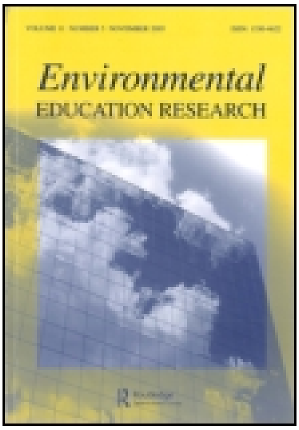

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Plants have a chance: outdoor educational programmes alter students' knowledge and attitudes towards plants

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Plants have a chance: outdoor educational programmes alter students' knowledge and attitudes towards plants

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Outdoor educational programmes are generally believed to be a suitable alternative to conventional biology settings that improve participants' environmental attitudes and knowledge. Here we examine whether outdoor educational programmes focused solely on practical work with plants influence participants' knowledge of and attitudes towards plants. It was found that mean scores of participants' attitudes towards and knowledge of plants significantly increased after the outdoor programme. These effects remained significant even after three months' post-testing. No similar patterns were found in the control group. Interestingly, the proportion of participants who liked biology as a school subject also significantly increased after the outdoor programme in the experimental group. Females showed better knowledge of plants than males, but attitudes towards plants were similar between genders. Having a garden at home was not associated with better knowledge or attitudes towards plants. Our results reveal that outdoor programmes significantly relieve 'plant blindness' and make biology more attractive to pupils.

Keywords: attitudes; knowledge; non-formal learning; outdoor programme; plants

Introduction

Many organisms in the world are under serious threat because of rapid large-scale deforestation. Deforestation, forest degradation and consequent species extinction all over the world is driven by various legal and illegal factors associated with the development of settlements, agriculture, infrastructure and many other factors. Every year a number of plants (represented especially by tropical forests) covering an area, the size of Poland, are destroyed (Kareiva and Marvier 2003). Plant loss has a very clear impact on biodiversity, with most forest-dwelling species unable to live in habitats that replace the forest (Dudley 2005). The global significance of greenhouse gas emissions caused by the loss of plants from the Earth has been generating increased attention (Baumert, Herzog, and Pershing 2006).

Current environmental problems have spurred various governments, conservation organizations and international agencies to develop strategies for protecting natural habitats. However, protection of nature without increasing public awareness of environmental problems is hardly possible. Some research revealed that environmental

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knowledge is an essential precursor of attitude formation (Kaiser, Wolfing, and Fuhrer 1999), but knowledge and attitude usually have a weak link to behaviour change (Kollmuss and Agyeman 2002; Saunders, Brook, and Myers 2006). Attitudes are decisive in achieving conservation goals (Martín-López, Montes, and Benayas 2007), which suggests that building positive attitudes towards the environment would at least partly improve effectiveness of nature protection programmes (Price, Vining, and Saunders 2009). Several works found that school pupils have positive attitudes towards the environment (Smith-Sebasto and Cavern 2006; Tuncer et al. 2005), but environmental knowledge is poor and fragmentary and pro-environmental behaviour is rare (Heimlich and Ardoin 2008; Naito et al. 2010; Rice 2006). This suggests that links between environmental knowledge and attitudes are not clearly understood (Kuhlemeier, Van Den Bergh, and Lagerweij 1999).

Environmental knowledge alone is not sufficient to solve conservation problems, and the role of environmental education (or social sciences in general) in solving these problems has become increasingly important (Mascia et al. 2003). Conventional classroom learning from books, wall charts and memorization of facts often results in pupils' negative attitudes towards science (Shrigley 1990). Environmental education researchers therefore have suggested that classroom interventions (reviewed by Zelezny 1999) or combinations with field experiences (Fernández-Manzanal, Barreiro, and Jimenez 1999; Hamilton-Ekeke 2007; Lindemann-Matthies 2005; Prokop, Tuncer, and Kvasničák 2007; for a review, see Rickinson et al. 2004; Stern, Powell, and Ardoin 2008) that actively involve pupils may promote pro-environmental behaviour, knowledge and positive attitudes towards the environment.

One problem with the majority of work focusing on outdoor activities and their effects on pupils is the absence of explicit estimation measuring how plants are perceived by school pupils. In particular, most measures of outdoor education outcomes are based on knowledge questionnaires that involve both animals and plants, but little is known how these activities influence attitudes towards plants. Plant traits strongly influence ecosystem processes such as primary production (Grime 1998). Growing number of evidences suggests that important ecosystem processes such as productivity and nutrient cycling can be significantly related to species richness of plants (Kinzig, Pacal, and Tilman 2002). Despite these facts, plants are generally less appreciated than animals by pupils (Martín-López, Montes, and Benayas 2007; Schussler and Olzak 2008; Wandersee 1986) most probably because plants lack movement like most animals (Kinchin 1999). Wandersee and Schussler (1999, 2001b) introduced the term 'plant blindness' which was summarized by Strgar (2007) as follows:

- The inability to see or notice the plants in one's own environment
- The inability to recognize the importance of plants in the environment and human affairs
- The inability to appreciate the aesthetic and unique biological features of plants
- The tendency to rank plants as inferior to animals

Ecological importance of plants in the natural ecosystem as well as the low interest of pupils in plants found by recent studies (Fančovičová and Prokop 2010) indicates that outdoor educational programmes should rigorously evaluate pupils' attitudes towards plants and their understanding of the role of plants in nature. Although some works explicitly investigated pupils' attitudes towards plants in surveys (Harvey 1989; for a review, see Wood-Robinson 1991), effects of outdoor programmes on pupils' attitudes towards plants have been largely overlooked (Fančovičová and Prokop 2010) and abilities of pupils to determine common plants are low (Bebbington 2005; Fančovičová and Prokop 2011). Moreover, some works largely misinterpreted their results. For example, DiEnno and Hilton (2005) investigated how application of constructivist learning theory to environmental education influences knowledge gains and attitudes towards non-native plant species among high school pupils. Although mean scores of attitudes (measured by only four items) and knowledge increased in the experimental group (learned by constructivist approach), pupils in the control group (learned by conventional approach) had higher pre-test and post-test score relatively to experimental group in both attitude and knowledge tests. These results suggesting positive effect of constructivism are therefore very unconvincing and questionable.

Previous research showed inconsistent evidences for gender differences in knowledge and preferences of plants. Some researchers found that females prefer plants more than males (Gatt et al. 2007; Hong, Shim, and Chang 1998; Lohr et al. 2004; Prokop, Prokop, and Tunnicliffe 2007; Prokop, Tuncer, and Chudá 2007; Schussler and Olzak 2008), but others found no gender differences (Lindemann-Matthies 2005; Fančovičová and Prokop 2010). Some studies found mixed results (Harvey 1989; Tunnicliffe 2001). Thus, gender differences in attitudes towards and knowledge of plants are not clear. Few studies investigated whether gardening influences attitudes towards plants (albeit not experimentally). Some evidences supported more positive attitudes towards cultivated plants in people who have or previously had a garden (Lohr and Pearson-Mims 2005; Fančovičová and Prokop 2010). Recent research of Passey, Morris, and Reed (2010) shows that school gardens have a positive influence on pupils' scientific knowledge and positive attitude to healthy food choices.

Purpose

The main aim of this paper is to investigate whether outdoor environmental programme influences Slovakian pupils' attitudes towards and knowledge of plants. The study refers to a local research project focused on cooperation between school children and conservationists. We first examined whether attitudes towards plants change after the programme. Given that the literature indicates that sustained contact with a given place best cultivates pupils' environmental knowledge and concern (Vaske and Kobrin 2001), we have chosen activities conducted in a school plot which allows simple replication of the experiment by teachers or researchers. Furthermore, we asked whether mean scores of males and females and scores of pupils who have and who do not have a garden are different. Finally, we asked whether improved knowledge and attitudes are associated with the popularity of biology as a school subject.

We predicted that (1) outdoor education programmes will positively influence pupils' attitudes towards plants; (2) outdoor education programmes will positively influence pupils' knowledge of plants; and (3) having a garden will be associated with more positive attitudes towards plants. Finally, applying evolutionary perspective showing that males were predominantly hunters and females were gatherers (Kaplan 1996), we predict that (4) females will gather more knowledge of; and (5) will have more positive attitudes towards plants than males.

Methods

Participants from one urban school participated in the study. All pupils were fifth graders (ages 10 and 11) and they were randomly divided into quasi-experimental ($N = 17$) and control group ($N = 17$). The selection of pupils who participated in the experiment was not based upon their interest towards biology, age or even grade from biology and experiences in field trips. Pupils in this grade were learning about organisms (animals, plants and fungi) inhabiting various ecosystems, namely meadows, agricultural fields, forests, water ecosystems, etc. Thus, outdoor activities described below were in direct connections with biology curriculum of fifth-grade pupils in Slovakia.

The primary school in Trnava was the only one from Trnava involved in a project called 'Trees'. Within the project, participants plant new trees in the school area every year in cooperation with experts. Experts communicate with pupils in this way.

The quasi-experimental group together with forest experts planted new stocks of trees (*Betula pendula* [*Ehrh.*], *Tilia cordata* [*Mill.*], *Picea pungens* [*Engels*]) in the area of the school in April 2009. Participants only from the quasi-experimental group listened to a talk on functions of forest economy and about amenity planting before planting and also during this activity. The time of these activities (gathering and listening) equated to three talks. Tree species used are native in Slovakia and all of them are commonly planted in urban parks or gardens. *T. cordata* is in addition the national tree of Slovakia. Wandersee and Schussler (2001a) used the term 'marquee plants' – that is plants that draw attention to themselves and capture imagination. They suggest that these plants attract the public attention, thus selection of all tree species in this study met Wandersee and Schussler's (2001a) criterion of 'marquee plants'. Moreover, these species represent both deciduous and coniferous trees which would make them more attractive to pupils.

The experiment was performed between April and October 2009 in the area of the experimental school. In May and June 2009, the quasi-experimental group implemented non-formal education of biology focused on botany with three engagements of 120 minutes (approximately six talks). We distinguished between informal and non-formal education following a definition of Eshach (2007):

> Non-formal learning occurs in a planned but highly adaptable manner in institutions, organizations, and situations beyond the spheres of formal or informal education. It shares the characteristic of being mediated with formal education, but the motivation for learning may be wholly intrinsic to the learner. (173)

In contrast, informal learning is defined by the same author as learning that 'applies to situations in life that come about spontaneously; for example, within the family circle, the neighborhood, and so on' (173). In our view, we agree with Eshach (2007) and define non-formal learning as guided learning, increasing and supporting learners' intrinsic motivation that is realized at least partly outside the school.

Participants were informed about this type of outdoor education programme. During the education, participants of experimental and control groups visited a meadow that was adjacent to the experimental school. Each group visited the meadow on a separate occasion. However, only experimental pupils were verbally instructed about the activities and tasks. In contrast, the control group was allowed to engage in sport activities that lasted a similar time to the activities of the experimental group. Instructors (one graduate student and two forest experts) provided interesting information about ecology and plants and observed organisms. Participants worked in groups of four or five based on their friendship and they solved the same tasks. All participants briefly noted their observations to their diaries. Discussions were held by instructors in the field about their observations at the end.

During the outdoor programme, pupils carried out the following activities: (1) determining the location of the particular ecosystem, (2) working with basic botanical methods, (3) gathering plants and identifying them by means of using the corresponding botanical keys, and (4) discussing the names and roles of plants in a particular ecosystem.

Measuring pupils' attitude and knowledge: the instrument

Pre-test, post-test and re-test procedures were applied to measure changes in pupils' knowledge of and attitudes towards plants as a result of the outdoor education programme. The questionnaire was not anonymous which allowed us to use data for further pair-wise comparisons. Data collection was based exclusively on quantitative data; even previous works demonstrated the validity of qualitative methods in examining children's knowledge of plants (Sanders 2007; Tull 1994). This was because repeated administration of questionnaires guarantees asking identical questions that are necessary for statistical methods based on repeated measures. Furthermore, interviewing 17 children (as an example of qualitative research design) in the quasi-experimental group and 17 children in the control group (each group for three times) would be time-consuming compared to conventional use of questionnaires. Finally, previous research examining effects of outdoor programme on students' attitudes and knowledge showed that data obtained by both qualitative and quantitative research techniques are complementary (Fernández-Manzanal, Barreiro, and Jimenez 1999), suggesting that quantitative methods are appropriate in this case.

The attitude questionnaire was comprised of a five-point Likert-type scale and called the Plant Attitude Questionnaire (PAQ). The questionnaire comprises 45 Likert-type items. Examples include: plants are very important for medicine; plants in towns are a problem because they cause allergies; I like visiting plant exhibitions. Full version of the questionnaire can be found in Fančovičová and Prokop (2010). Pupils responded to the items by choosing numbers from 1 (strongly disagree) to 5 (strongly agree). For each individual, we calculated a mean score of the questionnaire. The instrument's validity was established by three experts in the field of biology education. All were asked whether the items in each dimension were relevant to the goal of the questionnaire. Revisions were made according to their comments and suggestions. In our research, Cronbach's alpha (pooled data from both experimental and control groups) was determined as 0.87, 0.94 and 0.94 for the pre-test, post-test and retention tests, respectively. In psychology, tests with reliability > 0.7 are considered reliable (Nunnaly 1978). Thus, our research instrument showed acceptable reliability. Items in the questionnaire were created randomly. In statistical analyses, only means of the whole PAQ were used instead of means of each dimension separately, because our sample size was limited and did not allow us to use factor analysis for separating attitude dimensions (lowest sample size needed is $N = 200$; see Gorsuch 1983). Thus, we evaluated overall attitudes towards plants rather than changes within each dimension.

Knowledge of biology was measured by 13 items. The aim of this instrument was to examine pupils' knowledge about ecological relationships in the meadow ecosystem. For the purpose of testing factors affecting participants' attitudes towards and knowledge of plants, questionnaires contained demographic information such as age, gender, grade from biology and having a garden. All pupils were asked for their favourite school subject so as to ascertain the status of biology in comparison with other subjects. The test contained open-ended questions, assignment questions, multiple-choice questions, additive questions to complete a food web scheme and a question relating to drawing a meadow ecosystem. The aim of the questions was to find the level of knowledge about the meaning of plants in our life, pharmacological plants, poisonous plants, meadow plants. Examples of open-ended questions: What is the meaning of plants to humans and animals? What is the importance of plants for pharmacology? Do plants breathe? If 'Yes', when? Multiple-choice questions relate to the knowledge of herbs, choose plants which are herbs and abiotic factors, for example, 'Underline, what is *not* an abiotic factor of the environment: temperature, human activity, wind direction'. Participants were asked to draw all components of the meadow ecosystem. The four components of the drawings were scored: plants, animals, soil and sun. Each component received one point. Example of a child's drawing is shown in Appendix 1. Answers were scored differently, depending on the type of question. For example, for a multiple-choice question with only one correct answer, the maximum score was 1 and minimum score was 0. In general, maximum score per question was 6. Sum of scores of all questions per each participant was used for further statistical evaluation. Pupils were assured that questionnaires were not exam tests, just for researchers to know more about their knowledge of and attitudes towards plants. Overall, reliability of the pre-test, post-test and retention test was satisfactory (0.71, 0.80 and 0.81, respectively).

Pre-tests, post-tests and retention tests were applied to the experimental and control groups two days before and three days after and once more three months after realization of the outdoor programme, respectively. Control group did not participate in the programme, but instead participated in only conventional biology talks. However, participants of the control group were allowed to visit the experimental area with planted trees, but without any instructions from instructors.

Statistical analyses

Data were inspected for normality using the Shapiro–Wilk's test. All data were normally distributed (Shapiro–Wilk p's > 0.06), thus parametric tests were used. Only the distribution of final exam scores from biology significantly differed from normal (Shapiro–Wilk's $W = 0.83$, $p < 0.001$), thus the non-parametric Mann–Whithey U-test was used for comparison.

To test the effect of treatment, gender and having a garden (fixed factors) on pupils' knowledge of and attitudes towards plants (dependent variables), repeat measure multivariate analysis of covariance (MANCOVA) was used. Post-test and retention test knowledge or attitude score were defined as dependent variables and pre-test score was covariate. Both attitudes and knowledge were examined in separate MANCOVA tests. Data that were binomially distributed were calculated by Fisher's exact test.

One problem of this study is the small sample size. To make our statistical analyses more conservative, the power of statistical difference between experimental and control groups (or gender if the means were significantly different) was additionally analysed by calculating the effect size measure (Cohen's d) for groups (Cohen 1988), because it is independent of sample size. The measure is calculated as the difference between two means, divided by the standard deviation of either group. Cohen (1988) offered the following guidelines for interpreting effect sizes: $d = 0.20$ (small effect),

d = 0.50 (medium effect), and d = 0.80 (large effect). In commonsense terms, a d of 0.20 may be statistically significant but the difference is not apparent to the casual observer; a d of 0.50 is noticeable to the average person; and a d of 0.80 or higher is quite obvious (Lippa 2002).

Results

Differences between experimental and control groups

Final exam scores were similar when comparing the experimental and control groups (Mann–Whitney U-test, $U = 98.5$, $p = 0.12$). Only 24% of participants in the control group and 24% of participants in the experimental group reported having experiences with education in the field. This proportion remained the same in the control group, but increased to 100% in the experimental group after the treatment. This suggests that participants understood well the formulation of questions by researchers in tests. Initially, identical number of participants in both groups (71%) showed a desire to learn biology in nature. However, the proportion of participants in the experimental group in post-test and retention test (88% and 82%, respectively) rapidly increased, but remained significantly lower in control group (47% and 41%, respectively). These differences were statistically significant (Fisher's exact test for post-test and retention test, both $p = 0.03$).

Effect of field-based programme on participants' attitudes towards plants

Treatment showed strongly significant effect on attitudes of participants (MANCOVA, $F(1,25) = 53.53$, $p < 0.001$) and explained 68% of the variance of results. Gender and having a garden did not influence results significantly ($F(1,25) = 3.09$ and 2.63, p's > 0.095). The effect of covariate was marginally significant ($F(1,25) = 4.42$, $p = 0.046$) which suggests that the experimental group scored little better than the control group prior to starting the experiment. However, because this score was used as a covariate, results presented here are 'cleaned' from this confounding effect (Isaac and Michael 1972).

Cohen's d-values for the differences between experimental and control groups corroborate previous findings. To summarize, values obtained from calculating differences between experimental and control groups in pre-test, post-test and retention tests were d = 0.64, 2.41 and 2.56, respectively. This means that differences in mean scores favouring experimental group were moderate in the pre-test and very strong in the post-test and retention test.

Interactions between variables (treatment × type of test) revealed that the mean attitude score continuously increased between three tests in the experimental group, but not in the control group ($F(1,25) = 11.04$, $p < 0.01$, Table 1). Overall, mean attitude score reveals that participants in the control group had neither negative, nor extremely positive attitudes towards plants. The effect of treatment significantly improved participants' attitudes towards plants.

Biology was cited as the most favourable school subject by less than 30% of all participants in the pre-test with no differences between control and experimental groups (Fisher's exact test, $p = 0.68$). However, the proportion of participants who reported biology as their most favourable subject strongly increased in the experimental group, but not among control participants (post-test and retention test, 59% vs. 6% and 76% vs. 18%, respectively; Fisher's exact tests, both $p < 0.01$).

Table 1. Differences in attitudes towards and knowledge of plants between quasi-experimental (N = 17) and control groups (N = 17).

		Experimental group			Control group		
		Pre-test	Post-test	Retention test	Pre-test	Post-test	Retention test
Attitudes	Mean	3.59	4.09	4.20	3.29	3.17	3.29
	SE	0.10	0.08	0.06	0.12	0.11	0.11
Knowledge	Mean	23.29	38.82	35.00	25.29	22.23	19.06
	SE	1.66	0.81	0.82	1.63	1.56	1.53

Effect of field-based programme on participants' knowledge of plants

It was found that the effect of treatment showed the strongest effect on dependent variables, explaining 75% of the variance of results (MANCOVA, $F(1,25) = 75.75$, $p < 0.001$, Table 1). As in the case of attitudes, experimental group had significantly higher retention and post-test scores than control group. The effect of covariate was non-significant ($F(1,25) = 1.19$, $p = 0.29$), meaning that these two groups had similar knowledge of plants before starting the experiment.

Cohen's d-values for the differences between experimental and control groups in pre-test, post-test and retention tests were d = 0.30, 3.24 and 3.14, respectively. This means that differences in mean scores favouring the experimental group were moderate in pre-test and very strong in post-test and retention test.

Having a garden did not influence results, but the effect of gender (explaining 20% of the variance of results) was significant ($F(1,25) = 0.92$ and 6.26, $p = 0.35$ and 0.02, respectively). Females showed better knowledge of plants than males (Figure 1) consistently in all three types of tests. Interactions between variables (gender × type of test) were not significant which suggests that females scored better than males in both groups.

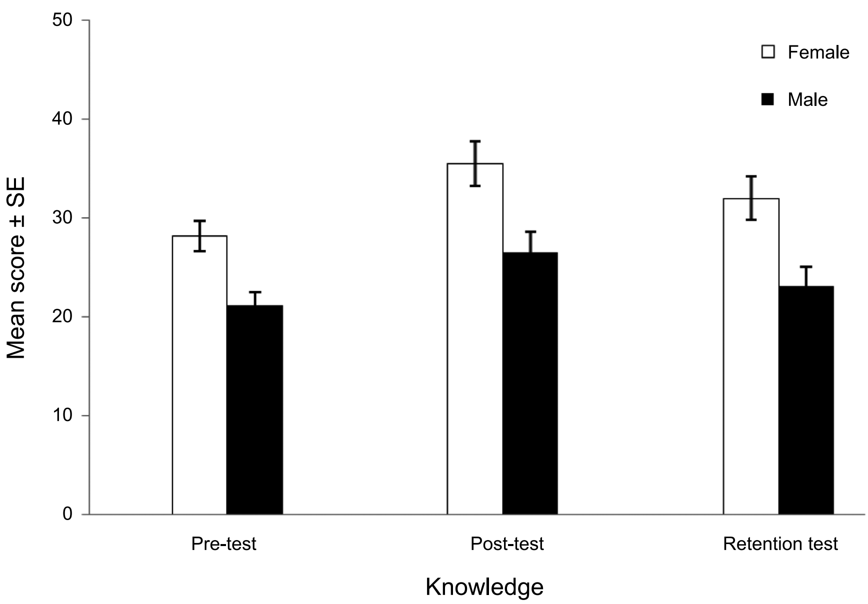

Figure 1. Gender differences in knowledge of plants.

Summarizing Cohen's *d*-values for gender differences, we corroborate previous finding that females scored better than males. Effect sizes for pre-test, post-test and retention tests were large for experimental group (range of *d*-values is 0.99–3.57) and moderate or large for the control group (range of *d*-values is 0.66–0.95).

Discussion

This study quasi-experimentally examined the effect of an outdoor education programme on participants' attitudes towards and knowledge of plants. As far as we are aware, this is the first study which evaluated an outdoor programme focused solely on practical work with plants with the incorporation of a delayed follow-up measures. Moreover, we assessed specifically attitudes towards plants, an area of the research that has rarely been systematically investigated previously (Fančovičová and Prokop 2010; Harvey 1989). Although results presented here clearly favour the positive effect of non-formal learning on pupils' attitudes towards and knowledge of plants, some caution must be made when interpreting these data due to the small sample sizes. Five hypotheses were explicitly tested:

(1) *Outdoor education programmes will positively influence pupils' attitudes towards plants*. In general, we found support for this hypothesis supporting and extending previous research in this field (e.g., Hamilton-Ekeke 2007; Prokop, Tuncer, and Kvasničák 2007; Rickinson et al. 2004; Stern, Powell, and Ardoin 2008; Žoldošová and Prokop 2006). Thus, we suggest that outdoor programmes can be successful not only when involving animals that are more attractive to pupils (Kinchin 1999; Martín-López, Montes, and Benayas 2007; Schussler and Olzak 2008; Wandersee 1986).

Until now, it was unclear whether outdoor programmes influence attitudes towards plants specifically. This lack of evidence emerged both because attitudes towards plants were not examined by conventional psychometric evaluations (Fančovičová and Prokop 2010) and because work with plants was explicitly involved in broader outdoor programmes (e.g., Fernández-Manzanal, Barreiro, and Jimenez 1999; Žoldošová and Prokop 2006), where the final outcome for participants in post-tests could be easily influenced by pupils' fascination with work with animals. The present study was not combined with practical work with animals, and the attitude measurement instrument was solely focused on plants. The research instrument used here has been previously psychometrically evaluated (Fančovičová and Prokop 2010) and is based on multiple items. Thus, this study shows clear and beneficial effects of outdoor programme on attitudes towards plants. It is probable that improved attitudes towards plants would contribute to willingness to pay for conservation of plants that are depreciated by people (Martín-López, Montes, and Benayas 2007) and/or it would enhance more pro-environmental decisions regarding plants in future. Further research in this area is required.

Furthermore, one important benefit that this study brings is that successful outdoor programmes need not be conducted in field areas far outside the school (which may have time and financial costs for teachers and learners), but planting trees within the school area in collaboration with forest experts, or some conservationists may have significant impact on pupils' understanding of the role of plants in nature as well as building positive attitudes towards them (Fančovičová and Prokop 2010). Moreover, our results provide the first experimental evidence showing that planting trees in schools meaningfully improves pupils' views of plants.

Notably, the effect of outdoor programmes was not restricted only to attitudes towards plants. The experimental group showed significantly higher appreciation of biology as a school subject and a higher desire to learn biology in non-formal settings (i.e., in the field). This suggests that outdoor settings focused on practical work with plants have an overall positive impact on participants' appreciation of biology. These results should be interpreted with caution due to limited sample size. However, these results support earlier work of Prokop, Tuncer, and Kvasničák (2007) who showed that the short-term effect of outdoor ecology programmes positively influenced participants' interest in biology as a school subject. However, their study did not measure pervasiveness of improved attitudes, because retention test was not administered. Thus, the present study significantly extends our understanding of the association between preferences of biology and outdoor programmes. To conclude, outdoor education seems to be a powerful instrument that improves pupils' attitudes towards biology.

(2) *Outdoor education programmes will positively influence pupils' knowledge of plants*. As predicted, outdoor educational programmes significantly improved pupils' knowledge of plants. This is very important considering the key role of plants in the ecosystems (Grime 1998) as well as the poor current knowledge of plants among school pupils (Bebbington 2005; Fančovičová and Prokop 2011). According to Tunnicliffe and Reiss (2000), 'school has a disappointingly low place in children's recollected learning about plants' (176). Our study shows one of the promising ways that children's knowledge of plants can be improved – with outdoor learning.

(3) *Having a garden should be associated with more positive attitudes towards plants* (Fančovičová and Prokop 2010; Lohr and Pearson-Mims 2005; Passey, Morris, and Reed 2010). This hypothesis was not supported, because gardening did not have significant effect on pupils' attitudes towards plants. Similarly, we found no effect of having a garden on knowledge of plants. There are at least two explanations for this phenomenon. Firstly, our study is based on a limited sample size in which differences between pupils with and without gardens are hardly detectable. In fact, previous research which detected the effect of gardening on attitudes was based on $N = 2004$ (Lohr and Pearson-Mims 2005) and $N = 310$ participants (Fančovičová and Prokop 2010). Second, it is questionable how much having a garden itself influences pupils' views of plants. Moreover, it is also unclear whether gardening influences attitudes towards wild plants or garden plants. Future research should take *active* gardening of pupils and its frequency into account and questionnaires should include items referring to both garden and wild plants (Passey, Morris, and Reed 2010).

Applying evolutionary perspective showing that males were predominantly hunters and females were gatherers (Kaplan 1996), we predicted that females (4) *will gather more knowledge of* and (5) *will have more positive attitudes towards plants than males*. The former hypothesis was supported, but the latter hypothesis was not supported. Females had a better knowledge of plants in all tests (pre-test, post-test, retention test) supporting an idea that females prefer to learn botany in comparison to males (Hong, Shim, and Chang 1998; Prokop, Prokop, and Tunnicliffe 2007; Prokop, Tuncer, and Chudá 2007). From an evolutionary perspective, females should be more attracted to plants due to the fact females were predominantly gatherers (Kaplan 1996) and bright colouring (fruits) signalled food sources for them (Harvey 1989; Heerwagen and Orians 1993). On the other hand, attitudes towards plants were not different between males and females supporting our previous research (Fančovičová and Prokop 2010). Our failure to find support for Hypothesis 5 would be explained such that items used in the PAQ measure various dimensions, not specifically planting, picking berries or other activities associated with survival of our ancestors. Our data therefore support the idea that a pupil's view of plants is not exclusively a domain of females (Fančovičová and Prokop 2010; Harvey 1989; Lindemann-Matthies 2005).

Limitations of the study

One could argue that the limited sample size in our research does not allow for generalization of presented findings. We acknowledge that higher sample sizes from more diverse samples would make the findings stronger. However, changes caused by the outdoor education programme do not seem to be short-lived. Instead, increased attitudes and knowledge scores measured by retention tests indicate that changes caused by the treatment remained to be detectable at least three months after realization of the outdoor programme. Effect sizes calculations (Cohen's *d*) that are independent of sample sizes, but are based on means and standard deviations, fully supported all results obtained by multivariate statistics. Further research is, however, necessary to allow generalization of these preliminary results. Researches involving children from broader age groups, larger sample sizes and replications within various countries are required. At present, our conclusions are restricted to Slovakian fifth graders (ages 10 and 11).

Conclusion

This is the study showing that an outdoor programme focused exclusively on plants had significant impact on participants' attitudes towards and knowledge of plants. Outdoor programmes can therefore play a promising role in improving 'plant blindness' (Wandersee and Schussler 1999, 2001b) and building more positive attitudes towards biology in general. Further research on what children know about plant specimens, their habitat, the role of plants in our lives and their aesthetic value is required. Motivating learners to physically maintain plants, especially planting trees, naming plants and their identification by keys, are believed to improve the understanding of the importance of plants in nature. All these activities can be done directly in school areas, thus no serious expenses (in terms of time or money) are expected. The use of non-lecture techniques and to rely on cooperative, collaborative and experiential learning seems to be promising for building positive attitudes of learners towards the environment (Gruenewald 2003). Teachers are therefore encouraged to utilize school gardens and garden plants for practical work with children. Greater attention on the use of plants in biology might also be beneficial for beautifying biology laboratories or classrooms in general. Direct experiences with plants probably heighten pupils' sensitivity to plants which is an important factor in building pro-environmental behaviour. Outdoor programmes can therefore be considered as good supplements to conventional biology settings that build more positive attitudes and better knowledge of living organisms.

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Notes on contributors

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Appendix 1. Example of drawing of a girl (age 10) of a meadow ecosystem. The presence of soil, plants, an animal and sun received together 4 points (maximum).