

Article

Species Learning and Biodiversity in Early Childhood Teacher Education

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Abstract: To understand biodiversity, it is crucial to have knowledge of different species and their life conditions. Biodiversity learning for children starts with observing plants and animals in the neighbourhood. Therefore, it is important that early childhood (EC) teachers know the local nature. There are few studies on species knowledge among EC student teachers but results from a Norwegian study show that although EC student teachers had poor species knowledge when entering university, their knowledge increased remarkably during their studies. Based on these results, the current study investigates the implementation of species learning in an EC teacher education course in Finland. Our aim was to study the student teachers' species identification skills, their views on the importance of species knowledge, and their experiences of species learning. The study used a mixed-methods approach and included species identification tests, a questionnaire, learning diaries, and focus group interviews. The results show that the student teachers were eager to learn about species. They found species learning important both for EC teachers and for sustainability, and they appreciated learning about species in a broad sense, from personal, educational, and social perspectives. Our conclusion is that implementing species knowledge in EC teacher education promotes an interest in the natural world and may form a significant contribution to nature and sustainability education for EC teachers.

Keywords: early childhood teacher education; early childhood education; biodiversity learning; biodiversity education; species knowledge; species learning; sustainability education; Finnish early childhood teacher education; outdoor education; student teachers

1. Introduction

Learning about nature and sustainability is an important part of early childhood (EC) teacher education in Finland. The National core curriculum for early childhood education and care and the National core curriculum for pre-primary education emphasize sustainability as a basic aim of early childhood education (ECE) [1,2]. Both documents stress that children need to develop a responsible relationship with nature. ECE shall promote the development of ethics and aesthetics in relation to nature, and offer children possibilities to study and explore nature, observe with all their senses, and experience the four seasons, according to the documents. In addition, children shall discover the local environment and learn to recognize plants and animals [2]. In Finland, ECE includes children from birth until the beginning of school at the age of seven. Pre-primary education means explicitly education in the last year before children enter school. This means that ECE is an umbrella concept.

Species knowledge is also a topic in the National core curriculum for basic education (age 7 to 16) in Finland [3]. However, Finnish primary school student teachers' species identification skills are poor [4–8], and the situation is the same in many other countries [7,9–11]. Species knowledge among EC student teachers is scarcely investigated. In a study from Norway, Skarstein and Skarstein found

that EC student teachers' species knowledge was low when they entered university [12,13]. However, after learning about local species in their first study year, they seemed to retain the knowledge well, and the student teachers used their species knowledge during their practical training periods in kindergartens. The majority of the student teachers also found it important that EC teachers have knowledge of common, local species. Based on these results, we decided to introduce species training into an EC teacher training course in Finland and to study the student teachers' species learning.

2. Literature Review

Before we describe this study in more detail, we will provide the background based on literature on species training in primary teacher and EC teacher education. Through policy documents and literature, we will also acknowledge the necessity of understanding biodiversity and having species knowledge for persons working within ECE.

2.1. Sustainability, Biodiversity and Species Knowledge

Sustainability is often divided into ecological (or environmental), economic, and social (or social/cultural) dimensions [14,15]. However, these dimensions overlap, and the distinction is widely discussed and criticized [15,16], and there are voices asking for new holistic sustainability paradigms [15,16], also in relation to ECE. Some of them, for example emphasize, post humanistic approaches and indigenous knowledge [16,17]. The United Nations Sustainable Development Goals (SDGs) were created as part of the post-2015 development agenda (Agenda 2030) and address today's global challenges, including climate change, environmental degradation, poverty, and inequality [18]. The agenda emphasizes that children need to be involved in sustainability processes. Likewise, Sustainable Development Solutions Network mentions children and young people as central agents of change in the shaping of a better future [19]. According to the Strategic Plan for Biodiversity 2011–2020, the protection of biodiversity strongly connects to the 2030 Agenda and its SDGs [20]. The strategic plan and its Aichi Biodiversity Targets adopted under the Convention on Biological Diversity set the global priority framework for biodiversity.

Biodiversity includes diversity at the genetic, species, and ecosystem levels and contributes directly to human well-being and development. Preserving biodiversity is vital for human existence and good quality of life because of human dependence on natural resources [21]. Nature provides food, energy, medicines, and various materials essential for all people in the world to fulfill their daily subsistence needs. In addition, biodiversity contributes to the non-material aspects of the quality of life [21] and relates to every species' intrinsic right to live [22]. The loss of biodiversity has been a problem for a long time, but more species on earth are threatened by extinction now than ever before during human existence. About 25% of the plant and animal species worldwide are under the threat of extinction [21] and several studies report on the ongoing global sixth mass extinction event consisting of a massive decline in biodiversity [23].

Learning about and understanding biodiversity requires basic knowledge of species, their life history, and identification [24]. Therefore, species knowledge is not only about naming. It is also about the ability to recognize the species in their habitats, knowing how and where they live, and how they interact with other species [13]. According to Skarstein and Skarstein, species knowledge, therefore, includes ecological knowledge [13]. The protection of biodiversity depends on humans that have knowledge about species, as well as ecosystems, and that understand how nature and species connect to society [25,26]. Although knowledge about species and understanding the importance of biodiversity relate to ecological sustainability, loss of biodiversity has obvious implications for societies and their economies as well.

Ecological literacy constitutes the ecological domain of sustainability and is thus an important aspect of ecological sustainability. It includes the ability to go out in nature and recognize organisms, to understand ecological processes, and to realize the human impact in particular places [27,28]. Those who learn to recognize plants, animals, and natural phenomena, and regularly spend time in

nature, develop skills to observe and make ethical judgments related to the human use of nature [25]. Species learning outdoors also promotes an understanding of ecology and biodiversity [27,29]. At the same time, nature offers exciting and unpredictable experiences, which can be aesthetic, kinetic, and emotional at the same time [25]. Species knowledge triggers both an interest in nature and an engagement in environmental issues [6,7,30]. Through species learning outdoors, adults can cultivate children's ability to observe, reflect, and remember what they experience.

2.2. Sustainability Education and Biodiversity Learning in Early Childhood Education

Sustainability education research in relation to ECE has been rare until recently, but the past decade has seen a remarkable increase in this field [31,32]. However, there is still an obvious lack of research on sustainability education in EC teacher education [33,34]. EC teachers are crucial promoters of young children's learning about sustainability issues [35,36] and methods for implementing sustainability education in ECE need to be developed [37]. EC teacher education should also be designed in a way that gives the future teachers the opportunity to actively work for a sustainable future and support children's learning about sustainability issues. In this process, adults are important as role models communicating their interest, knowledge, and appreciation of nature [38,39].

Biodiversity learning is an essential part of sustainability education. During a three-year biodiversity project in Finland, which included teachers and children from nurseries, preschools, and primary and secondary schools, it became clear that biodiversity is a topic that children can learn about already in their early years [40,41]. The EC institutions were, in fact, the most eager participants in this project. A crucial aim of biodiversity education for young children is that they begin to understand the importance of relationships between living and non-living nature and the species' dependence on local habitats [42,43]. Species learning in EC takes place mainly through play-based learning. In an Australian project that Edwards and Cutter-Mackenzie, and Edwards et al. describe, the teachers used three different play types: Open-ended play, modelled play, and purposefully framed play [42,44]. Of these play types, the first is the most child-centred and the third the most adult-led. Each play type aimed at triggering exploration, reflection, discussion and, last but not least, the children's awareness of biodiversity. Edwards and Cutter-Mackenzie see all the three play types as crucial and acknowledge the role of the teacher. The pedagogical strategies, like the teachers' choice of methods and way of teaching about concepts, are important in sustainability education with young children [42].

The Finnish project employed complex methods, including both indoor and outdoor activities [40]. According to the adults who replied to the evaluation inquiry, the outdoor experiences were more important than the indoor experiences when learning about biodiversity. However, the best results came from a combination of outdoor and indoor activities, in which the adults and children jointly processed the outdoor experiences indoors [41]. This correlates with the results of Edwards and Cutter-Mackenzie [42]. They report about a teacher who combined outdoor activities with looking at pictures indoors when the children learned about bug species. Besides outdoor studies, exploration, and trips, the Finnish participants used drama, music and visual art, picture studies, and cultivation of plants and taking care of stick insects, etc., indoors. Linguistic processing in the form of discussions dealt with both content knowledge and experiences but also ethics. Edwards and Cutter-Mackenzie used, for example, concepts like animal sounds, markings, camouflage, food supply, identification, classification, and habitat to teach the children about biodiversity [42]. In the Finnish project, the children discussed ethics related to, for example, whether it is right to pick flowers and keep small animals in jars [41]. Surprisingly, the children's ethical limits about what should be allowed were more restricted than the adults'.

According to Skarstein and Skarstein, species names are part of our language and culture [12]. They are important when communicating and sharing nature experiences with others. The names of the species help us to learn more about nature and relationships in nature. They are like hooks on which we can hang ecological knowledge [12].

Significant for learning at all ages is also the aesthetic dimension of learning in which experiences and understanding unite and develop in contemplation, reflection, and dialogue [25]. The aesthetic experience is a central part of humans' relationship with nature [25,45,46]. Humans experience nature aesthetically on many levels, from admiring beautiful landscape views to observing the coloration of butterflies and flowers. However, it is not only a visual engagement but builds on all senses [45–47]. Aesthetic experiences come about in situations in which humans interact with their environment [48]. Outdoor authentic nature experiences influence attitudes towards other species already in childhood [49].

2.3. Student Teachers and Species Knowledge

If teachers are ignorant when it comes to species, children cannot be encouraged to develop ecological literacy. Results from several studies show that adult role models are important in encouraging the development of children's positive attitudes towards nature and nature conservation [50–52]. In addition to family members and other close associates, teachers have an important role to play in sharing their interest, knowledge, and appreciation of nature with children and thus stimulating children's interest in nature. However, teachers need knowledge and skills to carry out high-quality teaching [24,53].

Not knowing something is not necessarily the same as not wanting to know. Researchers, who have studied species knowledge among student teachers, have found that even if student teachers might be ignorant when it comes to species knowledge, they often think this knowledge is important, especially in relation to sustainability [7,13,24]. Student teachers also view biodiversity as important for sustainability, although they might not be able to interpret the concept [24]. In addition, knowing about local species makes student teachers more confident when it comes to bringing children out in nature [10].

The majority of the EC student teachers in Skarstein and Skarstein's study viewed species knowledge as both important and useful, especially in connection with nature excursions with children [13]. The student teachers considered that species knowledge was important for EC teachers because it enabled them to talk to children about nature, answer children's questions, foster children's curiosity, and strengthen children's relationship with nature. They also argued that species knowledge is important for sustainability because it helps people to understand nature and develop a desire to take care of nature [13].

Indoor studies complement outdoor studies, but outdoor methods are more efficient when learning about species since outdoor environments offer crucial nature experiences [7,11]. In Palmberg et al.'s investigation among student teachers in three Nordic countries, the student teachers described outdoor experiences as authentic [11]. Authentic experiences enable hands-on experiences and promote long-term memory [54]. The student teachers thought that living plants and animals in their real habitats were the best sources for learning about species. Another study by Palmberg et al. focused on species learning in four countries (three Nordic, one Baltic) [7]. The student teachers in this study found it important not only to observe species but also to smell and touch, especially when it came to learning about plants.

3. Study Aims and Research Questions

The purpose of this study was to investigate Finnish EC student teachers' (from now on referred to as students) species identification skills and their views on the importance of species knowledge. We also aimed to investigate how the students experienced species learning when we introduced it as part of their study program. An underlying motive has been to improve nature and sustainability education for EC teachers. The research questions were:

1. How well do the students identify common species before and after species training?
2. What are the students' views on the importance of species knowledge for EC teachers?

3. What are the students' views on the importance of species knowledge for sustainable development?
4. How do the students experience species learning?

4. Materials and Methods

With experience from studies and practice in Norway [12,13], species learning was introduced as part of an EC teacher education science course at a university in Finland in spring 2019. The science course was called Nature, environment, and sustainability, and it was a 5 ECTS (European Credit Transfer and Accumulation System) course taking place in March and April. In both Finland and Norway, EC teacher education takes three years (bachelor's degree), and the students start their studies with secondary school education as a base. Both countries also have a tradition of outdoor activities and outdoor play as an important part of EC education.

The course Nature, environment, and sustainability runs during the second semester of the students' study program at the university. During the study, the number of participants on the course was 25. The course program included lectures, practical lessons (science experiments, biology studies), study visits, outdoor education (see Table 1), and independent individual and group work). During the teacher-led part of the course, the students participated in lectures, indoor activities in the science and biology rooms and learning activities in a botanical garden, a reuse center, an urban recreation area on a small island, and at a nature center (a field study center). In addition to the teacher-led activities, the students visited a zoological museum, a farm (open for families and children), and libraries (to explore books related to the course topic) on their own in small groups. Information about the course, such as lectures, exercises, literature, and a comprehensive weblink collection, was available on a course web page. During the entire course, the students had the possibility to train species knowledge during both the outdoor activities and indoors with the help of books, stuffed animal specimens, and digital species identification tools.

Table 1. The scheduled program of the course Nature, environment, and sustainability.

Content	Duration (x 45 min.)	Method
Introduction	2	Lecture
Science with children	2	Experiments in the science lab
Science learning	2	Lecture
Science meets art	4	Lecture and outdoor activities in collaboration with a lecturer in visual art (architecture, bird watching, nature art, etc.)
Learning about recycling and reuse	2	Visit to a reuse centre's educational office to meet their educators and see how they work
Species knowledge and children	2	Lecture
Learning about plants	2	Activities in a botanical garden
Sustainability and animal species	4	Lecture and group work indoors
Outdoor activities with children and sustainability	6	Whole day visit to a nature centre (outdoor and indoor activities)
Final seminar	4	Group work presentations and discussions

4.1. Study Design

The study had a mixed-methods design using both qualitative and quantitative approaches [55]. The purpose of mixing methods was to mutually enhance and enrich the different approaches, i.e., to complement the qualitative and quantitative results [56]. We collected the quantitative data using species identification tests and close-ended questions in a questionnaire, and the qualitative data using open-ended questions in a questionnaire, learning diaries, and focus group interviews. After analyzing the data, we compared and discussed the quantitative and qualitative results together.

4.2. Participants and Sampling Procedures

Even if the total number of students on the course Nature, environment, and sustainability was 25, the number of participants varied between 18 and 23 for the different parts of the study. All the students were namely not present on all sampling occasions (see results for exact sample sizes).

We conducted the first species identification test (pretest) and the survey at the same time at the beginning of the course, and the students answered the test and the survey anonymously. The second species identification test (post-test) and the focus group interviews took place on the last day of the course, and the students submitted their learning diaries after the course had ended. The site for the species tests, the survey, and the interviews was the university campus, but the students wrote their individual learning diaries at home. We designed the pretest, the questionnaire, and the focus group interviews solely for research purposes, whereas the post-test and the learning diaries were parts of the course program. To exclude the possibility of the students preparing, we did not inform them about the pretest, the survey, and the focus group interviews before the day these took place.

The study followed the national ethical guidelines of Finland. Participation in the study was voluntary, and all participants gave their informed written consent. In analyzing the post-test results and learning diaries, we used pseudonyms to protect the students' identities.

4.3. Species Identification Tests

The pretest included 18 printed color photographs of common species (six birds, six plants, and six mammals) (Table 2). All the 18 species were included in a species list that the students received after the pretest on the course web page. This list included 95 common Finnish species, which the students should learn to identify during the course (32 birds, 18 mammals, 4 reptiles, 3 amphibians, and 38 plants). In addition, the students had to learn five bird sounds.

The post-test included 24 color photographs of common species from the species list (seven birds, six mammals, one reptile, one amphibian, and eight plants) (Table 2). In addition, the test included one bird sound. Four of the species were the same in both the pretest and the post-test (Table 2), although the ermine picture in the pretest showed the animal in its winter coat and in the post-test in its summer coat.

In both tests, the students' task was to write down the common names of the species. When evaluating the answers, we were only concerned with the correct common names at the species level but accepted names in both Finnish and Swedish (the two official languages in Finland), as well as Latin, and names with minor spelling mistakes.

The study from Norway also tested students' identification skills with a species test, including 18 common Norwegian species [13]. Ten of the species in our pretest (five birds and five plants) were the same as in the Norwegian study since these were also common species in Finland (Table 2).

4.4. Questionnaire

The questionnaire, which the students answered at the same time as they took the pretest, included the following four questions:

- Q1.** Do you consider that species knowledge is important for those who work in nurseries and preschools?
- Q2.** Explain your answer.
- Q3.** Do you think species knowledge is important for sustainable development?
- Q4.** Explain your answer.

Table 2. Pre- and post-test species. The species marked with * are the same as used by Skarstein and Skarstein [13].

Pre- or Post-Test	English Name	Latin Name
Mammals		
pre	Yellow-necked mouse/ Yellow-necked field mouse	<i>Apodemus flavicollis</i>
pre	Glutton	<i>Gulo gulo</i>
pre	Mountain hare	<i>Lepus timidus</i>
pre	Badger	<i>Meles meles</i>
pre/post	Ermine	<i>Mustela erminea</i>
pre/post	Raccoon dog	<i>Nyctereutes procyonoides</i>
post	Wolf	<i>Canis lupus</i>
post	Common red-backed vole	<i>Clethrionomys glareolus</i>
post	Brown hare/European hare	<i>Lepus europaeus</i>
post	Eurasian lynx	<i>Lynx lynx</i>
Reptiles		
post	Ring snake/grass snake	<i>Natrix natrix</i>
Amphibians		
post	Common toad	<i>Bufo bufo</i>
Birds		
pre	Whooper swan	<i>Cygnus cygnus</i>
pre	White wagtail *	<i>Motacilla alba</i>
pre	Great tit *	<i>Parus major</i>
pre	Common magpie *	<i>Pica pica</i>
pre	Common bullfinch *	<i>Pyrrhula pyrrhula</i>
pre	Common blackbird *	<i>Turdus merula</i>
post	Eurasian skylark (sound)	<i>Alauda arvensis</i>
post	Mallard	<i>Anas platyrhynchos</i>
post	Bohemian waxwing	<i>Bombycilla garrulus</i>
post	Barnacle goose	<i>Branta leucopsis</i>
post	Western jackdaw	<i>Corvus monedula</i>
post	Robin	<i>Erithacus rubecula</i>
post	Barn swallow	<i>Hirundo rustica</i>
post	House sparrow	<i>Passer domesticus</i>
Plants		
pre	Lily-of-the-valley	<i>Convallaria majalis</i>
pre	Spruce / Norway spruce *	<i>Picea abies</i>
pre	Aspen *	<i>Populus tremula</i>
pre	Rowan *	<i>Sorbus aucuparia</i>
pre/post	Rosebay willowherb *	<i>Chamaenerion angustifolium</i>
pre/post	Coltsfoot *	<i>Tussilago farfara</i>
post	Alder	<i>Alnus glutinosa</i>
post	Common juniper	<i>Juniperus communis</i>
post	Oxeye daisy	<i>Leucanthemum vulgare</i>
post	Herb-paris	<i>Paris quadrifolia</i>
post	Greater plantain	<i>Plantago major</i>
post	Tansy	<i>Tanacetum vulgare</i>

Questions Q1 and Q3 were close-ended questions, where the students gave their score on a four-point Likert scale (the ranked categories were very important, important, less important and not important) with a fifth option of I don't know. Questions Q2 and Q4 were open-ended follow-up questions for Q1 and Q3, giving the students the possibility to explain their answers in their own words. The four questions were similar to those used in the Norwegian study [13]. In the questionnaire, species knowledge referred to a broader knowledge of the species than just the name, such as knowledge of how and where they live.

4.5. Focus Group Interviews

On the last day of the course, both authors together conducted two focus group interviews with two student groups. Nine students participated in each interview, which lasted 20 min per group. We audio-recorded and made notes during the interviews. No records were, however, made about which participant was talking at any given time.

The interviews were based on a series of questions concerning the students' thoughts about species training. We acted as moderators in the interviews, introducing the topics for discussion and facilitating the interaction. The character of the interviews was informal group discussions [57], where we encouraged the students to elaborate on their answers, to share examples of their own experiences and to reflect and comment on each other's opinions and thoughts.

4.6. Learning Diaries

After finishing the course at the end of April, the students wrote learning diaries of seven to ten pages with reflections on experiences from all parts of the course and related their experiences to theories from the course literature and other sources. On the course's web page, the students could find detailed instructions on how to write the learning diaries. The instructions included information about the aims and content, technical guidelines, and the criteria for the grading of the diary. The purposes of the diaries were that (1) the students would achieve deep learning by engaging in their own learning during the course, (2) the teacher would get a better understanding of how the learning occurs, (3) the diaries would contribute to active discussions and collective learning during the course.

The instructions for the diary stated that the content of the diary should include: (1) Knowledge of the central issues of the course in the form of facts, theories and concepts, and new research results and discoveries, (2) the students' own reflections and analyses based on lectures and exercises, (3) the students' own opinions and feelings about their experiences during the course (also negative reactions), (4) references to relevant literature in the field, (5) minutes from and thoughts on discussions during the course.

The deadline for handing in the diaries was at the end of May. Even if some of the students might have written their diaries during the course according to instruction, many of them did not complete their diaries until the course had finished. Of the total number of 25 students participating in the course, 23 submitted the learning diary.

4.7. Analyses

As described in our study design, we first analysed the quantitative and qualitative data separately and then compared and discussed them conjointly. We will now present the separate analyses.

4.7.1. Species Tests and Questionnaire Analyses

First, we calculated descriptive statistics for the results of the species tests and the frequencies of different ranked categories in the answers for the close-ended questions in the questionnaire (Q1 and Q3). Second, we transcribed and analyzed the open-ended answers (Q2 and Q4). When analyzing the open-ended answers, we first used inductive content analysis to find similar items and then deductive content analysis [58] using the categories from Skarstein and Skarstein [13]. However, we discussed the suitability of these categories to our material and, in agreement, modified the categories to better suit our data (Table 3). We excluded one of the categories used in Skarstein and Skarstein [13], since this category in their study included explanations for answers that viewed species knowledge as less important for EC teachers (Q1), and none of the students in our study chose this answer for Q1. We also added one extra category (Category 6: It is part of general knowledge) to include views not present in the Norwegian study. We then used the modified version when categorizing the answers. Both authors read the answers several times and individually categorized them. Due to the mutual understanding of the modified categories, there were very few mismatches in assigning answers. We further discussed

the few mismatches until we fully agreed on all responses. In cases when one answer included views belonging to several categories, we allocated the answer to each of the categories. Only two responses failed to fit into any of the categories.

Table 3. Categories for the analyses of student teachers' statements on the importance of species knowledge (modified from Skarstein and Skarstein [13]).

Question	Category	Description
Q2	1. To be able to teach about nature	Species knowledge is important for early childhood (EC) teachers because it enables them to teach and explain to children about nature.
	2. To be able to answer children's questions	Species knowledge is important for EC teachers because it enables them to answer children's questions about nature.
	3. To encourage children's curiosity and interest	Species knowledge is important for EC teachers because it gives them the possibility to encourage and foster children's curiosity about and interest in nature. These statements had a wider perspective in encouraging curiosity than simply answering children's questions, e.g., by discussion and exploration together with children.
	4. To enable children to develop a relationship with nature	Species knowledge is important for EC teachers because sharing their knowledge of species with children enables children to develop a relationship with nature.
	5. For practical reasons	Species knowledge is important for EC teachers because they should know whether different species are useful or dangerous, e.g., edible or poisonous.
	6. It is part of general knowledge	Species knowledge is important for EC teachers. It is part of general education (general knowledge) that everyone should have.
Q4	1. To understand nature	Species knowledge is important for sustainable development because it creates awareness of different species, understanding of nature and/or understanding of nature's interrelatedness.
	2. To understand how to take care of nature	Species knowledge is important for sustainable development because it helps us to understand how we can take care of nature and/or why nature preservation is important.
	3. To develop a relationship with nature	Species knowledge is important for sustainable development because it enables us to develop or foster a relationship with nature and/or respect for nature.
	4. To develop a desire to protect nature	Species knowledge is important for sustainable development because it stimulates the will or desire to protect and take care of nature.

4.7.2. Learning Diaries and Interview Analyses

We analyzed the focus group interviews and the learning diaries in parallel by employing hermeneutics [59]. Instead of searching for a common truth, hermeneutics is based on interpretation with the aim of showing that there are various views and that people can understand the same phenomenon very differently [59,60]. Our intention with the hermeneutic approach was mainly to find out how the students experienced the species learning (Research Question 4). However, the analysis also uncovered the students' opinions on their species knowledge before and after species training, and their thoughts on the importance of species knowledge for EC teachers and for sustainability. This illustrates how the results from the different methods complemented each other.

As researchers, we started our hermeneutic analysis by searching for our own subjective pre-understanding, which always varies from person to person. Our literature review and the pretest results further shaped our understanding. As an example, since Skarstein had undertaken similar studies in Norway, she had a different pre-understanding of species learning than Wolff had. This resulted in Wolff being more surprised than Skarstein when the students expressed a positive attitude to species learning already at the start of the study. When the students were asked at the beginning of the course whether they wanted to learn about species and take an identification test at the end, nobody responded negatively. Another element that influenced the researchers' individual understandings is that during the course, Wolff learned to know the students better than Skarstein. Wolff

was responsible for teaching the course, while Skarstein only joined one lecture and two excursions (one of them a whole day long).

Hermeneutics is not about trying to reach an unbiased understanding but trying to let ‘horizons’ meet [59], in our case, the researchers’ distinctive pre-understandings and the students’ meaning-making. In a hermeneutic analysis process, the researcher moves from the parts to the whole in the hermeneutic circle or spiral, to and fro in the data, in the pre-understanding and in theory [59,61,62]. That means that we as researchers repeatedly read the learning diaries, listened to the audio recordings from the interviews, related the students’ commentaries to their context, and reflected on and discussed our findings to reach a deeper understanding.

The students had structured the content in the learning diaries according to the dates and topics of the course. However, when we started to read the diaries, we realized that the students mentioned species learning in connection with most of the course themes, not only when the topic directly related to it. Therefore, we found it most suitable to read and interpret the diaries in parallel with analyzing the focus group interviews.

5. Results

We will now present the results from the different analyses of the data. The results include the species tests, the questionnaire, the learning diaries, and the focus group interviews.

5.1. Quantitative Results

On average, the students could identify 66% of the 18 species in the pretest and 90% of the 24 species in the post-test (Table 4). In the pretest, none of the 22 students recognized all of the species, 9 students recognized more than 75% of the species, and 6 students recognized less than 50% of the species (Table 5). In the post-test, 6 of 23 students recognized all of the 24 species, and only one student recognized less than 75% of the species (Table 5). Plants were the species group the students recognized on average best in the pretest, whereas there were very small differences between species groups in the results of the post-test (Table 4). Table 4 presents the percentage of correct answers in the pre- and post-tests.

Table 4. Descriptive statistics of species identification test scores. The scores are given as the percentage of correct answers. SD = standard deviation.

Test	Measure	All Species	Birds	Other Animals	Plants
Pretest (n = 22)	Mean	65.9	68.9	52.3	76.5
	SD	20.2	27.8	20.8	26.1
	Min	27.8	16.7	16.7	16.7
	Max	94.4	100.0	100.0	100.0
Post-test (n = 23)	Mean	90.0	91.3	89.7	89.1
	SD	11.2	12.7	13.4	15.2
	Min	50.0	50.0	50.0	50.0
	Max	100.0	100.0	100.0	100.0

Table 5. Students’ species identification scores for pre- and post-test grouped in five categories (the percentage of correct identifications).

Correct Identifications (%)	Number of Students in Pretest (n = 22)	Number of Students in Post-Test (n = 23)
100	0	6
75–79	9	16
50–74	7	1
25–49	6	0
0–24	0	0

The results from the close-ended questions in the questionnaire show that already at the beginning of the course, all the students considered species knowledge important for EC teachers (Question Q1). When considering the ranked categories, as many as 10 students (45%) regarded species knowledge as very important and 12 students (55%) regarded it as important ($n = 22$). None of the students found species knowledge less important or not important for EC teachers.

Most of the students also viewed species knowledge as important for sustainable development (Question Q3). As many as 8 students (36%) considered it as very important and 13 students (59%) as important ($n = 22$). Only one student (5%) found species knowledge less important for sustainable development, and none of the students considered it irrelevant (not important). Furthermore, none of the students chose the alternative I don't know for either Q1 or Q3.

5.2. Qualitative Results

We will first present the results of the content analyses of the questionnaire answers. Subsequently, we present the results of the hermeneutic analyses of the learning diaries and the focus group interviews, which we analyzed in parallel.

5.2.1. Open-Ended Questions in the Questionnaire

In the open-ended follow-up Questions Q2 and Q4 of the questionnaire, the students elaborated using their own words on their views about the importance of species knowledge for EC teachers. In response to Q2, the students explained why they thought species knowledge was important for EC teachers. Through content analyses, we divided these answers into six categories (Table 6). As one answer could belong to several categories, the percentage sum does not add up to 100.

Table 6. Number and percentage of answers for Question Q2 divided into categories through content analysis.

Category	Number of Answers	Percentage of Answers
1. To be able to teach children about nature	9	41
2. To be able to answer children's questions	6	27
3. To encourage children's curiosity and interest	12	55
4. To enable children to develop a relationship with nature	0	0
5. For practical reasons	1	5
6. It is part of general knowledge	6	27

More than half of the students' answers included statements that argued in different ways that species knowledge is important for EC teachers because it helps them encourage children's curiosity about and interest in nature (Table 6). An example of such an answer is:

It is important to be able to share knowledge and encourage an interest in species and nature, but above all, to be able to explore nature together with the children.

Many answers included statements, which argued, in one way or another, that species knowledge is important for EC teachers because it enables them to teach children about nature. Some students also explained that species knowledge is important so that EC teachers can answer children's questions about nature (Table 6). Examples of such answers are:

To be able to teach children about what is out there in nature, it is good that we know about different species.

Children always want to know what everything is and then it is good to know it yourself.

About one-fourth of the students explained that they saw species knowledge as important general knowledge, knowledge everyone needs to have. We found this same argument also in the learning diaries. An example of such an answer is:

Some basic knowledge is good for general education. At least such animals that can actually be seen in Finnish nature.

In the follow-up question Q4 the students explained why they thought species knowledge was important for sustainability, and we divided these answers into four categories (Table 7). As before, one answer could belong to several categories.

Table 7. Number and percentage of answers for Question Q4 divided into categories by content analysis.

Category	Number of Answers	Percentage of Answers
1. To understand nature	17	77
2. To understand how to care about nature	4	18
3. To develop a relationship with nature	2	9
4. To develop a desire to protect nature	0	0

The majority of the students argued that species knowledge is important for sustainable development because it helps people to understand nature (Table 7). An example of such an answer is:

It is important to know species to understand how food chains link to photosynthesis and the like. The work with sustainability issues together with children becomes meaningful if the educator has basic knowledge.

Some students also explained that species knowledge helps people understand how to take care of nature or to develop a desire to protect nature. An example of such an answer is:

It is important to know why and how to protect nature. It is also good to teach the children how to play when we are out in nature and which plants to pick and which to leave. For us to still have vital nature in 50 years, it is good for the children to think about this.

5.2.2. Learning Diaries and Focus Group Interviews

We will now present the results of the hermeneutic analyses of the learning diaries and the focus group interviews, which we analyzed conjointly. First, we present the students' thoughts about the species tests and then describe what kind of meaning the students saw in species learning.

It is obvious that the pretest triggered learning. When the students realized that they did not know all common species names in the pretest, they wanted to learn more. Some students explained that the low results in the pretest made them eager and triggered them to arrange time for species learning. Already at the beginning of the course, all students declared that species learning is important for EC teachers (see Section 5.1). Therefore, this was a reasonable reaction.

I was a little embarrassed that I didn't remember so many species. I have known much more before, but since I have not used that knowledge for several years, I have forgotten it. But now I have become inspired to learn again and it has been fun to look around in nature and try to recognize different species.

Opinions about the post-test varied. The post-test was part of the course assessment, which meant that all the students had to pass it. It was obvious that this student group had many examination tasks at this time at the end of the semester. For that reason, some students found preparing for the test stressful and made several suggestions regarding the practical arrangements of the test, for example that the test should be earlier in the semester. However, the students found the amount of species they had to learn suitable, because they were already familiar with some of the species, and a few students would even have liked to learn more species (like insects and fish).

Several students were also positive about the post-test and expressed that they would not have trained and learned as much without it. There were students who saw the post-test as a prestige issue, they wanted to succeed. One student told in the interview that the post-test actually became the biggest deal on the course for her, but she was not negative about it. In both the diaries and the interviews, a few students joked about their own failures in the test and described how from now on they would definitely remember the species they failed on.

Even though it seemed very hard to try to learn all the different species before the species test, I now become very happy when I go out in nature and recognize several different species!

The species test has given me the most throughout the course. I have learned so many species and I am very proud of this.

The diaries included much information about what kind of meaning the students saw in species learning. We divided the meaning into three categories. The species learning was beneficial for 1) myself as a person, 2) me as a teacher, or 3) the society and the earth. These categories are not definitive, and they do not exclude each other. The same person could write about the species learning in many places in the diary and their views might fit in several categories.

1) Meaning for myself as a person

The students expressed specifically how learning about species affected them. It changed the way they observed nature, they paid more attention to details, and changes in nature and learning about species increased their interest in nature. They told about how recognizing species is pleasing, makes them happy, and is fun and enjoyable.

Personally, it was a great moment to see a sea eagle through the binoculars.

I enjoyed standing alone for a quarter of an hour listening to a woodpecker's hammering in a lamppost before the others showed up.

I have never been interested in birds but due to the species test, I have learned to appreciate them.

The species exam was very hard for me because I had not used species knowledge much since the time I was forced to learn species in elementary school. Despite this, I already notice that I observe my surroundings in a different way than I have done before, and I must honestly say that it feels good.

The students also saw species knowledge as beneficial for their self-confidence, since this knowledge enables them to talk to children, as well as adults, about plants and animals, and use proper names. They also stressed that species learning is not only about naming but also about knowing something about the species. They were proud of being able to recognize species and felt that it was rewarding to have names for animals and plants they saw often.

It has inspired me to find out more about the plants, trees, animals, and insects that I see and hear around me as I walk outdoors and in the woods with my dog. It feels good to know so much when I walk with others and can tell them what we see and hear.

In addition, some students viewed species names as a natural part of the language, and they emphasized the importance of using them actively when talking about nature. The students also described species knowledge as general knowledge all people ought to have (cf. the results from the questionnaire).

I think it was good to have a species test and, as I said before, I think species knowledge belongs to general education, and therefore, everyone should maintain it.

2) Meaning for me as a teacher

Most of the diary texts about species knowledge dealt with education, about how it is important as an EC teacher to be able to talk to children about species. The students also suggested various ways to implement species knowledge in the nurseries and preschools together with children. Since some of the students work in preschools and nurseries alongside their studies, they had even experimented with implementing new ideas already during the course or had plans to do so soon. They talked about many kinds of activities they wanted to realize together with children. These included games, excursions, artistic and creative activities, storytelling, music activities, etc. The students also mentioned useful field study tools they wanted the children to experience, like binoculars, hand lenses, etc. The students talked eagerly about how they could promote the children's interest and knowledge. They used words like inspire the children, promote feelings for nature, feed their curiosity, and make them love nature.

The students saw language as an important tool, and naming species with their proper names became something positive during the course. This was also obvious in the interviews, and one of the students said that they as EC students really are the right target because they, in turn, can teach the children about species. Another student said that having more knowledge made them more interested, and with the interest came ideas:

There was a good example of how you can observe how birds fly because not every bird flies the same way. You could also wonder why different birds have different habitats and different characteristics. In connection with this, you could also do gymnastics with a bird topic, you could move like different birds.

The students very much liked a task in which they had to find out both the species names and living conditions for birds and small mammals with the help of stuffed animal specimens, the internet and books, and then tell each other about the animals at a level suitable for small children. Likewise, they enjoyed spending time in the greenhouse in the botanical garden and some of them started to imagine how this would be like if they were children. The children's perspective was often present. The students also combined their own personal interest with their interest as a future EC teacher.

I thought bird watching was very pleasant, and it was relaxing to stand there and listen to the bird songs, a nice variation from how we otherwise had it on the stress scale. So, I would have liked to have watched birds longer. This is something children also like, and I could easily take children out into the woods ... to discover birds and talk about them. Children love to learn new things, and this is probably something that would have a relaxing effect on them!

3) Meaning for society and the earth

Those who experienced species knowledge as beneficial for society and even the entire earth used words like sustainability, ecology, the environment, and the variety of species (biodiversity). However, the students did not mention these issues many times. These are some examples:

In addition, it is very important to have basic knowledge of species and their living conditions in order to understand why we must proceed cautiously and protect our environment.

In order for the teacher to be able to inspire children about nature, the environment and sustainability, the teachers need to be confident in their task. So I, who work with children, need to have some basic knowledge of nature.

6. Discussion

This study investigated the implementation of species learning in an EC teacher education course. Our aim was to get a broad and comprehensive view of the students' knowledge, skills, and thoughts

concerning species and species learning. To achieve this, we used a mixed-methods study design, which combined quantitative and qualitative methods.

The results show that at the beginning of the course, the students were familiar with some of the common Finnish species (on average two thirds of the species in the pretest), but they themselves considered their species knowledge inadequate and wanted to learn more. Some of the students described that it was a revelation to recognize that they did not know the names of common animals and plants. This shows that the pretest triggered learning. It was also obvious that the students, already at the beginning of the course, thought that knowing common species was important both for EC teachers and sustainability. At the same semester, all the students had attended two other courses with sustainability as a theme (in relation to art and literature). This most likely influenced their answers. They were familiar with the sustainability concept and understood the importance and urgency of sustainability, but they had not discussed how species knowledge is connected to sustainability. Despite this, at the beginning, during and especially after the course, the students eagerly reflected on the importance of species knowledge from both personal, educational, and social viewpoints.

Our results demonstrate clearly that the students enjoyed learning about species during the course and one-fourth of the students recognized all of the species in the final test at the end of the course. Many of them were very proud of their knowledge and the fact that they were able to use the names of the species they had observed in nature. The students expressed that they liked sharing their species knowledge with friends, family members, and children in nurseries and preschools.

It is obvious that the students learned about species during the entire course, and they took advantage of study trips and other occasions to learn more. The timing of the course was good since it was the last course period of the academic year and every time the students were outdoors, they could observe different species, especially migrating birds returning north. This made birds the most fascinating species group during the course and the students often mentioned birds in their reflections. It is also obvious that species naming became a reality during the course. The students used species names, especially bird names, when they described the various activities on the course, regardless of whether these activities had a focus other than species.

In the yard, we saw and heard black-headed gulls, chaffinches, blue tits, great tits, sparrows, fieldfares, and blackbirds. From the bird tower we saw cranes, Canada geese, swans, and a lapwing.

What we find especially interesting in our results is that learning about species meant so much to the students on a personal level. In the interviews, many of them spoke about their nature experiences in a proud, emotional, and even lyrical tone. They said that learning became joyful and rewarding for them and changed the way they regarded nature. In addition, they reported that they developed nature observation skills and self-confidence because of their increased knowledge about nature.

When we compare our results with other studies on species knowledge within teacher education, such as Skarstein and Skarstein's [13] study of Norwegian students and Palmberg et al.'s [7] study of Baltic and Nordic students, we find several similarities in the results. However, it must be taken into consideration that these studies are not directly comparable to our study due to differences in the students' study program, the extent of the participants' earlier studies, differences in some of the methods (e.g., not all the species in the species tests were the same), and the number of participating students. Nevertheless, similarly to our study, both of the above-mentioned studies found that the majority of the students regarded species knowledge as important and underscored the usefulness of species knowledge in outdoor situations.

The students' arguments for the importance of species knowledge in our study and in the study of Skarstein and Skarstein [13] also correlate well, with the exception of two categories. Answers arguing that species knowledge was general knowledge that everyone should have, formed a new category in this study. None of the Norwegian students expressed such views. In turn, very few of the Finnish students argued that species knowledge is important because it helps to develop a relationship with nature, an argument that was expressed by several Norwegian students. Another contrast with

our study is that the Norwegian students had much lower species knowledge when tested before participating in a course that included species learning (pretest). They could, on average, recognize less than one-third of the species they were tested on before the course. These differences might be due to cultural differences and differences in the national school curriculum for basic education in the two countries, something that would be interesting to investigate further with larger samples in future studies.

However, also the Norwegian students' knowledge of species improved a lot during their studies, and since in the Norwegian study, the researchers followed the students over a longer time span, their results show that the acquired species knowledge persisted relatively well throughout the students' studies. Our results do not tell anything about what the students remember in the long run, although it is reasonable to believe that the learning effect might last, since the students clearly viewed species knowledge as important and several of them expressed that they will continue to actively use species names. Our results also correlate well with Lindemann-Matthies et al.'s [10] study, which found that knowledge about species made students more confident and willing to bring children out into nature and investigate animals and plants with them.

The results of this study come from a small sample, not large enough for generalizing. In addition, the learning diaries were part of the course and were graded. Therefore, the students might have wanted to give an overall positive expression, although they were specifically instructed to also include negative reactions they might have had during the course. However, our study design gives a broad view of this student group's knowledge, skills, and thoughts concerning species and species learning, and therefore, provides novel information on the topic. As far as we know, no previous studies have used learning diaries and focus group interviews when exploring issues connected to species learning in teacher education.

7. Conclusions

An underlying motive of this study was to improve nature and sustainability education for EC teachers. We, in the role of teacher educators and researchers, see species knowledge as part of outdoor education for young children and as a foundation of sustainability education [16]. Therefore, one aim of this study was to investigate Finnish students' species identification skills and their views on the importance of species knowledge. Another aim was to investigate how the students experienced species learning when we introduced it as part of their study program. We also wanted to take a closer look at teaching methods that may promote students' learning and interest in nature so that they are able to promote children's interest in and understanding of nature. Through our study design, including species tests, a questionnaire, focus group interviews, and learning diaries, we have obtained a comprehensive view of the students' knowledge and thoughts concerning species and species learning. With this study, we wish to shed light on different methods to investigate species training, ways to implement species learning in EC teacher education and ways to make species learning an activity that students experience as useful, rewarding, and enjoyable.

We are convinced that if we do not teach students about species, we deprive them of the joy and pride of knowing, as well as sharing knowledge and exciting experiences, about life and the diversity of nature together with children. This study highlights the importance of species knowledge for understanding nature, as well as for evoking feelings and fostering values. We conclude with the words from one of the students:

I liked a lot to learn species and it increased my confidence in species knowledge. I have always felt inferior in that matter. However, as with most other things in life, with purposeful work, big changes can happen. In sum, the course gives a good taste of species knowledge and makes me more attentive in nature.

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