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# Assessing the “box for small natural scientists” regarding gain of species knowledge of pre-school children

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## ABSTRACT

*Children’s perception of nature influences their attitudes towards conservation and the development of an environmental consciousness in general. Awareness for diversity, which implies knowledge of biodiversity, ecosystems, and species, is highly important in this sense and should be supported from early age on. The researchers’ box for small natural scientists promotes nature experiences in early childhood education. It encourages children to get to know the species in their surroundings. Herein we present the outcome of a study investigating the gain of knowledge achieved by the use of the researcher’s box. Children who have worked with the researcher’s box during one year showed better performances in identifying plant and animal species and knowing of additional native species in particular. The intensity in which the tool was used only had a minor effect on the children’s capability to identify species. We concluded that the researcher’s box is a valuable tool because it stimulates an overall exchange about and examination of native species and thus leads to better species knowledge of pre-school children.*

*Key words: environmental education, kindergarten, early year’s education, education of sustainable development*

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## Introduction

The perception of nature directly influences the attitude towards it [1], [2]. In general there is no tendency and willingness for environmental protection in case of a negative perception of nature. Some negative perceptions of nature can partly be genetically determined and appear in early childhood as for instance the fear of spiders and other small animals [3]. However, a general negative perception is mainly determined by today’s often occurring alienation from nature. Rainer Braemer is nature sociologist and was the author of the past five editions of the “Jugendreport Natur” since 1979. In the last “Jugendreport Natur” [4] he complained that the relation of teenagers towards nature is becoming more and more abstract and formal. In contrast, a personal positive image of nature is likewise imprinted during childhood [5]. Thus, an early childhood education should focus on positive perceptions and experiences of and in nature. An education in this sense is meant to result in two main advantages: 1. the willingness to engage in environmental protection and sustainable development, 2. positive impacts on human health and well-being by being in nature [6].

One main approach to nature is the support of be-

coming familiar with species diversity. A basic understanding of nature requires the ability to identify species because the approach to different natural phenomena deserves a common language (see in [7]). Species knowledge is increasing drastically during early childhood years [8]. Hence, species knowledge should be preferably learned and supported from this age on. Since the present study focuses on pre-school children we use the term “species knowledge” describing the children’s ability to recognise specific plants and animals of their everyday surrounding and to call them by their common name. We assume that children will sometimes be able to distinguish between specific species (e.g. Blue Tit or Great Tit) and other times only recognise the taxonomic order, family or genus (e.g. spider).

The Office of Environmental and Consumer Protection of the City of Cologne together with the Institute of Biology Education of the University of Cologne initiated the design of a researchers’ box for small natural scientists to promote nature experiences in early childhood education. The researcher’s box supports more contacts with nature to encourage motoric, emotional and cognitive development as well as to draw the children’s interest in nature. Furthermore, it is aimed to increase urban biodiversity especial-

ly around the day-care facilities (e.g. by creating a wildflower meadow). The use of the researcher's box intends to support the children's species knowledge. The children learn to identify plant and animal species, which occur in their surroundings, and they learn the species characteristics, their habitats, and environmental needs. The overall goal of the researcher's box is to promote the children's consciousness and action for the environment and its protection.

The present study examined the effect of the researcher's box one year after it had been introduced in selected day-care facilities. It is following a pre-study of 2013, in which the species knowledge of the children had been examined before the introduction of the researcher's box [9]. In 2014 we conducted a comparable investigation of the children's species knowledge to evaluate the effectiveness of the researcher's box in this aspect regarding the research question: Does the use of the researcher's box affect the gain of species knowledge of pre-school children? The learning gain was further evaluated in dependency of the support intensity (based on the amount of utilized supportive activities from the researcher's box) since we hypothesized that this factor affects the gain of species knowledge of the children.

## Methodology

The state of knowledge of the children in day care facilities was controlled at two different points of time, before and after the introduction of the researcher's box. The first investigation was carried out in summer of 2013 [9]. The present study followed in summer of 2014. Both studies were carried out with the permission and assistance of the city of Cologne. Since the project of the "box for small naturalist scientists" was initiated by the city of Cologne, it was also on their behalf to choose day-care facilities to take part in the study in 2013 and subsequently in the present study. A standardized questionnaire was applied in 2013 and 2014 to evaluate the respective level of species knowledge. Furthermore, it was our interest to evaluate the gain of knowledge in relation to the use of the researcher's box. Thus, a second questionnaire was applied, which the educators should complete. The questionnaires were reconciled with representatives of the City of Cologne. Only children were questioned whose parents agreed in written form. Furthermore, the questioning was optional and the children were able to discontinue it at any time. An agreement of the local ethic commission was not necessary since apart from the children's mother tongue no sensible data were raised during the survey. The questioning was carried out anonymously.

## Sample and implementation of the questionnaire for the children

The increase of knowledge of the children in the age of kindergarten was investigated by comparing

the results of the study in 2013 [9] with the results of the present study implemented in 2014. In total 75 children of the 92 children interviewed in 2013 were again interviewed in scope of the present study. The children were interviewed individually in separate rooms in the day-care facilities with the interviewer reading out the questions of the questionnaire loudly and ticking the children's answers in the questionnaire. The questionnaire comprised mainly closed questions. One important criterion for the content of the questions was that they should be linked to the content of the "researchers' box". In the following we will solely focus on the area of species knowledge. During the work with the questionnaire the children were shown 6 pictures of four groups of organisms (trees, flowers, birds, and small animals) each. Only organisms that are addressed by the researcher's box were included in the questionnaire. The children were asked if they could identify the given organisms on the pictures and if they knew of additional species / organisms of each group.

## Questionnaire for the educators

A further questionnaire was developed to be filled in by the educators about the application of the supportive activities of the researcher's box. The aim of this questionnaire was to determine the support intensity for the different day-care facilities. In the questionnaire the different activities, which kindergarten teachers could conduct with the researcher's box, were listed and the educators were asked to mark those that were applied in their day-care facility. Additional supportive activities that were applied but not listed should also be written down. The fill-out of this questionnaire usually took 10 minutes and was done in the present of the interviewer, in case of any arising questions.

## Determination of learning gain - Data analysis

We applied two different approaches to compare the level of knowledge of the children:

- Comparison of two dependent samples: One group of the same children, who was first interviewed at the age of 4/5 in 2013 before the introduction of the researcher's box and was again interviewed at the age of 5/6 one year after the introduction of the researcher's box in 2014 ( $n = 75$ ). To exclude the age as a possible factor for a higher species knowledge of the 5/6 year old children we additionally applied a second approach to examine the learning gain:
- Comparison of two independent samples: Two groups of different 5 year old children, one that was interviewed in 2013 ( $n = 48$ ) and therefore did not have any contact with the researcher's box at that time and another that was interviewed in 2014 ( $n = 33$ ) and did work with the researcher's box.

First of all, we conducted a descriptive data analyses followed by statistical tests. Since the data of 2013 as well as the data of 2014 were not normally distributed we applied non-parametric tests to compare the different groups of children (Wilcoxon Test for dependent samples and Man-Whitney-U-Test for independent samples). Non-parametric tests were also applied to examine whether there are significant differences in the children's learning gain concerning support intensity for the different categories respectively. This factor was analysed by applying the Man-Whitney-U-Test. In addition to test for significance, the respective effect size was determined too. This statistical analysis was done with the program SPSS (Statistical Package for the Social Sciences of the version 23).

### Determination of support intensity

The determination of the support intensity is based on the data raised with the questionnaire for the educators. The support intensity was determined for each group of organisms, which is addressed by the researcher's box. The different groups of organisms were treated by means of different numbers of supportive activities. Hence, the category "trees" was met by a total of 7 activities being included in the researcher's box whereas the categories "flowers" and "birds" were met by 9 each and "small animals" by a total of 13 activities. For each category the number of ac-

tivities which were actually applied by the nurseries was determined and subsequently classified into low, average and high – one third of the total number of applied activities respectively per category.

### Results

The learning gain was investigated for the children's species knowledge. Furthermore, it was analysed in dependency of the respective support intensity.

#### *Learning gain of two dependent groups*

We found a significant learning gain regarding the species knowledge of all four categories: trees, flowers, birds, and small animals. The difference between the knowledge level, which means the number of species being identified or additionally named, of the children before and one year after working with the researcher's box was significantly high. The respective effect size  $r$  likewise shows a medium or even high effect and thus emphasizes the learning gain. Table 1 shows the level of knowledge before and after the introduction of the researcher's box and the respective learning gain after one year working with the box.

The majority of the children could identify more species after working with the researcher's box and knew more species than included in the questionnaire.

*Table 1: Learning gain of the children that worked with the researcher's box during one year. The variable "Identified" means those organisms that were shown to the children and could be recognized and named correctly. The Variable "Additional" means those organisms that were not shown on pictures to the children but of which they knew of.*

Species	Variable	Knowledge level 2013		Knowledge level 2014		Learning gain		
		Mean $\pm$ SD	Median (Min/Max)	Mean $\pm$ SD	Median (Min/Max)	Mean $\pm$ SD	Wilcoxon test	Effect size $r$
Trees	Identified	0.08 $\pm$ 0.32	0 (0/2)	0.36 $\pm$ 0.78	0 (0/3)	0.28 $\pm$ 0.80	$p = 0.002$	-0.34
	Additional	1.16 $\pm$ 1.54	1 (0/6)	3.09 $\pm$ 1.80	3 (0/8)	1.93 $\pm$ 1.90	$p \leq 0.001$	-0.74
Flowers	Identified	1.76 $\pm$ 1.16	1 (0/7)	2.52 $\pm$ 1.39	2 (0/6)	0.76 $\pm$ 1.28	$p \leq 0.001$	-0.55
	Additional	0.55 $\pm$ 0.84	0 (0/4)	1.37 $\pm$ 1.43	1 (0/6)	0.83 $\pm$ 1.55	$p \leq 0.001$	-0.50
Birds	Identified	0.99 $\pm$ 1.29	0 (0/5)	1.68 $\pm$ 1.61	1 (0/6)	0.69 $\pm$ 1.24	$p \leq 0.001$	-0.49
	Additional	0.89 $\pm$ 1.31	0 (0/7)	2.49 $\pm$ 2.24	2 (0/11)	1.60 $\pm$ 2.11	$p \leq 0.001$	-0.64
Small animals	Identified	4.52 $\pm$ 1.08	5 (2/6)	5.32 $\pm$ 0.74	5 (3/6)	0.80 $\pm$ 0.85	$p \leq 0.001$	-0.69
	Additional	1.41 $\pm$ 1.49	1 (0/6)	3.27 $\pm$ 2.30	2 (0/10)	1.85 $\pm$ 2.15	$p \leq 0.001$	-0.69

Here, we compared two comparable but different groups of five year old children. One group has worked with the researcher’s box the other group did not, hence we analysed two independent samples.

The overall species knowledge was better in the group of children who worked with the researcher’s box. However, the differences between the two independent groups of children were significant only for certain species categories. Table 2 shows the results for the comparison of the two independent groups of five year old children.

**Intensity of supportive measures of the day-care facilities**

Based on the educator’s filled-out questionnaires the day-care facilities applied between 10 to 34 activities of the researcher’s box. We classified the day-care facilities respective the number of activities they have applied: 8 day-care facilities were categorized as “less supportive” (implementation of 10-18 activities), 5 day-care facilities as “averagely supportive” (implementation of 19-26 activities), and 9 day-care facilities as “highly supportive” (implementation of 27-34 activities).

Table 2: Results of the comparison of the two independent groups of five year old children, one working with the researcher’s box (RB+) the other one not (RB-). The variable “Identified” means those organisms that were shown to the children and could be recognized and named correctly. The variable “Additional” means those organisms that were not shown on pictures to the children but of which they knew of.

Species		Mean ± SD		Effect Size r	Man-Whitney-U-Test
		RB-	RB+		
Trees	Identified	0.15 ± 0.41	0.3 ± 0.74	-0.13	p = 0.26
	Additional	1.54 ± 1.75	2.97 ± 1.55	-0.42	p < .001
Flowers	Identified	2.06 ± 1.44	2.45 ± 1.44	-0.15	p = 0.18
	Additional	0.65 ± 0.91	0.97 ± 1.26	-0.14	p = 0.212
Birds	Identified	1.19 ± 1.3	1.39 ± 1.56	-0.05	p = 0.663
	Additional	1.17 ± 1.51	2.45 ± 2.65	-0.28	p = 0.012
Small Animals	Identified	4.77 ± 0.95	5.18 ± 0.85	-0.24	p = 0.034
	Additional	1.77 ± 1.49	3.03 ± 2.13	-0.30	p = 0.006

With respect to those activities, which specifically addressed the species knowledge we found the following support intensities for the different categories: trees: low (0-2 activities, n = 24 children) and high (5-7 activities, n = 25); flowers: low (1-3 activities, n = 10) and high (7-9 activities, n = 36); birds: low (1-3 activities, n = 13) and high (7-9 activities, n = 18); and small animals: low (3-6 activities, n = 30) and high (10-13 activities, n = 28). The sample size n gives the number of children to be affected by the respective support intensity.

The factor support intensity only had a minor effect on the identification of tree species (U = 238.5, z = -1.822, p = 0.047, r = -0.26). No significant differences were found for the other species categories.

**Discussion**

The study could detect an appreciable learning gain since the children significantly approved their species knowledge during the year when they worked with the researcher’s box. Accordingly, Lindemann-Matthies [7] found that children increased their perception of common local species and their ability to distinguish them after participating in a program dealing with nature on the way to school. The learning gain was found for all animal and plant categories, which were analysed. However, since the learning gain was not as distinct between the two independent groups of five year old children the gain of species knowledge could be to a certain degree influenced by the general increase of knowledge over time (5 year old

children are expected to have a better knowledge than 4 year old children). Significant differences between the 5-year-old children who had access or no access to the researcher's box were detected mainly for the naming additional species. Knowing of further species could indicate that the children heard and learned about those plants and animals outside the kindergarten, possibly through their families or through media. The finding could also suggest that the use of the researcher's box encouraged an exchange and communication about species, which goes beyond the learning matter of the researcher's box. However, it stays unclear, why those species, which are addressed with the materials of the researcher's box were less well known as additional species.

The children showed an overall better knowledge of animal species than plant species, which is in accordance with former studies (e.g. [10], [11], and [12]). Generally, it became obvious that the children showed best performances in the easiest category. The level of identification was easier for the category small animals than for instance for birds. The children had only to identify certain animal classes such as "snail" or "spider", whereas they had to differentiate on species level between for example Great Tit and Blue Tit in the category birds. This finding implies that regarding the questionnaire the level of difficulty should be better equalized between categories for future investigations.

We could not detect a relation between the support intensity in the different knowledge categories and the learning gain of the children. Therefore, we can assume that it is not the amount of undertaken tasks included in the researcher's box which benefits the learning gain, but the quality of the work with the box in general and the exchange about respective topics in connection with outdoor experiences. Talking about and dealing with the different topics of nature and species in particular already leads to better knowledge in these fields. This is again in accordance to the study of Lindemann-Matthies [7] where the increase of species perception could not be attributed to a specific activity.

We can finally conclude that the application of the different activities of the researcher's box had a positive effect on species knowledge. Considering the absolute numbers of identified given species and of additionally named species a further increase of species knowledge is still desirable. More research would be desirable to further investigate a possible effect on ecological knowledge concerning animal and plant species addressed by the researchers' box as this aspect has not been examined yet. However, the researcher's box can still be seen as a useful tool to promote environmental education in early years as it is able to support an overall and deeper dealing with ecological and environmental themes including species diversity and allows nature experiences. This might subsequently lead to a develop-

ment of environmental awareness in young children. The researcher's box is therefore a valuable tool to help to imprint a positive image of nature [5]. The children might become generally more interested in nature topics and particularly in species which, however, was not analysed in the study on hand. We therefore encourage the use of the researcher's box and similar tools, to increase nature experiences and hence knowledge and awareness of species already in early childhood years (see also [13], [14]. Especially because an early childhood education supporting environmental awareness is highly desirable facing today's environmental problems and thus to develop a consciousness towards conservation [1], [2]. In this sense it would be interesting for future investigations to analyse the young children's understanding of ecological relations and of the role of species in an ecosystem and furthermore how this understanding supports the children's environmental attitude.

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