Journal of Science Education and Technology, Vol. 16, No. 3, June 2007 (© 2007)
DOI: 10.1007/s10956-007-9044-8

Short-Term Effects of Field Programme on Students' Knowledge and Attitude Toward Biology: a Slovak Experience

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Field trips are ideal for increasing students' experience and perceptions of various organisms and their relationship between the original habitat. However, in general field trips are greatly neglected by teachers and their short-term effects are thought to be questionable. Therefore, we conducted a one-day field trip for both improving students' knowledge in ecology and for examining short-term effects. Based on the results of the research conducted 3 days after the trip, we found a significant and positive increase in students' attitudes toward biology, natural environment outside and future career in biology. Moreover, students displayed a better understanding of ecology concepts like ecosystems and food webs. However, no similar pattern was observed for the control group experienced only traditional biology settings. Thus, this study is unique showing significant short-term effects of a field trip on students' attitude and knowledge toward biology.

KEY WORDS: attitudes; ecology; field trip

INTRODUCTION

Current curricula of various countries are endorsed to engage students in biology/science to use inquiry-based approach. This approach supports students' natural interest in science; students are engaged to make their own questions, test hypotheses and gather and present information from various sources. In contrast, traditional learning involves memorization of facts, which often results in students' negative attitudes toward science (Selim and Shrigley, 1983; Shrigley, 1990).

Except practical works (Gott and Dugan, 1996) that are less frequent than traditional settings, several restrictions in traditional learning could be recognised. First, the time limitation does not facilitate obtaining data and their analyses. Second, biology curricula, at least in Slovakia, indirectly favour memorization facts. Third, classrooms (for biology settings) do not provide a natural environment for obtaining data. Thus, students' logical understanding and curiosity cannot be supported and they cannot get opportunities to deal with nature. In contrast, constructivist theory frames learning as an active, continuous process whereby students construct meaning based on prior ideas and experiences (Driver and Bell, 1986) through physically and mentally acting on objects. There are several studies, which reported the significance and effectiveness of the theory on students' learning of environmental subjects (Ballantyne and Packer, 1996; DiEnno and Hilton, 2005). Accordingly, constructivist theory models have been used to improve students' motivation toward science. Haunsel and Hill (1989) and Soyibo and Hudson (2000), for example found out that students using computers had more positive attitude towards biology and natural sciences than students who were educated by traditional style.

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Similarly, Predavec (2001) showed that students experienced with virtual dissection of rat, benefited in greater knowledge relative to control group which experienced normal dissection. However, rapid growth of virtual environments at the expense of practical works in biology has been recently criticised (Partridge, 2003; Tranter, 2004), because computers do not supplement natural environment for science. Accordingly, several studies have shown that educational benefits are higher when virtual environment is combined with first hands-on experiences (Akpan and Andre, 1999; Franklin *et al.*, 2002; Spicer and Stradford, 2001).

Another way to improve student' attitudes and interest toward science is non-formal learning carried out through science centres (Eshach, 2007). The importance of informal learning of science has been increased rapidly in modern societies (reviewed by Salmi, 2003). Major aims of informal learning in science centres are creation of positive attitudes toward science, encouraging students to learn science and maximizing opportunities in society for scientific applications (Dillon *et al.*, 2006; Salmi, 2003). Visitors acquire better understanding and/or first hands on experience with science, which should improve their knowledge and attitudes toward science. Several studies examined the effectiveness of informal science learning (reviewed by Dillon *et al.*, 2006; Rickinson *et al.*, 2004). Gibson and Chase (2002) found that longitudinal, 2-year impact of an inquiry-based science summer programme positively influenced middle school-students' attitudes toward science. An increased interest for science was detected for students who were experienced the summer science programme than students that did not. Knox *et al.* (2003) examined effects of relative short lasting (2–4 weeks) science summer programme in high school students; post-test scores of participants revealed that their knowledge and skills in science were significantly increased. Subsequent study of Markowitz (2004) confirmed that effects of summer science programmes had a long-term impact on students' attitude and interest in career in science. Salmi (2003) conducted four case studies which show that a short-term visits of a science centre increased knowledge about science, intrinsic motivation (especially in primary children) and affected science-related career choice of participants. There are also some earlier studies that reported positive impact of environmental programmes on students' knowledge and attitudes. However, Leeming *et al.* (1993) in their review of 34 environmental education studies published since 1974, stated that most of them have serious methodological or statistical errors and value of vast majority of them is questionable. For example, Lisowski and Disinger (1991) reported that 7 days lasting intensive course of marine ecology significantly influenced students' achievement in ecology. However, they did not use control group, so it is not clear whether changes in knowledge and attitudes toward environment are not caused by other factors. More recently, Žoldošová and Prokop (2006a) evaluated the effects of visits to a science centre on primary children's intrinsic motivation. Although their science programme had great success among children and their science teachers, the authors couldn't find a significant increase in children's natural curiosity (intrinsic motivation) in comparison with the control group. Thus, it can be assumed that extracurricular courses lasting about 14 days and more should have significant impact on students' attitudes and knowledge toward biology. Effects of shorter courses are, however, questionable (Dillon *et al.*, 2006).

Learning science in the field for more than 1 day may not be practical and/or beneficiary because of the various reasons such as time, season and economical concerns. Students cannot stay in a camp during school semester period but they may spend few hours in natural environment outside to perform several activities, which may be designed to support biology/science education and may provide interesting experiences and shifts from everyday school uniformity. The value of such activities, however, is poorly understood. Therefore, the present study was designed to examine the short-term effects of one-day field experience on the students' knowledge and attitudes toward biology.

Research Question

Our research question is; "*Are there any effects of short-term experiences in the field on student' attitudes and knowledge toward biology?*"

METHOD

Sample

Students from one urban and two rural schools participated in the study. All students were sixth graders (age 11/12) and they were randomly divided into experimental (one class from urban school 1 and one class from rural school 1, $N = 74$) and control group (one class from urban school 1 and one class from rural school 2, $N = 69$). The selection of students who participated in the experiment was not based upon their interest toward biology. About 2 months prior the field trip, each student was tested for their opinion on the favourite subject, interest in animals and plants and experiences in field trips. Dichotomous responses (yes/no) were then compared with chi-square test. No differences were found between the groups (Table I). In addition, students' last exam scores from biology were also compared, but *t*-test did not revealed any difference (experimental vs. control group, mean ± SD: 1.78 ± 0.1 versus 1.79 ± 0.1, $t = -0.09$, df = 141, $p = 0.93$). Thus, we considered both groups as similar with respect to their interest toward biology, field trips and success in biology. Results of the above mentioned initial tests were presented in the Table I. Values in the table represent number of students that agree with the corresponding statement, percentages are shown in parentheses. The *p*-values denote that, no differences were found between students' interest towards biology and field trips, prior to the field trip.

Procedure

The Field Trip

In May 2005, the experimental group (divided into two subgroups in order to maintain more effective teacher-student contact) conducted the trip. The trip lasted 1 day (approximately 10 h) and focused on ecology in the field. Students were informed about the field by means of a field education programme, similar to the one that was conducted in Modra–Harmónia by Trnava University (Žoldošová and Prokop, 2006ab). During the field trip, students of the experimental group visited three different ecosystems: freshwater, meadow and wood. In the wood periphery there was a glade with leafs on the ground. Here it is a need to call special attention to soil ecosystem, which was then scored separately in addition to the three ecosystems mentioned above.

All students were orally instructed in the day of field trip about activities and tasks. During the field trip, students carried out the following activities: (a) determining the location of the particular ecosystem, (b) working with basic zoological methods for capturing arthropods in each ecosystem (sweep netting, exposition of soil traps, substrate screening, tree scaling and plankton netting), (c) capturing animals and plants and identifying them by means of using the corresponding keys, (d) discussing the names and roles of captured animals in the food webs of the particular ecosystem. Instructors (Radoslav Kvasničák and Zuzana Pištová) provided several interesting information about ecology and life cycles of the observed organisms. All students briefly noted their observations to their diaries. Discussions were held exclusively by instructors in the field. Students were not explicitly instructed to work in groups or pairs, but they freely formed small subgroups probably based on their friendship. Students in these subgroups held discussions about what they observed or captured, at the end of the trip. Detailed information and examples of teaching activities in the Field Centre can be found in Žoldošová and Prokop (2006a).

Measuring Students' Attitude and Knowledge; the Instrument

Pre-test/post-test procedure was applied to measure changes in students' knowledge and attitudes toward biology as a result of the field trip. The attitude questionnaire was comprised of a five point Likert-type scale and called as the Biology Attitude Questionnaire (BAQ, Table II). The questionnaire was modified from the one used by Salta and Tzougraki (2004) for measuring attitudes toward chemistry. Although the original version of Salta and Tzougraki's questionnaire comprises 30 Likert-type items, a shorter version was used for the current study, since it was focused only to attitudes. The BAQ consisted of 12 items and was divided into three dimensions as; biology as school subject, natural

Table I. Initial Differences between Students

Group	Experimental	Control	Chi-square test	
Item	$N = 74$	$N = 69$	χ^2	p
Biology is my most favourite school subject	21 (28.4)	19 (27.5)	0.01	0.91
I am interested in wild animals and plants	50 (67.6)	48 (69.6)	0.07	0.79
I have experiences with field education	16 (21.6)	20 (29.0)	1.03	0.31
I would like to realise biology education in the field	66 (89.2)	59 (85.5)	0.44	0.51

Table II. The Biology Attitude Questionnaire (BAQ)

Dimension	Item
Biology as school subject	I like biology
	I would like to have biology more often
	Biology is not interesting in comparison with other subjects*
	I like activities with living organisms on biology
Future work in biology	I would like to be a biologist
	My biology teacher is my personal model, I would like to work like he
	I like watching natural history films; I would like therefore make a career in this in this field
	I am not planning to study biology*
	I thing that biology as a job is not interesting*
Natural environment outside	I like observing plants and animals in natural environment
	I am interested in scientific names of animals
	Biology knowledge is essential for understanding other courses and phenomenons

Items Marked with asterisk (*) were scored in reverse order.

environment outside and future work in biology. Students responded the items by choosing numbers from 1 (strongly disagree) to 5 (strongly agree).

The instruments' 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. Cronbach's alpha (pooled data from both experimental and control group) was determined as 0.74 for the pre-test and 0.77 for the post-test. Cronbach's alpha measures how well a set of items measures a single unidimensional latent construct. In psychology, tests with reliability >0.7 are considered reliable (Nunnaly, 1978). Thus, our research instrument showed acceptable reliability.

Knowledge of biology, on the other hand, was measured by two different ways. First, 16 items two-tier multiple-choice test was applied. The test was subdivided into four categories according to four ecosystems which students were experienced on. The aim of this instrument was to examine students' knowledge about ecological relationships in the four ecosystems and it was originally developed by Radoslav Kvasničák in March 2005. The instrument then reviewed by three experts in biology education in order to maintain instruments' validity. Reliability of the two-tier test was alpha = 0.78 which indicate appropriate reliability of the test. Some examples of items are provided below. Correct answers are marked with "+".

1. Ecological relationships in *water ecosystem*

Water ecosystems are influenced by:

(a) biotic and abiotic components of water environment +
(b) animals living in the water
(c) water animals and plants

The reason for my answer is that

(a) this is a typical coenosis of water animals and plants
(b) these animals and plants living only in the water
(c) there is an energy flow between components of water ecosystem +

2. Ecological relationships in soil ecosystem

The Violet ground beetle *Carabus auratus* is a typical litter-dwelling (epigaeic) beetle. This beetle can be classified in the food webs as

(a) producent
(b) consument +
(c) reducent

The reason for my answer is that

(a) these beetles comprise the largest compound of food webs
(b) the dietary habits of these beetles comprise decomposed leavings of animals and plants
(c) this beetle consumes other invertebrates +

Second method to test students' knowledge on biology was aimed to examine students' ideas about the ecosystems and realised by means of drawing with open ended questions focused on organisms living in a particular level of food web. The open-ended questions were focused on the names of common organisms in each ecosystem, methods of capturing of these organisms (e.g. sweep-netting) and basic characteristic of their biology. Several of the example items of this step can be presented like: What species of organisms you drew? What do you know about organism you drew? How these organisms can be captured from the field?

Students were assured that the questionnaire is not a test. For the drawing part, they were simply asked to draw their impression about each ecosystem (i.e. water, soil, meadow and forest). Below each drawing there was a scheme of food web and students were asked to complete the scheme with their knowledge about tropic relationships within each ecosystem.

Pre- and post-tests were applied to the experimental group 1 month before and 3 days after the field trip, respectively. The same procedure was applied to the control group. Students of this group did not attend the field trip and the course, but they only attended a traditional biology lecture. The questionnaire was not anonymous which allow us to use data for further pair-wise comparisons.

RESULTS

Attitudes Toward Biology

No differences had been detected between experimental and control groups for the pre-test, as a result of student's *t*-test. However, significant differences were found for experimental group in the post-test (Table III). As is shown in Table III, the mean score significantly increased for each dimension for the experimental group, but they remained unchanged for the control group. The *p*-values indicate that attitudes of students in experimental group, who participated in field trip significantly increased (*$p < 0.05$, **$p < 0.01$), whereas those of students from control group remained unaffected. It can be concluded by means of the mean values that, in general, students' attitude toward biology lessons and toward natural environment are positive, but attitudes toward future work in biology were rather neutral.

Multivariate analysis of covariance (MANCOVA) was used to examine other possible factors which could affect students' attitudes toward biology. Gender, school area (village versus city) and lecture were used as factors and pre-test scores were used as covariates and post-test scores were used as dependent variables for MANCOVA analysis. The univariate analysis of variance (ANCOVA) was used for the determination of initial differences between groups and for the correlation analysis between means (Isaac and Michael, 1972). Among other factors, defined above, only the field trip was considered as significant item of change in students' attitudes ($F_{(3,130)} = 4.57, p = 0.004$). Other variables remained insignificant. Results of this study, therefore indicate that only field trip, influenced the students' attitude toward biology, gender and school type were found to be insignificant.

Biology Knowledge

Biology knowledge of the students had been tested by two different methods; by means of applying a two-tier test and by a drawing test. Followings are the results of these applications.

Two-Tier Test

The mean scores and statistical differences between groups are given in Table IV. While differences in pre-test between experimental and control groups were not significant, a clear increase had been detected in the mean scores of the experimental group for the post-test. The *p*-values for experimental group indicated that only this group showed a significant increase as far as biology knowledge is concerned.

Table III. Change in the Students' Attitudes Toward Biology

		Lecture									
		Experimental ($N = 74$)					Control ($N = 69$)				
		Pre-test		Post-test			Pre-test		Post-test		
Dimension	Number of items	M	SD	M	SD	Paired *t*	M	SD	M	SD	Paired *t*
Biology as a school subject	4	14.46	0.37	15.52	0.31	−3.01**	14.45	0.37	14.26	0.34	0.37
Natural environment outside	3	10.58	0.29	11.14	0.30	−2.51*	10.52	0.29	10.16	0.27	0.85
Future work	5	13.61	0.48	14.93	0.96	−3.17**	13.23	0.46	13.1	0.45	1.51

*$p < 0.05$, **$p < 0.01$.

Table IV. Two-tier Test Results

	Experimental					Control				
	Pre-test		Post-test			Pre-test		Post-test		
Ecosystem	M	SD	M	SD	Paired *t*	M	SD	M	SD	Paired *t*
Water	3.31	0.21	5.81	0.21	8.98***	3.33	0.19	3.41	0.33	0.57
Soil	3.12	0.23	5.61	0.23	−8.75***	3.11	0.2	3.16	0.15	0.85
Meadow	3.39	0.21	6.01	0.23	−9.28***	3.36	0.54	3.4	0.23	0.47
Wood	3.03	0.23	5.92	0.23	−9.73***	3.1	0.19	3.12	0.34	0.73

***$p < 0.001$.

Detailed observation of Table IV shows that the mean score per each ecosystem within and between groups was similar. Students achieved about 3–4 points, out of 8 (50%), for each ecosystem. However, post-test scores of the experimental group were very much higher, suggesting that the field trip had a significant impact on students' biology knowledge. Pre-test/post-test differences were measured by paired *t*-test and significant differences were found between two groups. Moreover, multivariate analysis of covariance (MANCOVA) was applied on two-tier post-test score of both experimental and control group in order to examine the influence of other factors on the students' biology knowledge. Analysis was further controlled for the possible effect of pre-test scores (covariates) on the effects of field trips (Lisowski and Disinger, 1991). As a result, no effects other than the effect of field trip ($F_{(4,128)} = 30.1$, $p < 0.001$) were found. In other words neither gender nor school area influenced students' achievement in biology.

MANCOVA was used to examine the effect of other factors. A significant interaction has been found between lecture and school placement ($p = 0.041$). More specifically, wood ecosystem was better understood by the experimental group from the village compared to that of from the city (univariate $p = 0.004$). No similar patterns were found for the control group.

Drawings and Food Webs

The presence of basic abiotic (sun and soil) and biotic factors (animals and plants) in students' drawings was scored. An interesting pattern of the occurrence of biotic and abiotic factors was observed in students' drawings. Similar patterns were observed in the pre-test both for experimental and control groups, (Figures 1 and 2); sun and soil were drawn least frequently, plants more frequently and animals

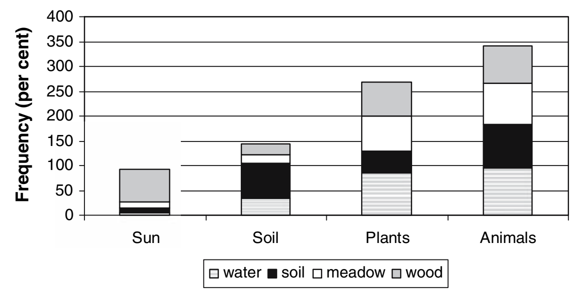

Fig. 1. The frequency of distribution of abiotic and biotic factors in students' drawings from the experimental group (pre-test).

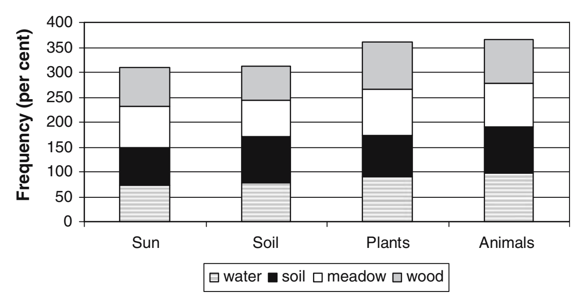

Fig. 2. The frequency of distribution of abiotic and biotic factors in students' drawings from the experimental group (post-test).

most frequently. However, students used abiotic factors (sun and soil, $\chi^2 = 290.1$ and 107.6, $p < 0.001$, respectively) more frequently, in addition to plants and animals ($\chi^2 = 48.3$ and 5.9, $p < 0.001$ and 0.05, respectively) in post-test drawings. Therefore, it can be concluded as a result of these observations that, students' understanding of ecological relationships has been increased, which is also confirmed by further comparisons.

While examining scores from food webs for reliability, Cronbach's alpha was high (0.93). As shown in Table V, means scores obtained from food web schemes were significantly increased after lecture for the experimental group. Although scores from the

Table V. Results of "Food Web Schemes" Test

	Experimental					Control				
	Pre-test		Post-test		Paired *t*	Pre-test		Post-test		Paired *t*
Ecosystem	M	SD	M	SD		M	SD	M	SD	
Water	9.04	0.5	15.55	0.44	−13.57***	9.04	0.52	10.28	0.54	−1.64
Soil	6.07	0.48	15.97	0.47	−16.17***	10.31	0.45	10.36	0.48	−0.07
Meadow	6.09	0.5	15.14	0.51	−14.66***	6.31	0.52	5.91	0.52	0.61
Wood	5.54	0.56	14.38	0.59	−12.88***	5.81	0.59	6.54	0.5	−1.02

*** $p < 0.001$.

pre-test reached only about 50% (maximal number of points per each ecosystem was 16), post-test scores was as high as 90%. Besides, no significant difference was observed between pre-test and post-test for the control group.

A result of MANCOVA, no effect of other variables (except field trip, $F_{(4,128)} = 27.3$, $p < 0.001$) was found as significant on students' attitude and knowledge toward biology. Thus, experimental group displayed significantly higher scores compared with control group, as far as food web schemes activity is considered.

DISCUSSION

It is found as a result of this study that, attitudes and knowledge of 6th grade students from Slovak schools toward biology were affected by one-day lasting field course, whilst gender and school area does not play an important role. Students' interest toward biology lessons and toward natural environment was initially positive, but after the field course they became more conscious about the items in the natural environment. Their ecology knowledge significantly increased after experiencing the field trip. Analysis of drawings of ecosystems showed that students consider the role of abiotic factors less essential; however, their understanding rapidly increased after their experience in various ecosystems. As far as their drawings are concerned for example, although they do not prefer to draw sun and soil before the trip, they used them more frequently in their drawings afterwards; showing an increase in their understanding about ecological relationships. As far as students' answers to the multiple choice questions were considered, on the other hand, the percent of right answers were increased two fold. However, students' interest in future career in biology was low; short-term effect of the informal learning in the field improved their attitudes from negative to neutral.

In comparison with other studies related to field trips and their effects on students' knowledge and attitude toward environment (Armstrong and Impara, 1991; Fernández-Manzanal *et al.*, 1999; Hart, 1978; Kinsey and Wheatley, 1984; Lisowski and Disinger, 1991; Orion and Hofstein, 1991, 1994; Yount and Horton, 1992), the results of the current study are similar with Orion and Hofstein's study, that displayed the shortest known impact of a field trip on students' biology knowledge and attitude with a very high level of significance. Moreover, Fernández-Manzanal *et al.* (1999) conducted a similar study and they worked on the freshwater ecosystem only. Combining qualitative and quantitative methods, they found significant impact of field trip and additional ecology activities after experiment lasted approximately 4 weeks. The reason for Žoldošová and Prokop (2006a), on the other hand, for failing to find a significant effect of approximately 5 day field trips on the children's curiosity, on the other hand, was probably the use of an unsuitable research instrument or an unsuitable evaluation method. Because evaluation of results of the same sample with different methods resulted with an increased interest of students toward science (Žoldošová and Prokop, 2006b). School placement (urban versus rural) was found as to have a significant effect on the primary school students' attitude toward forests in the USA (Strommen, 1995). Whereas, our results showed that the effect of school placement on the Slovak students' biology knowledge and attitude is weak. There may be two major reasons for this result: first, there exists no big difference between schools in Trnava (city) and the rural schools, since Trnava is small city with about 100,000 inhabitants. Thus, children in this region can spend similar amount of time in the natural environment regardless of where they live. Second, greatest formation of ideas about biology is expected until age 10 (Carey, 1985). So, primary children participated Strommen's study were probably more influenced by visiting woods in comparison with older participants of the current study. In general, field trips focus mainly on concrete interaction between the students and the environment. First hand experiences in various ecosystems greatly contribute to deeper understanding and perceptions of relationships between animals, plants and their environment and bring new experiences with various organisms in their natural habitats. Experiences and knowledge affect attitudes and their influence behaviour. So, field trips are effective way how to increase students' views of biology as school subject and, more importantly, their awareness toward nature protection. Although our study does not include the examination of the persistence of the positive attitudes gained by the students, results of similar studies (Lisowski and Disinger, 1991; Markowitz, 2004) show that, positive attitudes will last in the cases that such activities are continued. Because knowledge and attitudes influence pro-environmental behaviour (Grodzinska-Jurczak *et al.*, 2006) together and contribute to the environmental literacy of citizens (Roth, 1992), it can be assumed that field trips are affective dimension of biology education that shouldn't be neglected (Alsop and Watts, 2003; Eshach, 2007).

As a conclusion of all, the results of this study encourage us to consider field trips as an indivisible part of biology/science education. And we hope that science teachers, curriculum developers and researchers are also encouraged by the results of this work, to consider field trips as a part of science education.

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