



STUDENTS AND STUDENT TEACHERS' ABILITY TO NAME ANIMALS IN ECOSYSTEMS: A PERSPECTIVE OF ANIMAL KNOWLEDGE AND BIODIVERSITY

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Introduction

The knowledge of animal names and animal taxonomy of students and student teachers is examined in this study. Several studies have reported (Flannery, 1991; Hershey, 1996; Löwe, 1992; Randler, 2008a; Randler et al., 2012; Wandersee, 1986; Wandersee & Schlusser, 1999) that people are more interested in animals than they are in plants or fungi; thus it was expected that the respondents can more easily name animals than other organisms, and therefore, the animals were a natural choice for the study object.

The ability to name animals depends on the knowledge of animal names of the respondents and on their identification skills (Prokop & Rodak, 2009), i.e. which of the names can be remembered easily and recalled (Schussler & Olzak, 2008). Pupils easily remember animals like squirrel, deer, elephant and shark (Strommen, 1995). Also animals people express their attitudes to like spectacular ivory-billed woodpecker (Dalton, 2005) or charismatic dolphins (Barney et al., 2005), "disgusting animals" (Prokop & Tunnicliffe, 2008), animals people are afraid of, e.g. a bear (Prokop & Fančovičová, 2010; Rakison, 2009) or popular animals like squirrel, rabbit, ladybird (Eloranta & Yli-Panula, 2005) or unpopular animals like disease carrying mouse, predator wolves (Prokop & Tunnicliffe, 2010) are easily remembered.

The body size of the animal also makes them attractive to humans and easy to remember (in Schulz, 1985 (see Randler, 2010). Recent research reveals mammals, especially large and impressive ones, are mentioned by respondents most often (Patrick et al., 2013; Yli-Panula & Matikainen, 2011, 2013a). According to the study of Patrick and others (2013) the school students were most aware of mammals and secondly of birds. In their study the free-listed animals by Finns were named in the following order: endemic, exotic, pets, domestic and farmed animals, i.e. the animals they had learnt during the socio-cultural interactions and via sharing folk biological knowledge of animals (socially shared beliefs of animals). In general the knowledge of mammals has been shown to be more precise than that of e.g. birds and arthropods (Huxham, Welsh, Berry & Templeton, 2006; Prokop, Kubiato &

Abstract. *In this survey Finnish lower and upper secondary education students' and student teachers' (n=514) knowledge of the animal names (species) in relation to ecosystems was studied using a questionnaire. The results were interpreted with regard to the biodiversity of the ecosystem. Nordic fen, spruce-dominated coniferous forest, tropical rainforest, and savannah were studied. The respondents were aware of animals living in the four ecosystems, especially of mammals and birds. The animals of the indigenous Nordic fen were the least known, as evidenced by the low average number of the names and the highest number of falsely named animals. Furthermore, the animals of the savannah were the best known by the students in lower and upper secondary education, while the animals of the spruce-dominated coniferous forest were best known by student teachers. The invertebrates were nearly forgotten from all ecosystems, although they are an essential part of biodiversity and food chain/web. Research results show that students' knowledge of the animals in relation to their autecological matters should be improved in all information sources provided.*

Key words: *animals, biodiversity, ecosystem, Finnish students in lower and upper secondary education, Finnish student teachers*

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Fančovičová, 2007). In the study of Randler and Bogner (2006) the young respondents were able to classify birds into the right order or family but had difficulties with the correct names of species. According to Randler (2008a) at least 80-100 vertebrate species seem to be appropriate to know and name.

Biological definition of biodiversity is based on knowledge. The most common entity for living organisms is species (van Weelie & Wals, 2002). However the concept of biodiversity is broad and therefore it is hardly possible to form a simple, comprehensive and fully operational way to define it. Biodiversity implies variations in species diversity, species variations or genetic factors, as well as variations in the occurrence of the living organisms depending on their habitat, ecosystem and the ecological complexes in which they occur (Convention on Biological Diversity, CBD, 1992; International Union for the Conservation of Nature, 1994; Hamilton, 2005; Hooper et al., 2005; Walker, 2006). In this study the biodiversity is interpreted as different species/animals living in the same ecosystem. We used the named animals, their amount and their taxonomical groups in connection to the habitat/ecosystem they live in as the measure of the respondents' knowledge of biodiversity.

The purpose of this study was to address the ability of students and student teachers to name animals into the four selected ecosystems. For the first time in this study the named animals were researched in relation to the ecosystem they live in. A minor study objective was to interpret the results of named animals with regard to the biodiversity of the ecosystems studied.

Background

Species Identification and Animal Knowledge

Surveys of students from different age groups worldwide have revealed that species identification by students is alarmingly weak (Lindemann-Matthies, 2005, 2006; Menzel & Bögeholz, 2009; Palmberg et al., submitted; Randler, 2008b). Lindemann-Matthies (2002) observed that Swiss children and adolescents were not adequately able to name local animal species and were only aware of few local species of flora and fauna. Tunnicliffe and Reiss (1999), in their study, concluded that children identified animals mostly by anatomical features and seldom by behaviour or habitat.

In the study of 9-19 years old students, Randler (2008a) showed that the animal species knowledge increased until 8th grade (the age of 14) after which it was shown to decrease (Balmford et al., 2002), whereas the skills to identify species were increased with age, up to the age of eight or nine (Huxham et al., 2006). However, according to the study of Kaasinen (2009) the plant species identification skills improved from student teachers (young adults) to university teachers (Kaasinen, 2009). Indigenous animal species are shown to be more known than exotic ones (Huxham et al., 2006).

In general the animal knowledge includes, in addition to the knowledge of the animal names and species identification or animal taxonomy, also the understanding of animals in relation to their habitat and ecosystem where they live and breed, their autecology. In this study the animal knowledge of a respondent includes animal names and taxa in relation to different ecosystems and biodiversity.

The Knowledge of Animals in Relation to Their Ecosystem and Biodiversity

Man's contacts to animals and people's general level of species knowledge seem to have declined significantly in the past decades (Braun, Buyer & Randler, 2010; Lindemann-Matthies & Bose, 2008; Palmberg, 2012; Randler, 2008a). Also the significance of species for biodiversity stays often unclear for man (Dikmenli, 2010; Gayford, 2000; Helldén & Helldén, 2008; Palmberg et al., submitted; Norrgård-Sillanpää et al., submitted). In addition, the concept of biodiversity is shown to be unknown (Lindemann-Matthies & Bose, 2008) and connection between species identification and biodiversity unclear (Norrgård-Sillanpää et al., submitted; Yli-Panula & Pollari, 2013) among Finnish student teachers, therefore the characterisation of the animal diversity of the ecosystems should involve the ecological matters, e.g. food web to support people's system thinking.

Studies on children and student teachers have reported that certain vertebrate taxa especially mammals, birds and reptiles are overrepresented in relation to factors like biomass in rainforest ecosystem (Snaddon et al., 2008) or animal abundance in food web (Yli-Panula & Matikainen, 2013b). In the aforementioned study mostly vertebrates were named as animals living in certain ecosystems and hardly any invertebrates. In the study of nesting animals (Yli-Panula & Matikainen, 2013a) the results were similar. Mammals were the most named and they



were overrepresented in relation to all studied ecosystems, while the nesting birds could have expected to be the major class in this study. In these Finnish studies (Yli-Panula & Matikainen, 2011, 2013b) it was also shown that primary school student teachers named more animals in the local spruce-dominated coniferous forest and exotic savannah than in the exotic rainforest or national ecosystem fen.

Animal Studies in the School Curricula and the Sources of the Animal Knowledge

In the educational system of Finland, children in kindergarten, students in lower and upper secondary education, primary school student teachers, and biology and geography student teachers are taught about animals native to Finland and those that live in exotic ecosystems. In addition to the study of the ecosystems and animal species (other taxa) in relation to their living ecosystem, also endangered, threatened, vulnerable, near extinct species are in focus (National Board of Education, 2003, 2004). Further different learning and teaching methods to study animals, e.g. field working or inquiry based learning, are written in core curricula. Therefore, according to the Finnish National Core Curricula, living organisms and animal biodiversity has been and remains one of the main subjects both in primary and lower secondary schools and should also be taught outside the classroom.

Teaching and learning in schools are obviously one source for animal and biodiversity knowledge. Randler and Bogner (2006) showed that stuffed animals and identification books with student centred teaching methods were successful learning environments for secondary school pupils. The use of identification books scored significantly in animal knowledge, but the similar relation was not found using, e.g. "the internet" as a source of animal knowledge (Randler, 2010). Randler (2010) also showed that animal related activities like walking in nature, museum and animal park visits, watching TV- nature programs, etc. have a positive effect on animal knowledge. However, there are also studies showing that the knowledge is not always based on learning at school. According to Tunnicliffe and Reiss (1999) children aged 5–14 learned species at home or by direct observation. Recently, "school" was confirmed to be less important source for animal knowledge in the studies of Patrick and Tunnicliffe (2011) and Patrick and others (2013), while animals are known via socio-cultural issues, e.g. via animals used as food in kitchens. Reading the literature, e.g. fairy tales, in childhood (Eloranta & Yli-Panula, 2005; He, 2009) can be one source for animal names.

The Aims and Research Questions of the Study

The aim of this research was to study the ability of students and student teachers to name animals to the four selected ecosystems. It has been hypothesized that students have a limited ability to name animals (Eloranta, 2004; Eloranta & Yli-Panula, 2005) in ecosystems, especially at the species level, and mammals were expected to be the most known among all the animals. According to the hypothesis *the main goals and objectives of the study* targeted the following study questions:

1. How many animals (mammals; birds; reptiles, amphibia and fish; invertebrates; up to 10 per ecosystem) were the respondents able to mention?
 - a) How many of the animals were mentioned by primary school student teachers in relation to other respondents at the species, genus, family or at a higher taxonomic level?
 - b) According to animal groups (mammals; birds; reptiles, amphibia and fish; invertebrates).
2. According to ecosystems studied.
3. Which of the scientific Finnish names of species, genera, and families of the animals were the most commonly mentioned by respondents in each of the ecosystems?
4. Where did the respondents get their information?

The researchers further hypothesized that the students' knowledge of the animal diversity in a functional ecosystem and its habitats and niches is limited. *Additional minor study objectives* aimed to interpret the results of the named animals with regard to the animal diversity of the ecosystem, and the straightforward study questions were: 5) Does the number of the named animal groups simulate the animal diversity of the certain ecosystem(s)? 6) What does this tell about the respondents' knowledge of the ecosystems and biodiversity?

The results of this study have been discussed according to study questions 1-4 and further interpreted with reference to biodiversity and hidden ability of ecological literacy of the respondents.



Methodology of Research

General Background of Research

This survey is part of a bigger research project to study students' and student teachers' animal knowledge and self-efficacy and has a quantitative approach with qualitative features. In this study the animal knowledge of respondents means simply the named animals, their taxa and relation to the ecosystems and biodiversity. The study was carried out in South Western Finland in years 2005–2011. The respondents included students from lower secondary (LS, lower secondary school student, $n = 82$; 13-14 years old) and upper secondary education (US, upper secondary school student, $n = 123$; 17-18 years old); and student teachers in University ($n=309$). The student teachers included two various groups: a) the primary school student teachers (PT, $n = 258$; 94 % in the age of 19-22 years; qualifying to teach at primary school, no specific disciplines), who studied their first year pedagogical studies, and b) subject student teachers (ST, $n = 51$; 98% in the age of 23-26 years), who were specialized in biology and geography disciplines and attended their first and the only study year of pedagogical studies. The subject student teachers had already studied a minimum of 2 years biology and geography. After finishing their studies they are qualified to teach both at lower and upper secondary school. The primary school student teachers will be teachers for children at the primary school level. The term "student teachers" is used to mean both primary school and subject student teachers, and "students" to mean both lower and upper secondary school students, and "respondents" to mean all students and student teachers throughout this study. The same questionnaire was used for all respondents.

Sample Selection

The data of the lower secondary school students have been collected from one lower secondary school (4 classes) and data of the upper secondary school students from one upper secondary school (4 classes). The data concerning primary school student teachers has been gathered at the beginning of their biology studies in the first year course and data dealing with subject student teachers has been collected during the first two months of their one-year pedagogical studies. These student teachers studied at the same University. School students and student teachers were asked to name 10 animal species that live in each of the ecosystems included in this survey and the same form was used for all respondents. Very few species were named; therefore, the results were analyzed not only at the species level but also in terms of taxa.

Instrument and Procedures

A questionnaire containing pictures of four ecosystems - spruce-dominated coniferous forest (SCF), Finnish fen (FEN), savannah (SAV), and tropical rainforest (TRF) - was used in this study. A middle-aged coniferous forest illustrated the SCF (Figure 1). Fen was presented in a drawing of few coniferous trees and a typical field layer rich with different plant species. The layers of the TRF were clearly drawn, and tree savannah was depicted in the picture of the savannah. Neither the TRF nor the SAV drawings were labelled with any specific geographical location. The students were asked to name and write the 10 animals on the lines beside the picture and some additional questions were asked (data not shown here).



4. Nimeä 10 eri eläinlajia, jotka elävät kuvien esittämässä ympäristössä. Nimeä mahdollisimmin monta alueella pesivää lajia. Rengasta pesivien numerot. Sijoita vastaava numero ympäröiden kuvan siihen kohtaan, jossa tiedät eläimen pesän (pesäpaikan) olevan. TUORE KANGASMETSÄ

① muurahainen
 ② metsäparis
 ③ puurokalleluu
 ④ korhu
 ⑤ ahma
 ⑥ metsähiiri
 ⑦ orava
 ⑧ hirvi
 ⑨ metsämyyrä
 ⑩ kettu

	kyllä	ei
a		
b	x	
c	x	

Arvioi tehtävän 4 (eri ympäristöittäin) vaikeusastetta rastittamalla joko kyllä tai ei kohtiin a-c seuraavasti:
 a) Onko kysymys vaikea?
 b) Onko kysymysmuoto selkeä?
 c) Kuuluuko kysytty asia mielestäsi perustietoihin? (Perustiedot ovat tietoja, joita tarvitaan menestymiseen opettajan työssä.)

Figure 1: The figure represents a middle-aged spruce-dominated coniferous forest (SCF, tuore kangasmetsä), which was one of the four ecosystems in this study. Students and teacher students were asked to name 10 animal species that live in this ecosystem. Fen, savannah, and tropical rainforest were the other ecosystems included in the study questionnaire.

(Image modified from Nyberg and Lehtiö, 1997. *Koulun biologia, Metsät ja suot, opettajan opas*. p 51).

Data Analysis

The background information of respondents was coded and all the research material was compiled in an excel sheet. Named animals of each ecosystem were categorized according to taxa (species, genus, family or higher) by two researchers, independently. To ensure that the animal classification groups were equal, the two researchers harmonised the categorisations at the end of the data collection. The categorization was equal in the vast majority of cases (98%). During the analysis, the number of animals named for each ecosystem was calculated (falsely named animals were excluded); also the endangered animals were categorized. Problems encountered due to unclear classification in terms of taxonomy and/or language, were solved in favour of the students and student teachers. Spelling mistakes that did not result in naming another animal were overlooked. This was an introductory description of the study material and therefore no statistical analyses were carried out - neither based on the results of an individual respondent or group of students/student teachers nor based on the results concerning each ecosystem.

Results of Research

The Amount of Named Animals in the Four Studied Ecosystems

A total of 14513 animals were mentioned altogether for the four ecosystems (Table 1), accounting for 70% of the theoretical maximum (20560). Furthermore, 47% of the mentioned animals were identified at the species level (Figure 2). Mainly mammals were named. Very few students and student teachers mentioned reptiles, amphibia, or fish among vertebrates. Invertebrates were rarely mentioned, mainly named at the family level, mostly mentioned by primary school student teachers.

Table 1. The number and frequency (%) of mammals (MAM); birds (BIR); reptiles, amphibia, and fish (RAF); and invertebrates (INV) named by lower secondary (LS; n = 82) and upper secondary (US; n=123) school students and primary school student teachers (PT; n = 258) and subject student teachers (ST; n = 51).

		LS students	US students	PT students	ST students
MAM	N (%)	1200 (67)	2170 (68)	4574 (59)	975 (55)
BIRD	N (%)	207 (12)	470 (15)	1523 (20)	468 (27)
RAF	N (%)	246 (14)	290 (9)	697 (9)	143 (8)
INV	N (%)	133 (7)	265 (8)	971 (12)	181 (10)
SUM	N (%)	1786 (100)	3195 (100)	7765 (100)	1767 (100)

Subject student teachers were able to name the highest number of animals and animal species out of ten asked per ecosystem, accounting for 87% of the maximum possible number of animals, 60% of these animals named at the species level. 62 % primary school student teachers were able to name about half of the asked number of animals. The number of mentioned animals increased with age of the respondents; primary school student teachers mentioned 75% of the maximum possible number of animals; upper secondary school students, 64%; and lower secondary school students, 54%. Student teachers could name approximately half of all the animals at the species level while only 30% of upper secondary school students reached the species level. The vast majority (84 %) of the primary school student teachers named 8-10 animals to SCF and nearly all of them were able to mention 5 animals or more to SCF. 62 % of the primary school student teachers were able to mention 5 or more animals to FEN (see detailed data: Yli-Panula & Matikainen, 2011).

Large mammals were the most frequently named, and about 60% of those were named at the species level (Table 1; Figure 2). The number of birds and invertebrates that were mentioned increased with age of the respondents or increasing level of specialization of the students; conversely, the number of mammals and reptiles mentioned decreased with increasing age of the respondents. Among the animals named, birds constituted one-fifth of all answers by the primary school student teachers and one-sixth of all answers by the lower and upper secondary students. Subject student teachers mentioned birds in general and bird species in the highest frequency of all study groups. The students had lower interest in reptiles and amphibians, and these animals represented only one-sixth of their responses, and only one-tenth of reptiles and amphibians were named at the species level.

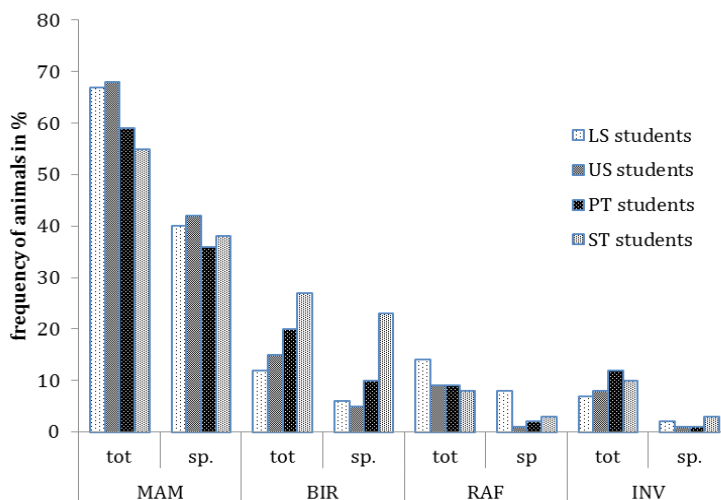


Figure 2. The total frequency (tot) of mammals (MAM); birds (BIR); reptiles, amphibia, and fish (RAF); and invertebrates (INV) counted as the percentage of all mentioned animals. The frequency of species (sp.) was counted for all the mentioned animals in each respondent group. Results are sorted by groups of respondents. LS: lower secondary school students (n = 82), US: upper secondary school students (n = 123), PT: primary school student teachers (n = 258), ST: subject student teachers (n = 51).



The Taxonomic Categorisation of the Animals Mentioned by Primary School Student Teachers in Relation to Other Respondents

(1) Categorisation by Animal Groups (mammals; birds; reptiles, amphibia, and fish; invertebrates)

All the three taxa (species, genus, family or higher) included in this study were mentioned in the answers of the students and student teachers for all vertebrate groups (MAM, BIR, and RAF), while only family or higher taxa than species were very commonly mentioned for invertebrates (Figure 2, 3). Even several mammals were mentioned at this level. However, primary school student teachers (Figure 3) and subject student teachers mentioned mammals and birds at the species level (detailed data not shown) more frequently than any other animal group. Students tended to mention higher taxa more often than they mentioned species.

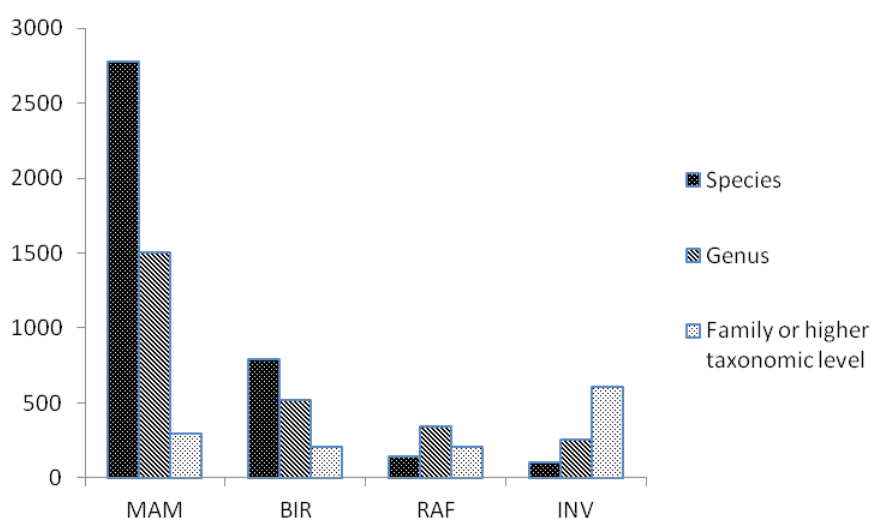


Figure 3: The number of mentioned animals was sorted into three taxonomic categories (species, genus and family or higher taxa) according to the animal groups (mammals (MAM); birds (BIR); reptiles, amphibia, and fish (RAF); invertebrates (INV)). These results are based on the animals named by the primary school student teachers (PT; n = 258).

(2) Categorisation by Ecosystems

Animals mentioned by respondents were placed mainly to the right ecosystem. Most of the animals of the SCF were known (the highest number of species) as compared to the other ecosystems. In the TRF ecosystem, the species level was not common in the answers of the primary school student teachers (Figure 4) or in any other study groups (data not shown). 84 % of the primary school student teachers were able to name 8–10 animals in the SCF ecosystem, and nearly all primary school student teachers could name at least 5 animals (Figure 4). And further bigger % of primary school student teachers were able to name only 1-4 animals to fen compared to those who succeeded to name 8-10 animals (see detailed results: Yli-Panula & Matikainen, 2011). Furthermore, animals from different continents such as Himalayan yak (*Poephagus grunniens*) were named along with animals in the African savannah.



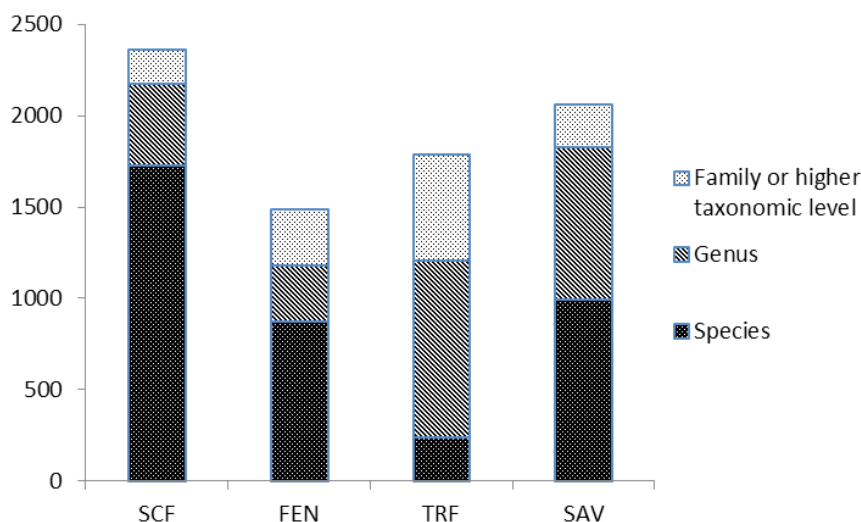


Figure 4: The number of animals mentioned in the three taxonomic groups (species, genus, and family or higher) according to the ecosystem (SCF = spruce-dominated coniferous forest; FEN = Scandinavian fen; TRF = tropical rainforest; SAV = savannah). These results are based on the animals mentioned by the primary school student teachers (n = 258).

According to the results 90% of the primary school student teachers could mention 5 or more animals in SAV and TRF. However, only 66% of the primary school student teachers were able to mention 8–10 animals in the SAV versus 84% in the SCF ecosystems. Some of student teachers named 10 species in SCF, while only subject student teachers could name at least 10 species in FEN. Some students and student teachers could name 10 animals each in the TRF and SAV ecosystems. None of the lower and upper secondary school students and only a few student teachers knew the names of the species of these animals.

Only few students or the student teachers could name all the 40 animals required, i.e. 10 per ecosystem. However, at least one respondent in each study group could name 10 animals in at least one of the four ecosystems. Some animals were wrongly named or named for the wrong ecosystem; most of these errors occurred for the FEN ecosystem. Student teachers and students were able to name only few animals living in the FEN ecosystem. In general, the animals in the FEN ecosystem were the least known. Mammals and birds were the most frequently named animals in all ecosystems.

The Most Commonly Mentioned Species, Genus, and Family Names in Each Ecosystem

Large mammals were the most commonly named animals among all respondents in all ecosystems; furthermore, some threatened or endangered animals were mentioned (Figure 5). As compared to the other respondents, subject student teachers mentioned considerably more bird species in the SCF ecosystem with a higher frequency.



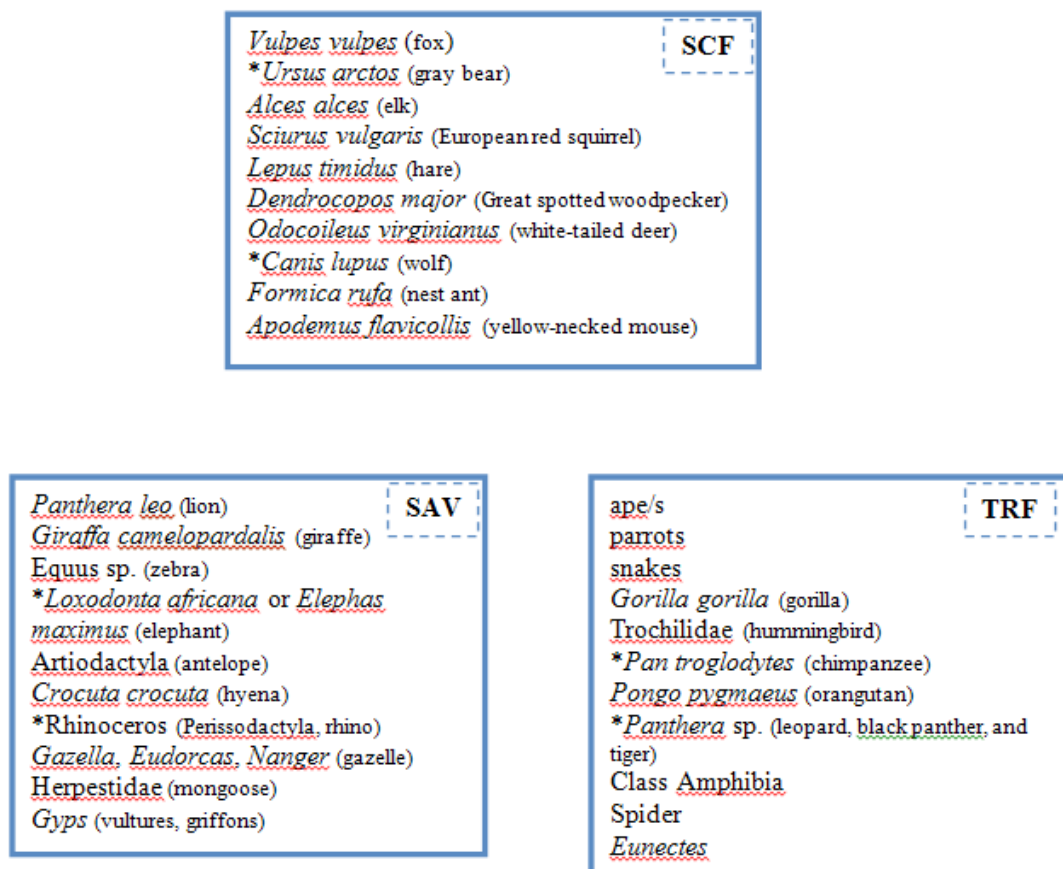


Figure 5: The ten most frequently mentioned animals by respondents in the spruce-dominated coniferous forest (SCF), savannah (SAV), and tropical rain forest (TRF) ecosystems. Threatened or vulnerable animals (*)

In the SAV ecosystem, mammals dominated the responses of all the respondents. One bird genus (*Gyps* spp.) was on the list of the most common names.

Two groups of birds (parrots and hummingbirds) and amphibian were frequently mentioned for the TRF ecosystem, indicating a wider variation between the TRF animal groups than the SAV groups. In both the SAV and TRF ecosystems, some responses included animals from two or three different continents for the same ecosystem.

Animals of FEN were least known, though the animals that were most frequently mentioned in the fen ecosystem were nearly identical to those in the SCF ecosystem, except for animals such as reindeer (*Rangifer tarandus*), common crane (*Grus grus*), mosquitoes, and western capercaillie (*Tetrao urogallus*). The fen ecosystem had the greatest variation of mentioned animal names as compared to any other ecosystem.

The Information Sources of the Animal Knowledge

It was found that in general, school was the primary source of information, followed by the media (TV, magazines, scientific books) and the home. Hobbies and other sources such as friends or fairy tales were considerably less important sources of this information. No mentioning of poems or person's own ability to draw conclusions, were found.



Discussion

In this study students' and student's teachers' ability to name the animals with reference to four ecosystems were studied. The first general finding was that the majority of respondents were able to name mainly *the right animals* into the corresponding ecosystems. The connection between the animal and the ecosystem seemed to be known by respondents for their free-listed animals. This is in line with the results of the study of Eloranta and Yli-Panula (2005), where the respondents drew animals they want to conserve in the ecosystem. The second finding was that there was *little variation between the animal names* mentioned by respondents. The animal names were almost the same than in the study where respondents were asked to name nesting animals into the same four ecosystems (Yli-Panula & Matikainen, 2013a). These results confirm the hypothesis that students and student teachers have a limited ability to name animals according to their living environments, *especially at the species level* (the third finding).

Mammals and *birds* were the most frequently mentioned animal groups. This result corresponds to recent studies, where pupils were asked to free-list the animals they know (Patrick et al., 2013) or to name nesting animals in ecosystems (Yli-Panula & Matikainen, 2013a) or to draw animals in the landscape the pupils would like to conserve (Eloranta & Yli-Panula, 2005). However, the results are not in line with the most frequent, commonly appearing organisms or taxa in nature or animal biomass of the ecosystem (see Snaddon et al., 2008). Further, the number of birds was only one third of mammals. This result is in keeping with the hypothesis of the present study and with earlier studies (Bell, 1981; Kellert, 1985; Morris, 1982; Snaddon et al., 2008). The *invertebrates* were often forgotten from all ecosystems, although they are an essential part of biodiversity, as it was the case in cerrado ecosystem by Bizerril (2004).

Lindemann-Matthies (1999) stated that the children's observations of the species reflect their *preference to certain animals*, which are mainly mammals. Patrick and Tunnicliffe (2011) reported similar findings. The impressive appearance of these mammals may be a factor why they were frequently mentioned to all ecosystems and especially to the SAV and TRF ecosystems. The exotic animals included large mammals such as giraffes, lions, elephants, rhinoceros, gorillas, leopards, and closest evolutionary relatives of humans - orangutans or chimpanzees. Some of these big mammals are threatened or vulnerable species. The results concerning the exotic animals are in line with those of Gayford (2000), Morris and Schagan (1996), who showed that the students are mainly interested in exotic animals, especially animals living in rainforests. In their studies, the students did not focus on the habitat of the animals as much as they did on the animal itself.

The variety of animal names was small compared to the number different animals existing in the ecosystems, however there was some variation in relation to the autecological matters. The names included predators / carnivores (i.e. hyenas, gyps), preys (i.e. hare, woodpecker, nest ant), herbivores, few threatened or vulnerable mammals (e.g. wolves and rhinoceros) and birds (sea eagle). According to recent studies (Prokop et al., 2011; Prokop, Kubiátko & Fančovičova, 2008; Prokop & Tunnicliffe, 2010) people often have attitudes towards the predators, carnivores or their prey - fear or feelings - and this is often why they are easily remembered. The attitudes were most probably one important explanation to the results of the present study, so was the large size for the remembered animal names. None of the respondents had included representatives of all levels of food chains in their answers, e.g. detritivores were mostly missing. It appeared that naming of animals was not based on the food chain/web. Research results show that students' knowledge of the animals in relation to their autecological matters is weak and should be improved in teaching and in all information sources provided.

The animals of the Finnish fen were less known compared to SCF and two exotic ecosystems. According to the Finnish biology and geography curricula (National Board of Education, 2003, 2004), not only the local SCF ecosystem, but also the fen ecosystem is required to be studied at school. SCF ecosystem is common in Finland, however the fen is not easily reached because it is more common in the northern part of Finland, so the lack of respondents' personal nature experience of the fen, could partly explain these results. In line with our results also Lindemann-Matthies (2002), Lindemann-Matthies and Bose (2008), and Patrick and Tunnicliffe (2011) emphasized the importance of rich personal experiences and observations to be able thoroughly learn the local, regional species.

The present results, in terms of low number of animal names of Nordic fen, most clearly showed the *limited ability of animal autecological knowledge* of the respondents. They had named numerous animals, which can appear both in SCF and in FEN. However, these animals were named into SCF ecosystem only, not into the fen, although there were suitable hiding, eating and reproduction places in both ecosystem pictures for these animals to survive. This means that the respondents knew the animal names, but in lack of knowledge of the animal autecology they



were not able to link the animals to all possible ecosystems. Examples of these animals could be elk (exists in fen and SCF) and some species of monkeys in exotic ecosystems. An ant, which was named in some of the answers, could be an example of an animal existing in all of the four ecosystems.

Maintaining *biodiversity* is a crucial issue and animals are important in regard to biodiversity of the ecosystems. The answers of the respondents did not show strong understanding of biodiversity (the answers included representatives of only 2 or 3 animal groups, very few species etc.). There is general agreement that knowledge of the existence of living organisms in relation to their environment is as important as the skills to observe these organisms. This is one of the central issues of education with regard to the biodiversity (Lindemann-Matthies & Bose, 2008). According to this there are several biodiversity-related issues, which should be studied in the future.

The main *information sources* were school and media. Finnish schoolbooks introduce often mammals and birds, but more seldom fish, amphibia, reptiles and invertebrates. These information sources also partly explain why mammals and birds were over-represented in the results. Reading the literature, e.g. fairy tales, in childhood (Eloranta & Yli-Panula, 2005; He, 2009) can also help to remember the names of the animals. Animals of the Finnish fairy tales, e.g. wolf, fox, ant, swan, goose and crow were listed among named animals. Also socially shared beliefs and folk biological knowledge of animal classification (Patrick et al., 2013) can be a source to explain some of the remembered animal taxa in this study, but these were not included to the alternatives of sources asked. However, the respondents were not very conscious of animal taxonomy, since no species names were provided for many of the mentioned animals, although the survey asked for the species name.

It has been shown that internet itself did not induce better learning results (Randler, 2010), however, several virtual learning tools have already been introduced and this rises up the question, how should the students in general be stimulated to reach the higher-order cognitive skills (Anderson et al., 2001) in animal related issues in virtual studies - how should their system thinking be supported. The power of virtual learning is shown in the study of Ballour and others (2011) showing that schoolchildren were more prone to protect "virtual" (unseen, exotic) animals than local animal species.

The researchers encountered some challenges in appropriately classifying the animals into different taxonomic levels (see studies Yli-Panula & Matikainen, 2011, 2013b). These problems caused by unclear classification with respect to animal taxonomy/ language were solved in the respondent's favour. Spelling mistakes were overlooked. One limitation dealing with the information sources was that there should have been more detailed categories about the sources. However the study groups seem to be representative, especially with regard to the primary school student teachers in Finland since the basic knowledge level of the primary school student teachers (30 % attended both studies) was very similar in three Finnish Universities (Palmberg et al., 2008).

This study design was not built up to study deeply the knowledge of autecological issues of animals of the respondents, but the results - in a simple way - showed that in order to understand biodiversity the respondents need also to have the ability of autecological understanding. This is an important point for effective learning and should be a focus when learning animals at schools.

Conclusion and Implications

The results show that the respondents knew animal names in relation to ecosystem, and the free-listed 10 animal names did not vary very much between the respondents. Mammals and birds were the most frequently named animals. As expected, the knowledge of animal species increased with age and the "best" responses (other names than mammals, a number of species mentioned per ecosystems) were those by subject student teachers. However, the thoughts or knowledge connected to the autecological issues of animals were not shown in the answers, neither was the multifaceted ecosystem thinking and food web approach common or possible to be interpreted in the answers of any of the respondent groups. Now, once we have an overview of the level of respondents' animal knowledge, it rises up some challenges.

One implication of this study is how the curricula and teaching/learning practices could support students' system thinking and ecological approach to animals or support the animal related activities and outdoor learning to study animals or as a future aspect how the animal studies should be better organized in virtual environments.

The other implication simply is how the studies of the local animals versus exotic species should be developed. The virtual study environment can visualize the animals to make learning attractive, but how to organize the learning in relation to environment to support cognitive skills or interactive and collaborative learning in virtual environments - this should be a future focus when learning animals at schools.



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References

- Anderson, L. W., Krathwohl, D. R., Airasian, P. W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Rath, J., & Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing. A revision of Bloom's taxonomy of educational objectives*. Abridged Edition. New York: Addison Wesley Longman.
- Ballood, J. M., Ballouard, J. M., Brischoux, F., & Bonnet, X. (2011). Children prioritize virtual exotic biodiversity over local biodiversity. *PLoS ONE*, 6 (8), 1-8.
- Balmford, A., Clegg, L., Coulson, T., & Taylor, J. (2002). Why conservationists should heed pokémon. *Science*, 295 (5564), 2367.
- Bell, B. F. (1981). When is an animal, not an animal? *Journal of Biological Education*, 15 (3), 213-218.
- Barney, E. C., Mintzes, J. J., & Yen, C. F. (2005). Assessing knowledge, attitudes, and behavior toward charismatic megafauna: The case of the dolphins. *Journal of Environmental Education*, 36 (2), 41-55.
- Bizerril, M. X. A. (2004). Children's perceptions of Brazilian Cerrado landscapes and biodiversity. *The Journal of Environmental Education*, 35 (4), 47-58.
- Braun, M., Buyer, R., & Randler, C. (2010). Cognitive and emotional evaluation of two educational outdoor programs dealing with non-native bird species. *International Journal of Environmental & Science Education*, 5, 151-168.
- Convention on Biological Diversity, CBD (1992) Article 2. *Use of Terms*. Retrieved from: <http://www.cbd.int/convention/articles.shtml?a=cbd-02> Accessed: February 10th 2012.
- Dalton, R. (2005). A wing and a prayer. *Nature*, 437, 188-190.
- Eloranta, V. (2004). Maisema, joka halutaan säilyttää – suomalaisten ja venäläisten lasten ja nuorten piirrosten analyysi. [Landscapes that Finnish and Russian children and adolescents want to conserve – an analysis of drawings]. In: S. Ahonen & A. Siikaniva (Eds.), *Eurooppalainen ulottuvuus. Ainedidaktinen symposium 6.2. 2004. Helsingin yliopiston soveltavan kasvatustieteen laitos, Tutkimuksia*, 252, 3-15.
- Eloranta, V., & Yli-Panula, E. (2005). Animals in the landscape drawings of the Finnish and Russian young people – in the landscape they want to conserve. *Nordic Studies in Science Education*, 2 (5), 5-17.
- Flannery, M. C. (1991). Considering plants. *The American Biology Teacher*, 53, 306-309.
- Finnish National Core Curricula* (2004). Helsinki. National Board of Education.
- Gayford, C. (2000). Biodiversity Education: A teacher's perspective. *Environmental Education Research*, 6 (4), 347-361.
- Hamilton, A. (2005). Species diversity or biodiversity? *Journal of Environmental Management* 75, 89-92.
- Helldén, G., & Helldén, S. (2008). Students' early experiences of biodiversity and education for sustainable future. *Nordic Studies in Science Education*, 4 (2), 123-131.
- Hershey, D. R. (1996). A historical perspective on problems in botany teaching. *The American Biology Teacher*, 58, 340-347.
- He, C. Z. (2009). Poetic wolves and environmental imagination: representations of the wolf in recent Chinese literature. *Neohelicon*, 36 (2), 397-410.
- Hooper, D. U., Chapin III, F. S., Ewel, A., Hector, P., Inchausti, P., Lavorel, S., Lawton, J. H., Lodge, D. M., Loreau, M., Naeem, S., Schmid, B., Setälä, H., Symstad, A. J., Vandermeer, J., & Wardle, D. A. (2005). Effects of biodiversity on ecosystem functioning. *Ecological Monographs*, 75, 3-35.
- Huxham, M., Welsh, A., Berry, A., & Templeton, S. (2006). Factors influencing primary school children's knowledge of wildlife. *Journal of Biological Education*, 41 (1), 9-12.
- International Union for the Conservation of Nature (1994) *A guide to the convention on biological Diversity*. Gland, Switzerland, IUCN.
- Kaasinen, A. (2009). *Kasvilajien tunnistaminen, oppiminen ja opettaminen yleissivistävän koulutuksen näkökulmasta*. [Plant species recognition, learning and teaching from the viewpoint of general education]. Helsingin yliopisto, Käyttätymistieteellinen tiedekunta, Soveltavan kasvatustieteen laitos, Tutkimuksia 306. Ph.D. Thesis, University of Helsinki, Finland.
- Kellert, S. R. (1985). Attitudes toward animals: age-related development among children. *The Journal of Environmental Education*, 16 (3), 29-39.
- Lindemann-Matthies, P. (1999). *Children's perception of biodiversity in everyday life and their preferences for species*. Ph.D. Thesis, University of Zurich, Switzerland.
- Lindemann-Matthies, P. (2002). The influence of an educational Program on children's perception of biodiversity. *The Journal of Environmental Education*, 33 (2), 22-31.
- Lindemann-Matthies, P. (2005). Loveable mammals and lifeless plants: how children's interest in common local organisms can be enhanced through observation of nature. *International Journal of Science Education*, 27 (6), 655-677.
- Lindemann-Matthies, P. (2006). Investigating nature on the way to school: Responses to an educational programme by teachers and their pupils. *International Journal of Science Education*, 28 (8), 895-918.
- Lindemann-Matthies, P., & Bose, E. (2008). How many species are there? Public understanding and awareness of biodiversity in Switzerland. *Human Ecology*, 36 (5), 731-742.



- Löwe, B. (1992). *Biologiunterricht und Schulerintresse an Biologie*. Weinheim: Deutscher Studien Verlag.
- Menzel, S., & Bögeholz, S. (2009). The loss of biodiversity as a challenge for sustainable development: How do pupils in Chile and Germany perceive resource dilemmas. *Research of Science Education*, 39 (4), 429-447.
- Morris, D. (1982). *Der Mensch mit dem wir leben*. München: Droemersch Verlaganstalt.
- Morris, M., & Schagan, I. (1996). *Green attitudes or learned response?* Slough: NFER.
- National Board of Education (2003). The Finnish National Core Curriculum for Basic Education. Retrieved from: http://www.oph.fi/english/curricula_and_qualifications/basic_education.
- National Board of Education (2004) The Finnish National Core Curriculum for General Upper Secondary School. Retrieved from: http://www.oph.fi/english/curricula_and_qualifications/general_upper_secondary_education
- Norrgård-Sillanpää, P., Berg, I., Jeronen, E., Kärkkäinen, S., Palmberg, I., Persson, C., & Yli-Panula, E. (submitted). Student teachers' interest in and conceptions about species and species identification.
- Nyberg, T., & Lehtiö, P. (1997). *Koulun biologia, Metsät ja suot, opettajan opas*. Helsinki: Otava.
- Patrick, P., & Tunnicliffe, S. D. (2011). What plants and animals do early childhood and primary students' name? Where do they see them? *Journal of Science Education and Technology*, 20, 630-642.
- Patrick, P., Byrne, J., Tunnicliffe, S. D., Asunta, T., Carvalho, G. S., Havu-Nuutinen, S., Sigurjonsdottir, H., Oskarsdottir, G., & Tracana, R. B. (2013). Students (ages 6, 10 and 15 years) in six countries knowledge of animals. *Nordic Studies in Science Education*, 9 (1), 18-32.
- Palmberg, I. (2012). Artkunskap och intresse för arter hos blivande lärare för grundskolan. [Student teachers' knowledge of and interest in species]. *Nordic Studies in Science Education*, 8 (3), 244-257.
- Palmberg, I., Jeronen, E., & Yli-Panula, E. (2008). Luokanopettajaksi opiskelevien tiedot ja käsitykset opetusuunnitelman sisältämistä biologian, maantieteen ja terveystiedon perustiedoista opiskelun alkuvaiheessa. [The primary school students teachers' knowledge and conceptions of the basic knowledge of biology, geography and health education]. In A. Kallioniemi (Ed), *Uudistuva ja kehittyvä ainedidaktiikka. Ainedidaktinen symposiumi 8.2.2008, Osa I. Tutkimuksia* 298, 51-64
- Palmberg, I., Berg, I., Jeronen, E., Kärkkäinen, S., Norrgård-Sillanpää, P., Persson, C., Vilkonis, R., & Yli-Panula, E. (submitted). Nordic-Baltic student teachers' identification of species and understanding of biodiversity and sustainability.
- Prokop, P., & Rodak, R. (2009). Ability of Slovakian pupils to identify birds. *Eurasia Journal of Mathematics, Science & Technology Education*, 5 (2), 127-133.
- Prokop, P., Kubiátko, M., & Fančovičová, J. (2008). Slovakian pupils' knowledge of and attitudes toward birds. *Anthrozoos*, 21 (3), 221-235.
- Prokop, P., & Fančovičová, J. (2010). Perceived body condition is associated with fear of a large carnivore predator in humans. *Annales Zoologici Fennici*, 47 (6), 417-425.
- Prokop, P., & Tunnicliffe, S. D. (2008). "Disgusting" Animals: Primary school Children's Attitudes and Myths of Bats and Spiders. *Eurasia Journal of Mathematics, Science & Technology Education*, 4 (2), 87-97.
- Prokop, P., & Tunnicliffe, S. D. 2010. Effects of having pets at home on children's attitudes toward popular and unpopular animals. *Anthrozoos*, 23 (1), 21-35.
- Prokop, P., Usak, M., & Erdogan, M. (2011). Good predators in bad stories: Cross-cultural comparison of children's attitudes towards wolves. *Journal of Baltic Science Education*, 10 (4), 229-242.
- Rakison, D. H. (2009). Does women's greater fear of snakes and spiders originate in infancy? *Evolution and Human Behavior*, 30, 438-444.
- Randler, C. (2008a). Pupils' factual knowledge about vertebrate species. *Journal of Baltic Science Education*, 7 (1) 48-54.
- Randler, C. (2008b). Teaching species identification – a prerequisite for learning biodiversity and understanding ecology. *Eurasia Journal of Mathematics, Science and Technology Education*, 4 (3), 223-231.
- Randler, C., & Bogner, F. X. (2006). Cognitive achievements in identification skills. *Journal of Biological Education*, 40, 161-165.
- Randler, C. (2010). Animal related activities as determinants of species knowledge. *Eurasia Journal of Mathematics, Science & Technology Education*, 6 (4), 237-243.
- Randler, C., Osti, J., & Hummel, E. (2012). Decline in interest of biology among elementary school pupils during a generation. *Eurasia Journal of Mathematics, Science and Technology Education*, 8 (3), 201-205.
- Schussler, E. E., & Olzak L. A. (2008). It's not easy being green: student recall of plant and animal images. *Journal of Biological Education*, 42 (3), 112-118.
- Snaddon, J. L., Turner, E. C., & Foster, W. A. (2008). Children's perceptions of rainforest biodiversity: which animals have the Lion's share of environmental awareness? *PlosOne*, 3 (7), 1-5.
- Strommen, E. (1995). Lions and tigers and bears, Oh My! Children's conceptions of forests and their inhabitants. *Journal of research in science teaching*, 32 (7), 683-698.
- Tunnicliffe, S. D., & Reiss, M. J. (1999). Building a model of the environment: How do children see animals? *Journal of Biological Education*, 33 (3), 142-148.
- Walker, B. H. (2006). Biodiversity and Ecological Redundancy. *Conservation Biology*, 6 (1), 18-23.
- Van Weelie, D., & Wals, A. E. J. (2002). Making biodiversity meaningful through environmental education. *International Journal of Science Teaching*, 24 (11), 1143-1156.
- Wandersee, J. H. (1986). Plants or animals—which do junior high school students prefer to study? *Journal of Research in Science Teaching*, 23 (5), 415-426.
- Wandersee, J. H., & Schlusser, E. E. (1999). Preventing plant blindness. *The American Biology Teacher*, 61, 84-86.
- Yli-Panula, E., & Matikainen, E. (2011). Tiedot eliökunnan monimuotoisuudesta perustana kestäväälle kehitykselle - Opettajaksi



- opiskelevien eläinlajitietämys ekosysteemeittäin. [Knowledge of biodiversity of animal kingdom as the basis for sustainable development – Student teachers' consciousness of animal species according to ecosystems]. In: L. Tainio, K. Juuti, A. Kallioniemi, P. Seitamaa-Hakkarainen and A. Uitto (Eds.), *Näkökulmia tutkimusperustaiseen opetukseen. Suomen ainedidaktisen seuran julkaisuja, Ainedidaktisia tutkimuksia*, 1, 185-200.
- Yli-Panula, E., & Matikainen, E. (2013a). Preservice teachers' ability to name nesting animals in ecosystems – a perspective of biodiversity. In: J. Wright (Ed.), *Proceedings of the AARE-Conference*, Adelaide 2013, Australia. Retrieved from: <http://www.aare.edu.au/index.php>
- Yli-Panula E., & Matikainen E. (2013b). Opettajaopiskelijoiden nimeämät pesivät eläimet ekosysteemeissä – monimuotoisuus ja ympäristölukutaito. [Primary school teacher students' ability to name animals in ecosystems – a perspective of biodiversity and environmental literacy]. *Natura*, 3, 57-65.
- Yli-Panula E., & Pollari H. (2013). Luokanopettajien tietämys lajintuntemus, biodiversiteetti ja kestävä kehitys käsitteistä ja niiden väliset suhteet. [The consciousness of primary school student teachers of the concepts species identification, biodiversity and sustainable development and their relation]. In: E. Yli-Panula, H. Silfverberg and E. Kouki, (Eds.), *Opettaminen valinkauhassa. Suomen ainedidaktisen tutkimusseuran julkaisuja, Ainedidaktisia tutkimuksia*, 7, 35-49.

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