because I love animals.' outdoor: 'I like to study in the classroom.'; 'It wasn't okay. The animals grossed me out.'
No answer	13 (29%)	5 (11%)	5.40 $p < 0.05$	

experience of outdoor learning without a computer as more enjoyable is interesting. There were a handful of students who did not enjoy contact with animals, but in contrast to this, about one-third of the students who studied with the aid of a computer explicitly claimed that they would rather have studied outdoors.

Limitations of the study

Two of the primary limitations of this study are its sample size and its task time. Only 90 students were studied, taught by a single teacher in one school, and the study only lasted for two months. Therefore, it is unclear what conclusions can be drawn from the findings regarding students in other schools. It is obvious that further more extensive studies are required, especially in schools in which there is lower access to animals and plants. Another limitation is the absence of pre-tests on the students. A comparison between pre- and post-tests might have reinforced the findings regarding the differences between the students' achievements in the different learning environments. A further limitation is the teacher's involvement as a participant in the study. Although the teacher was aware of her influence and was careful not to give preference to any one learning setting, it is nonetheless impossible to deny a bias in the findings as a result of this. A further limitation is the matter of the open questions posed to the students. Young students often have trouble answering open questions and it seems that interviews with students would have yielded more comprehensive and in-depth responses.

Conclusions and research recommendations

Our study found that outdoor learning promotes scientific knowledge no less than learning with a computer, that it provides a positive learning experience, and that it encourages positive environmental perceptions among young children. Proper integration of outdoor settings into the teaching sequence can contribute to the pupil's perception of the topic as relevant to their lives, drawing them closer to the environment and to science. Examples of such outdoor settings include field trips, community environmental events, a study garden, a greenhouse, potted plants, habitat and butterfly gardens, and an animal enclosure (Graham et al. 2005; Blair 2009; Shih-Jang 2004).

The learning potential of the outdoor settings can be realized through rigorous preparation of study topics, the character of study, and becoming familiar with the outdoor environment. Moreover, it is important to plan the incorporation of outdoor study into the overall teaching sequence.

It is possible that the key to advancing outdoor study is actually related to the emphasis put on computer-based study in schools. The integration of mobile technologies in outdoor study can facilitate direct and multisensory learning in nature combined with the advantages offered by computers. The students can collect online information while they engage directly with flora or fauna, use digital field guides, etc. Accordingly, the challenge is to develop teaching programs that combine computer technology with outdoor learning and can contribute both to study and to societal values.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix. Environmental Perceptions Questionnaire

The statement	Not true at all	Somewhat true	Moderately true	Very true
1. Fuel consumption should be decreased because it pollutes.				
2. We should buy less products whose production pollutes.				
3. My trash affects the environment				
4. I have to act in connection with dirt in my surroundings				
5. Man's activity harms plants and animals				
6. Clean electricity should be produced even if it's more expensive				
7. Nature interests me				
8. If I recycle, it will improve the quality of the environment				
9. Water pollution harms plants and animals				
10. I'm concerned about the effects of air and water pollution on my health and my family's health				
11. Every person can have an effect on the environment				
12. I like animals				
13. I'm responsible for taking part in the improvement of the environment				
14. The environment should be high on the agenda				
15. I want to learn more about the environment in school				
16. I'm willing to buy less in order to decrease damage to the environment				
17. I want to get to know plants that grow in Israel				
18. I can influence an environmental issue in a group				
19. Even in modern society, we need nature				
20. Population growth in the world causes environmental problems				
21. I'm worried about the effects of air and water pollution on public health				
22. I enjoy being in nature				
23. Factories should be fined for harming the environment				
24. It's important to me for the environment to be clean				