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EARLY SCIENCE OUTDOORS: LEARNING ABOUT TREES IN THE PRESCHOOL PERIOD

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Abstract

The natural environment is known to be a perfect place for learning early science and there is a lot of literature describing activities for children in the forest. Yet there is a lack of concrete data illustrating how much children can actually learn through such activities. The aim of the research was to establish children's progress in their knowledge about trees and in process skills they gained through structured activities and free play in the forest. A quasi-experiment with one control and one experimental group was carried out, each comprising 16 children aged 5–6 years. The state of the children's previous knowledge and observational skills regarding trees was established through individual interviews. The children were given three tasks: naming a leaf (10 leaves); connecting a fruit or cone (8 fruits) to the corresponding leaf; and choosing the leaf they recognise as the same as each of the 10 given test leaves among a total of 17 leaves (this activity sought to investigate the progress in the children's observational skills). Children from the experimental group then continued with the activities in the forest. Following those activities, the knowledge and skills they had acquired were established via repeated interviews in both groups. The results show that at the beginning of the experiment the children's prior knowledge of trees was poor. After the activities were performed, children in the experimental group showed a statistically significant improvement in their results for naming the leaves and connecting the fruits or cones to the corresponding leaf. Progress in observational skills through the task of choosing a pair of leaves from among many could not be identified since the result had also significantly improved in the control group. Familiarity with the task may well have had a stronger influence on the results than the forest activities themselves. The result of the research allows the conclusion that appropriate forest activities enable children to progress in the field of early science, and it is therefore suggested that outdoor activities form an essential part of preschool education.
Key words: *children, early science education, observational skills, outdoor play and learning, trees.*

Introduction

The natural environment is known as a perfect place for acquiring early experiences in science. The literature contains many examples of outdoor activities where preschool children learn about trees (Griffin, 1992; Airey & Jereb, 1994; Mollo, 1994; Argast & MacDonald, 1995; Stivers, 2002; Sterling, 2006; Ashbrook, 2014). Yet, specific data about how much children can actually learn in this way are lacking. Therefore, based on an example of learning about trees

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the present research aimed to demonstrate concretely the preschool children's progress in both the knowledge and process skills they acquired through their activities in the forest.

It is vital that children spend time in the natural environment. Numerous advantages of regularly spending time in nature have been established for them. The results of many studies indicate that children's frequent interactions with nature improve their physical health (Fjørtoft, 2001, 2004), enhance the development of their motor abilities (Fjørtoft, 2001), improve their concentration (Mårtensson et al., 2009) as well as reduce aggressiveness and confrontations (Ouvry, 2003; Wilson, 1995). The natural environment offers children an incredible wealth of sensory experiences with natural materials and objects. It encourages children's holistic development (Wilson, 2008; Maynard & Waters, 2007). Nature's variety and unpredictability allow children self-initiated research that facilitates knowledge, skill and concept acquisition (Fjørtoft, 2001).

Frequent positive interactions with the natural world can help children develop respect and care for the natural environment, with the outcome that playing in the natural environment provides a basis for effective environmental education during early childhood. Children should be given experiences with nature during the first years of their lives, otherwise such attitudes might never develop (Kahn & Kellert, 2002; Wilson, 2008; Torkar, 2014). Beside the emotional component, attitudes have a cognitive component (Verplanken & Hoftsee, 1998) and the development of positive attitudes to nature can be encouraged if children learn significant concepts about it (Hadzigeorgiou et al., 2011).

Forests offer space for very diverse activities with different degrees of adult involvement: from free, child-led play that holds a high pedagogical value due to the children's initiative and enhanced creativity (Maynard & Waters, 2007) through more or less structured activities, designed and guided by adults. The principles of developmentally appropriate practice provide the basis for designing learning activities for teaching young children (Bredekamp & Copple, 1997). Since play is one of the most efficient ways of learning in early childhood (Bilton, 2002), even structured activities attract greater interest if they are designed so that new knowledge and skills are achieved through play. In the preschool period, children primarily acquire knowledge through direct experience (Bredekamp & Copple, 1997). Based on these experiences, they construct their own concepts through interaction with the physical and social environment surrounding them (Labinowicz, 2010; Fosnot, 1996).

Learning about trees was the objective of the investigated forest activities. Young children see and think about plants differently from adults. Some young children do not consider trees to be plants or have a misconception that a tree was a plant, when it was young and small (Bell, 1981). Other children even struggle with the concept of plants being alive (Gatt et al., 2007). It is common knowledge that children are less attracted to plants than animals (Wandersee, 1986; Schussler & Ozak, 2008). In many adults, 'plant blindness' can be detected. Wandersee and Schussler (2001) defined this term as "the inability to see or notice the plants in one's own environment, leading to the inability to recognise the importance of plants in the biosphere and human affairs". Plant blindness also comprises an "inability to appreciate the aesthetic and unique biological features of the life forms belonging to the Plant Kingdom" and "the misguided, anthropocentric ranking of plants as inferior to animals, leading to the erroneous conclusion that they are unworthy of human consideration" (Wandersee & Schussler, p. 3). Nevertheless, plants still readily engage children's interest (Tunnicliffe & Reiss, 2000).

The research questions of the study presented in this paper were to determine:

- how much knowledge about forest trees 5- to 6-year-old children can gain through activities in nature; and
- what is the progress that such children make in their skills of observing tree parts through activities performed in the forest.

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The following hypotheses were formulated:

- Through developmentally appropriate activities in the forest, 5- to 6-year-old children can significantly improve their knowledge about trees.
- The activities performed in the forest with 5- to 6-year-old children result in progress in their observational skills.

Methodology of Research

Research Approach

A quasi-experiment with a control and an experimental group was conducted. Before the activities commenced, individual interviews of members of both groups about forest trees were performed to explore the children's prior knowledge and process skills. The experimental group then carried out activities in the forest. Following those activities, the interviews were repeated in both groups.

Sample of the Research

The control and experimental groups comprised a total of 32 children: 16 children (7 boys and 9 girls) in the control group, and 16 children in the experimental group (5 boys and 11 girls). The children were 5 and 6 years old and all were attending preschool. The sample size and structure was limited by the number of consents given by parents for participation in the research.

Ethics

For this study, the parents' and teachers' consent had to be obtained to carry out the experiment. Prior to the study, the researchers explained the purpose of the research and invited the children to participate in the study. The children could opt not to participate. The research was conducted in a kindergarten, namely on premises well known to the participants.

Conducting the Experiment

In order to establish the children's initial knowledge about forest trees, the children in both groups (experimental and control) were individually interviewed. In selecting the tree species used for the research, it was taken into consideration that all of these trees grow in the forest close to the kindergarten where the activities in the experimental group were subsequently performed, so they could be included in the first-hand activities. The children were given three tasks involving specific examples of natural materials: (1) naming the tree to which each of the 10 test leaves belong; (2) connecting each of eight given tree fruits or cones with the corresponding leaf; and (3) choosing the leaf they recognise as the same as each of the 10 given test leaves among a total of 17 different leaves. The names of the relevant trees are given in Table 1.

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Table 1. Tree species used in the research (the ten trees used as test plants in the leaf matching task are marked in bold and the eight trees used in the task of connecting a leaf with a fruit or cone are marked with *).

Latin name	English name
Picea abies	Common spruce *
Abies alba	European silver fir
Pinus sylvestris	Scots pine *
Larix decidua	European larch
Fagus sylvatica	European beech *
Carpinus betulus	European hornbeam
Betula pendula	Silver birch
Tilia platyphyllos	Large-leaved lime *
Corylus avellana	Common hazel
Populus alba	Silver-leaf poplar
Prunus padus	Bird cherry
Acer pseudoplatanus	Sycamore *
Quercus robur	Common oak *
Castanea sativa	Spanish chestnut *
Aesculus hippocastanum	Common horse-chestnut *
Robinia pseudacacia	Black locust
Sorbus aucuparia	European mountainash

The children were interviewed individually. The testing was carried out in a quiet environment (a story-telling room). At the beginning, the children were given oral instructions on the procedure and whether they understood the instructions was checked. The tree parts were displayed on a small table, arranged in random order. Each leaf or fruit or cone was clearly visible. The instructions were repeated during the testing if necessary. The researcher contemporarily recorded the results of the test.

In the third task (choosing a leaf they recognise as the same as each of the 10 given test leaves among a total of 17 different leaves), a child was asked to observe all of the leaves and then pick the test leaf up and hold it in their hands. They were then asked to carefully observe the other leaves on the table. During this activity the child was free to move around the table. The purpose of this task was to carefully observe the other leaves and compare them with the one held in their hands, and to choose the leaf they recognised as being the same as the one they were holding, and place the test leaf beside the chosen leaf on the table. This activity was not limited by time. The task then continued with another test leaf from the list, meaning that in total each child had to compare ten test leaves. Before starting, the researcher demonstrated the test using an example of a leaf which was not part of the test.

Children from the experimental group then proceeded with activities in the forest which is a place the children visit regularly and is within walking distance from the kindergarten. The activities were planned to comprise seven visits to the forest over a 5-week period. Table 2 presents the activities that were carried out. During all activities, the children were encouraged to carefully examine the parts of the trees which they were handling. The researcher observed the children during these activities and noted down their reactions.

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Table 2. Description of the preschool children's forest activities.

Activity	Description of the activity with natural objects – parts of trees: leaves, twigs, fruits, cones, pieces of bark
Matching pairs	Children have their cards ready on which pieces of double-sided adhesive tape are placed. Some parts already have leaves, fruits, twigs or pieces of bark fixed onto them. Children are asked to look for the object that is as similar as possible to the taped one and, using the spare piece of adhesive tape, fix it next to that object.
Doubling	The teacher prepares five objects and covers them with a piece of cloth. He/She gathers the children, uncovers the objects for half a minute and recovers them. Children try to memorise them and then find as many and as similar objects as possible, with each child making a pile of them beside the covered objects. The teacher uncovers the objects again, the children compare their piles of collected material with the uncovered objects.
Making colourful crowns, 'magic carpets' and 'gnome homes'	Children gather leaves that vary as much as possible in colour, shape and size. They fix them with paper clips onto a cardboard band and make crowns and plumes. On the forest floor they make 'carpets' by completely covering part of the forest floor surface with objects making patterns and sequences. They make 'fairy houses' and 'gnome homes' from twigs, leaves, fruits, cones and bark.
Meeting a tree	The teacher blindfolds a child and leads her/him from the starting point to a tree, whose branches and leaves hang low enough for them to reach. The child is encouraged to get to know the tree by using their other senses. Then they are brought back to the starting point, their blindfold is removed and, by using their sight, the children should find the tree they encountered, and then with their touch and smell check from up close if it is the right tree.
Colour palette	Children are given colour palettes with a range of different colours on which some double-sided adhesive tape is fixed. Children gather different tree leaves and classify them by colour.
Finding similarities and differences	Each child is given two similar leaves or cones. She/He carefully observes the details, listing the two objects' similarities and differences.
Classification of leaves	Children classify leaves according to different criteria. A set of criteria is given by one group of children, while other children have to find out what classification criterion they had in mind.
Gross motor game: "Go for the right tree!"	The children are shown a leaf from a nearby tree. They are instructed to find the tree the leaf belongs to and to explain in which way one can find and reach this tree (by walking, jumping, crawling, rolling...). Moving in the same way, the children then return to the teacher with a leaf from that tree in their hands.
Free play	Child-initiated play with as little teacher interference as possible

After the experiment, the children's knowledge and skills were re-examined by again holding individual interviews in both groups. We compared the results with those of the previous set of interviews and were able to draw conclusions on progress they had made in their knowledge and process skills.

Data Analysis

The success of completing a task was measured by scoring. Children received one point for each correct answer. A maximum of 10 points (for naming tree leaves or matching the correct leaf) or 8 points (for matching the leaf to the corresponding fruit or cone) could be achieved.

After verifying that the data were free from errors, matrix analyses were conducted. Given the research questions and hypotheses, mainly descriptive (absolute and relative frequency,

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mean, standard deviation) procedures and statistical tests (one-way analysis of covariance (ANCOVA)) were applied. The covariate in ANCOVA were the test results before the experiment. Partial eta-squared was calculated as a measure of effect size (Coolican, 2014).

Results of Research

Naming the Tree Leaves

Before the experiment, the children's knowledge about naming tree leaves was poor in both groups (total test score for the control group: *M=0.63, SD=0.81;* for the experimental group: *M=0.44, SD=0.63*; the difference was not significant: *F=0.54, p>0.05).*

The results of naming tree leaves after the experiment are shown in Table 3 and Figure 1. Following the experiment, the test results in the experimental group improved significantly (total test score: *M=5.75, SD=3.87*), while in the control group they remained low (total test score: *M=0.69, SD=0.79*).

Table 3. Means and standard deviations of the post-experiment test results for correctly naming tree leaves.

Tree	Group	M	SD
Sycamore	Control	0.06	0.25
	Experimental	0.44	0.51
Scots pine	Control	0.25	0.45
	Experimental	0.37	0.50
European beech	Control	0.00	0.00
	Experimental	0.37	0.50
European silver fir	Control	0.19	0.40
	Experimental	0.56	0.51
Common oak	Control	0.06	0.25
	Experimental	0.63	0.50
Common horse-chestnut	Control	0.06	0.25
	Experimental	0.63	0.50
Common spruce	Control	0.06	0.25
	Experimental	0.69	0.48
Large-leaved lime	Control	0.00	0.00
	Experimental	0.56	0.51
Spanish chestnut	Control	0.00	0.00
	Experimental	0.87	0.34
Silver birch	Control	0.00	0.00
	Experimental	0.63	0.50
Total test score	Control	0.69	0.79
	Experimental	5.75	3.87

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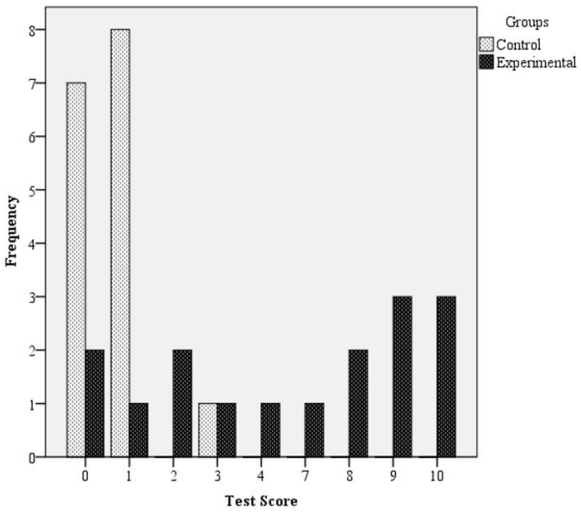

Figure 1: Frequency distribution of post-experiment test scores for naming tree leaves.

The F tests showed that the differences in naming tree leaves after the experiment between the experimental and control groups were statistically significant for all leaves and for the total test score (F=29.20, p<0.05; the effect size was large ($\eta^2 \geq 0.14$)) (Table 4).

Table 4. Statistical test of differences in the post-experiment test results of naming tree leaves between the experimental and control groups.

Tree	F	p	Effect size – η^2
Sycamore	10.91	0.00	0.27
Scots pine	7.46	0.01	0.21
European beech	9.00	0.01	0.23
European silver fir	10.73	0.00	0.27
Common oak	19.48	0.00	0.40
Common horse-chestnut	23.39	0.00	0.45
Common spruce	20.71	0.00	0.42
Large-leaved lime	19.296	0.00	0.39
Spanish chestnut	88.00	0.00	0.75
Silver birch	25.00	0.00	0.46
Total test score	29.20	0.00	0.50

Correspondence: Leaf – fruit or Cone

Before the experiment, this task had been very difficult for the children and the results were low in both groups (total test score for the control group: *M=0.25, SD=0.45*; for the experimental group: *M=0.50, SD=0.82;* the difference was not significant: *F=1.15, p>0.05).*

The post-experiment results for the experimental and control groups are given in Table 5 and Figure 2. After the experiment, the test results in the experimental group were significantly higher (total test score: *M=3.00, SD=2.92*), while in the control group they remained low (total test score: *M=0.25, SD=0.45*).

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Table 5. Means and standard deviations of the post-experiment test results for correctly matching tree leaves with the corresponding fruit or cone.

Tree	Groups	M	SD
Sycamore	Control	0.00	0.00
	Experimental	0.25	0.45
Scots pine	Control	0.13	0.34
	Experimental	0.38	0.50
European beech	Control	0.00	0.00
	Experimental	0.25	0.45
Common oak	Control	0.00	0.00
	Experimental	0.25	0.45
Common horse-chestnut	Control	0.00	0.00
	Experimental	0.38	0.50
Common spruce	Control	0.06	0.25
	Experimental	0.56	0.51
Large-leaved lime	Control	0.06	0.25
	Experimental	0.50	0.52
Spanish chestnut	Control	0.00	0.00
	Experimental	0.44	0.51
Total test score	Control	0.25	0.45
	Experimental	3.00	2.92

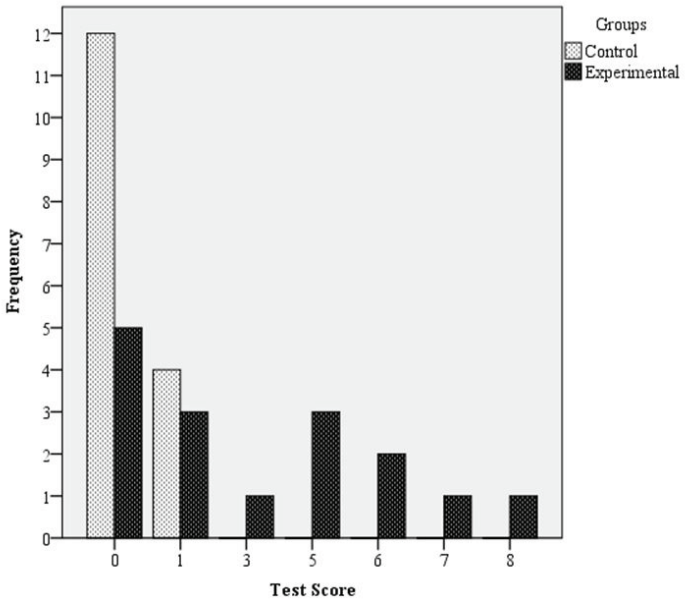

Figure 2: Frequency distribution of the post-experiment test scores for correctly matching tree leaves with the corresponding fruit or cone.

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The F tests revealed that the differences between the experimental and control groups after the experiment were statistically significant for all trees and for the total score (F=13.87, p<0.05); the effect size was large ($\eta^2 \geq 0.14$) (Table 6).

Table 6. Statistical test of differences in the post-experiment test results for correctly matching tree leaves with the corresponding fruit or cone between the experimental and control groups.

Tree	F	p	Effect size – η^2
Sycamore	5.00	0.03	0.14
Scots pine	6.28	0.02	0.18
European beech	5.00	0.03	0.14
Common oak	5.44	0.03	0.16
Common horse-chestnut	9.00	0.01	0.23
Common spruce	11.51	0.00	0.28
Large-leaved lime	14.03	0.00	0.33
Spanish chestnut	7.11	0.01	0.20
Total test score	13.87	0.00	0.32

Observation Task: Finding the Matching Pair of a Tree Leaf

Even before the activities started the children were very good observers. A large majority of them chose the correct leaf (total test score for the control group: *M=9.12, SD=0.89*; for the experimental group: *M=8.25, SD=1.18*; the difference was significant: *F=5.61, p<0.05*; the effect size was large: $\eta^2 \geq 0.14$).

The effect of the statistically significant difference between the control and experimental groups before the experiment was statistically controlled and removed by using ANCOVA.

Table 7 presents the results of correctly matching leaves after the experiment. The number of matched trees was significantly higher in both the experimental and control group (total test score for the experimental group: *M=9.94, SD=0.25*; for the control group: *M=9.88, SD=0.34*).

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Table 7. Means and standard deviations of the post-experiment test results for correctly matching trees leaves.

Tree	Group	M	SD
Sycamore	Control	1.00	0.00
	Experimental	1.00	0.00
Scots pine	Control	1.00	0.00
	Experimental	1.00	0.00
European beech	Control	1.00	0.00
	Experimental	0.94	0.25
European silver fir	Control	1.00	0.00
	Experimental	1.00	0.00
Common oak	Control	1.00	0.00
	Experimental	1.00	0.00
Common horse-chestnut	Control	1.00	0.00
	Experimental	1.00	0.00
Common spruce	Control	1.00	0.00
	Experimental	1.00	0.00
Large-leaved lime	Control	0.87	0.34
	Experimental	1.00	0.00
Spanish chestnut	Control	1.00	0.00
	Experimental	1.00	0.00
Silver birch	Control	1.00	0.00
	Experimental	1.00	0.00
Total test score	Control	9.88	0.34
	Experimental	9.94	0.25

Table 8 presents the mismatched leaves before and after the experiment. Some mismatches were more frequent than others (for example, Scots pine – European larch, Silver birch – European hornbeam, Large-leaved lime – Common hazel). Analysis of the characteristics of the leaves most often mismatched allows the conclusion that the children mismatched leaves very similar in shape and leaf surface size.

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Table 8. Frequencies of mismatches made by the children in the experimental and control groups before and after the experiment.

Test leaf	Leaf chosen by the child instead of the test leaf	Experimental group – before	Experimental group – after	Control group – before	Control group –after
		f	f	f	f
Scots pine	European larch	7	0	4	0
European beech	European hornbeam	5	1	1	0
Large leaved lime	Common hazel	4	0	2	1
Common spruce	European larch	4	0	0	0
European silver fir	European larch	1	0	2	0
European beech	Large-leaved lime	2	0	1	0
Scots pine	European silver fir	2	0	0	0
European silver fir	Scots pine	0	0	1	0
Common spruce	European silver fir	1	0	0	0
Large-leaved lime	Silver birch	0	0	1	1
Silver birch	Large-leaved lime	0	0	1	0
Large-leaved lime	European hornbeam	1	0	0	0
Silver birch	European hornbeam	1	0	0	0
Sycamore	Large-leaved lime	0	0	1	0
Total number of mismatches		28	1	14	2

Discussion

Initially, the children only knew a modest amount about trees. After the activities, however, the children in the experimental group showed a statistically significant improvement in their knowledge. They were able to identify the morphological characteristics of the leaves and fruits, and to name them. Naming improves children's recognition of objects (Sloutsky, 2010) and naming was therefore considered an important part of learning about trees.

Part of the present research focused on investigating progress in observation skills through activities held in nature. Natural objects typically entail great variety and heterogeneity, and thus strongly encourage observation. They are suitable for gaining a better insight into what the skill of observation looks like in young children. Observation is considered to be a key skill in the educational process and is the basis of all means for collecting data (Harlen and Qualter, 2009, Johnston, 2011). Children should be encouraged to use all of their senses when seeking to develop their observation skills. In the context of such exploration, children should learn to distinguish between what is relevant and what is irrelevant (Harlen and Symington, 1987; Harlen, 1993; Millar 1994). They should be offered as many opportunities as possible to observe details, not only gross features (Harlen, 1993). In the present research, children aged 5 to 6 proved to be very good observers of tree leaf characteristics. Through the test of finding the corresponding leaf pair, progress in the development of observational skills could not be detected as the majority of children had already solved the task excellently during the pretest, making virtually no errors during the post-test. Few mismatches were made between leaves greatly similar in size and leaf surface shape. After the performed activities, the control group's results were not significantly different from those in the experimental one. It can therefore be concluded that the familiarity with the task may have had a stronger influence on the results than the activities in the forest themselves. In spite of this, it can be inferred that the activities

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performed in the natural environment did stimulate the development of process skills. This can also be assumed because other test tasks (in which progress was evident) also included observation skills, finding similarities and differences and classification. These skills provide firm foundations for concept development, extending knowledge (Harlen & Symington, 1987), better hypothesising in later phases of formal learning and researching (Tomkins & Tunnicliffe, 2001) and form the starting point for biology (Tunnicliffe & Ueckert, 2011).

Learning through play in the natural environment strongly motivated the preschool children. Such an environment provided them with enough space to move freely and investigate on their own. Positive emotional responses could be detected in the course of their activities in the forest. Some authors (Carson, 1956; Chawla, 1990; Louv, 2006; Sebba 1991) have noted children's distinct sensitivity to nature. For children in early childhood, nature represents a particular fascination, a source of joy, inspiration and calm. Carson (1956) calls this innate relation a »sense of wonder«, experienced by children in intimate contact with nature. The »Biophilia hypothesis« suggests that man's relationship with nature continues to be still strong since technological development has been so rapid that human evolutionary adaptation to new environments has not had enough time to develop (Wilson, 1984). Another aim of the forest activities was to deepen the children's connection with nature. This is particularly important for children growing up in an urban, highly technological environment who otherwise do not have sufficient opportunities to spend time in the world of nature (Clements, 2004; Waller et al., 2010). Early childhood is precisely the critical period in which such opportunities should be offered, building up the basis for developing positive attitudes to nature (Kahn & Kellert, 2002; Wilson, 2008; Torkar, 2014). Considering the modern reality that young children spend a large part of their days at kindergarten, practitioners should be aware of the great importance of outdoor play and learning for preschool children and provide them with regular opportunities to experience natural environments (Waller, 2007). According to the fact that positive attitudes to nature can be encouraged via children's familiarity and knowledge about the world of nature (Verplanken & Hoftsee, 1998; Hadzigeorgiou et al., 2011), it can be concluded that the progress in children's knowledge about trees presented in this research positively affected the development of their environmental ethics.

Many studies show that activities in a natural environment, which is an infinite source of natural objects and materials, promote children's progress in many developmental domains (Wilson, 2008; Maynard & Waters, 2007). The present research demonstrated how this can happen in the field of early science education.

Conclusions

Three main conclusions can be drawn from the results of the present research. The first is that developmentally appropriate outdoor activities can lead to preschool children making progress in their knowledge about trees. Next, the forest proved to be a learning space of high pedagogical value. Third, 5- to 6-year-old children are good observers of tree leaf characteristics, although it is difficult to show the progress made in children's observation skills through outdoor activities.

However, the small sample size limits the ability to generalise these conclusions. The external validity of the research should be improved with a larger sample. The experiment was carried out in a kindergarten setting so not all of the confounding variables could be controlled.

The results of the research hold an important educational implication. Since the forest has been shown to be a strongly motivating and appropriate learning space for achieving science knowledge and skills, play and learning in the natural environment should become a vital part of preschool practice in early science education.

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