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Curious children and knowledgeable adults – early childhood student-teachers' species identification skills and their views on the importance of species knowledge

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ABSTRACT

This study investigates early childhood (EC) student-teachers' species identification skills and their views on the importance of species knowledge. The study used a mixed methods approach, including a species identification test and a questionnaire, and involved 186 Norwegian EC student-teachers. Our results reveal that species knowledge of first-year students was poor when they entered university. During their first semester, the students learn about common, local species and this knowledge seems to be maintained throughout their studies. The majority of the students had use of species knowledge during their practical training periods in kindergartens and considered species knowledge important for EC teachers as well as for sustainable development. The need for species knowledge was often associated with spontaneously occurring situations initiated by children during nature excursions. The students argued that species knowledge is important for fostering children's curiosity, increasing their understanding of nature and strengthening their relationship with nature. We hope that this study can illustrate the importance of species knowledge in EC teacher education. It is essential that students acquire both the knowledge and skills to facilitate the variety of learning possibilities that exist in nature and are able to provide children possibilities to learn about the diversity of nature as well as to develop a relationship with it.

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KEYWORDS
Early childhood education; teacher education; species identification; species knowledge; nature; outdoor education; sustainable development; sustainability

Introduction

> Once upon a time, words began to vanish from the language of children. They disappeared so quietly that at first almost no one noticed – fading away like water on stone. The words were those that children used to name the natural world around them: acorn, adder, bluebell, bramble, conker – gone! Fern, heather, kingfish, otter, raven, willow, wren … all of them gone! The words were becoming lost: no longer vivid in children's voices, no longer alive in their stories. (Macfarlane & Morris, 2017)

Several European researchers have expressed concern about today's children's poor knowledge of common species (Balmford, Clegg, Coulson, & Taylor, 2002; Bebbington,

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2005; Kaasinen, 2019; Randler & Wieland, 2010). Even more concerning, and likely associated with children's poor species knowledge, is that primary school student-teachers' knowledge of species has also been shown to be low (Bebbington, 2005; Kaasinen, 2019; Lindemann-Matthies et al., 2011; Palmberg et al., 2015). Not surprisingly, studies looking at species knowledge of the general public also indicate a relatively poor knowledge of common species (Dallimer et al., 2012; Randler, Höllwarth, & Schaal, 2007).

As species can be viewed as the basic units in biology, knowledge about species is important for understanding nature, the importance of biodiversity and the influence of humans on different ecosystems (Helldén & Helldén, 2008; Magntorn & Helldén, 2005; Randler, 2008). Species knowledge can also be seen as important for building a relationship with and appreciation for nature. Positive nature experiences in childhood and the company of significant adults modelling appreciative attention to plants and animals in nature, have been shown to be important factors in developing positive attitudes towards nature and nature conservation (Chawla, 2007; Helldén & Helldén, 2008; Palmer, Suggate, Robottom, & Hart, 1999). The significant adults in this context are adults who have meaningful relationships with the child and they model appreciative attention by sharing their knowledge of nature with the child and by being role models who notice nature in a respectful way (Chawla, 2007). Other studies have shown a positive relationship between species knowledge and appreciation of nature in school children. Outdoor educational programmes focusing on species knowledge, ecology and experiencing nature first-hand, have shown to increase understanding, positive attitudes and interest towards nature both among school children (e.g. Fančovičová & Prokop, 2011; Lindemann-Matthies, 2005) and among primary student-teachers (Magntorn & Helldén, 2005).

Children in Norwegian kindergartens spend a fair amount of time outdoors, both on the kindergarten's premises as well as on nature excursions. However, several Norwegian researchers have identified a need for more critical reflection on the pedagogical content of the time spent outside and question if simply being outdoors in itself is sufficient to meet the objectives in the curriculum concerning outdoor play and exploration (Kaarby & Tandberg, 2017; Moser & Martinsen, 2010; Skarstein, Berrefjord Ugelstad, & Grøsvik, 2018). Matters of concern have also been raised by Swedish researchers on early childhood (EC) teachers' abilities to recognise and fully facilitate the learning possibilities available outdoors, and particularly regarding the manners in which the teachers communicate with children about nature (Gustavsson & Pramling, 2014; Thulin, 2006; Thulin & Pramling, 2009). Gustavsson and Pramling (2014) point out that on nature excursions it seems that children are often left to make their own experiences and discoveries, although children also need assistance in order to notice different phenomena when learning about nature. Furthermore, a study by Thulin (2006) showed that children's questions about nature were often answered by a counter question from the EC teacher or were simply left unnoticed. In the former case, the counter question from the teacher often led to the situation changing to something else, consequently leaving the child's question unanswered.

A possible reason for an insufficient ability to recognise or facilitate learning possibilities during nature excursions may be associated with a shortage of nature knowledge or inadequate skills or confidence to explore nature. As stated earlier, a good proportion of today's children and adults seem to lack the appropriate knowledge and skills for recognising common species, which is a fundamental part of being able to read nature. Magntorn and Helldén (2005) describe the ability to *read nature* as the ability to go out into nature and recognise organisms, understand processes taking place and to see the human impact in the area visited. The ability to read nature can be seen as an important aspect of ecological literacy and an essential competence for EC teachers in providing children with learning opportunities during nature excursions. Studies based on Norwegian EC teachers' own evaluations of their practices, show that teachers seem to consider a shortage of knowledge as a somewhat challenging factor when working with natural sciences (Skarstein et al., 2018) and in providing children with varied experiences in nature (Kaarby & Tandberg, 2017). Learning to read nature should thus be an important part of EC teacher education. As a comparative study of four teacher education institutions in Europe showed, good knowledge of local species added strongly to primary student-teachers' confidence to carry out outdoor teaching, such as investigating wildlife close to school (Lindemann-Matthies et al., 2011).

Outdoor play and exploration have a significant place in the Norwegian Framework Plan for Kindergartens (Norwegian Directorate for Education and Training, 2017). Experiencing, exploring and learning about nature and its diversity are in the framework plan seen as important aspects in developing respect for nature, encouraging environmental awareness and contributing to sustainable development. The kindergarten staff are expected to use nature as an arena for play and learning and together with children reflect on natural phenomena as well as relationships in nature.

Sustainable development is in the framework plan defined as one of the core values of kindergartens and, in accordance to The Gothenburg Recommendations on Education for Sustainable Development (Ottosson & Samuelsson, 2008), kindergartens are seen as important actors in promoting values and practices for more sustainable communities. To meet these objectives of the framework plan, EC teachers should have, among other competences, good knowledge of common plants and animals in the kindergarten's local nature areas.

Purpose of the study

The purpose of this study is to get a closer look at EC student-teachers' species knowledge, their usage of species knowledge and their thoughts on the importance of species knowledge for EC teachers, in particular, as well as for sustainable development in general. More specifically, we investigate students' level of species identification of common local plant and animal species and their views on and use of species knowledge in their practical training periods in kindergartens. To our knowledge, there are no previous studies that have investigated these issues concerning EC student-teachers (from now on referred to as students).

The research questions of this study were:

(1) How well do the students identify common plant and animal species, and how well are their identification skills retained after passing their obligatory species identification exams?
(2) How and in what contexts (if any) have the students had use of species knowledge in their practical training periods in kindergartens?

(3) What are the students' views on the importance of species knowledge for EC teachers?
(4) What are the students' views on the importance of species knowledge for sustainable development?

Materials and methods

Participants and sampling procedures

In total 186 Norwegian students participated in this study, consisting of two student groups, named A and B. Group A consisted of 96 students and group B consisted of 90 students. In Norway, the EC teacher education is a 3-year bachelor's programme, and the students in group A participated in the study during the first year of their studies, whereas the students in group B participated in the study during the first and the last year of their studies. All students participating were studying at the same teacher education institution and following the same study programme, but the students in the two groups were from different year classes.

Information was collected through a species identification test and a questionnaire. The species test was designed solely for research purposes and was not a part of the students' ordinary education. Participation in the study was voluntary and both the test and the questionnaire were answered anonymously. The surveys were conducted at the university in between ordinary lessons, and the students were not informed about the surveys beforehand to exclude the possibility of training for the species test. All participants gave their informed written consent to participate in the study.

Species identification test

Students in group A took the species test twice within the first year of their studies. The first round was conducted in mid-August when the students entered the university. This test will be referred to as A*pre* test (96 participants). The second round was conducted 8.5 months later, in the beginning of April, and will be referred to as A*ret5* test (92 participants). Between the two rounds, the students received lessons in ecology (a study entity equivalent of approximately five ECTS), including theoretical and practical lessons on common local species, and by the end of November all of the participants had passed their three obligatory, simple species identification exams included in their education (in each exam the students had to identify 10–15 species). There was thus a time period of minimum five months between these exams and the A*ret5* retention test.

Students in group B followed a similar lesson plan as students in group A and also had two rounds of the species test. The first round was conducted in the beginning of March during the first year of their studies. This was three months after passing their obligatory species exams and this test will be thus referred to as B*ret3* test (90 participants). The second round was conducted in the beginning of April during the final semester of their studies. This was 28 months after passing their obligatory species exams and will be referred to as B*ret28* test (70 participants). No pre-test was conducted with group B students.

The species test consisted of 18 common local species (Table 1). The organisms were selected among the 89 species (36 plants, 30 birds and 23 intertidal organisms) the students were expected to learn for their obligatory exam. The test was based on printed

Table 1. A list of the species included in the species identification test.

Common English name	Latin name	Common Norwegian name
Plants		
Norway spruce	*Picea abies*	Gran
Coltsfoot	*Tussilago farfara*	Hestehov
Rosebay willowherb	*Chamaenerion angustifolium*	Geitrams
Foxglove	*Digitalis purpurea*	Revebjelle
*Rowan	*Sorbus aucuparia*	Rogn
Aspen	*Populus tremula*	Osp
Birds		
Bullfinch	*Pyrrhula pyrrhula*	Dompap
Magpie	*Pica pica*	Skjære
Blackbird	*Turdus merula*	Svarttrost
*Great tit	*Parus major*	Kjøttmeis
*White wagtail	*Motacilla alba*	Linerle
*White-throated dipper	*Cinclus cinclus*	Fossekall
Intertidal marine organisms		
Blue mussel	*Mytilus edulis*	Blåskjell
Common cockle	*Cerastoderma edule*	Hjerteskjell
Common limpet	*Patella vulgate*	Albusnegl
Green shore crab	*Carcinus maenas*	Strandkrabbe
Toothed wrack	*Fucus serratus*	Sagtang
Bladder wrack	*Fucus vesiculosus*	Blæretang

*Not included in the B*ret3* test. See text for further explanation.

colour photographs and the students were asked to write down the common name of the organism. The level of identification skills was evaluated only concerning the correct common names at the species level. However, answers with minor spelling mistakes, for example a missing letter, were accepted as correct answers.

The A*pre*, A*ret5* and B*ret28* tests all included the 18 species shown in Table 1. However, due to a sampling error, the B*ret3* test only included 14 of these species (Table 1). We nevertheless decided to include also this sample in the study, as it is an important reference point between the two student groups (second study semester). In statistical analyses comparing the B*ret3* test scores to any of the three other tests, only the 14 species that were used in the B*ret3* test were included.

Questionnaire

In combination with the B*ret28* test, the students were asked to answer a short, written questionnaire including three questions regarding their views on species knowledge. The questionnaire had a mixed methods design for the purpose of mutually enhancing and enriching the qualitative and quantitative approaches used, i.e. mixing methods for the purpose of *complementarity* between the qualitative and quantitative results (Schoonenboom & Johnson, 2017).

The three questions investigated if the students have had use for species knowledge in their practice periods in kindergartens (Q1), the students' opinions about the importance of species knowledge for EC teachers (Q2) and the students' views about the importance of species knowledge for sustainable development (Q3). Q1 was a simple *yes* or *no* – question while on Q2 & Q3 the students were asked to give their score on a four point Likert scale, (the four ranked categories were: *very important*, *important*, *less important*, *not important*) with a fifth option of *don't know* (see Krosnick and Presser (2010) for the reasoning behind a *don't know* option). Each question was also followed by an open-ended sub-question, which gave the students a possibility to elaborate on their answer. The open-ended question associated with Q1 was ‘How?’, for Q2 and Q3 is was ‘Why?’.

Whereas the species test only tested the students’ identification skills and their knowledge of species names, the concept of ‘species knowledge’ in the questionnaire referred to a broader knowledge of the species, i.e. some knowledge on the organism’s way of life, such as habitat and behaviour.

The students who answered the questionnaire had at this point of their study had in total 17 weeks of practical training in kindergartens and had worked with children between age zero and six years.

Analyses

The species tests scores were analysed using quantitative statistical analysis. The responses from question Q1, Q2 and Q3 were analysed using a mixed methods approach (Creswell, 2012; Schoonenboom & Johnson, 2017), where quantitative analyses were used on the Likert-scale responses and a qualitative analysis was used on the open follow-up sub-questions. The results of the quantitative and qualitative analyses of responses to Q1, Q2 & Q3 were subsequently compared and discussed together.

Quantitative analyses

The quantitative information from the species test and the questionnaire was coded and analysed using the statistics package SPSS 25 (Mac-version). Distributions were tested for normality using the Shapiro-Wilk’s test. As most of our variables deviated from the normal distribution, ranked data were used in tests with assumptions of normality, as suggested by Conover and Iman (1981). Descriptive statistics are presented using original non-transformed data. To investigate differences in scores between A*pre*, A*ret5*, B*ret3* and B*ret28* tests, we used one-way ANOVA (with Tukey HSD post hoc multiple comparisons tests). Correlations between continuous variables were analysed with Spearman rank correlations. Two-category group differences were tested for significance using Student’s *t*-tests. The four point Likert scale variables from the questionnaire (Q2 & Q3) were analysed as scaled variables, as suggested by Sullivan and Artino (2013).

Qualitative analyses

To be able to obtain thematic overviews of the respondents’ views on how they have had use for species knowledge and how they view its importance for EC teachers and for sustainable development, answers to the three open-ended sub-questions to Q1, Q2 and Q3 were analysed using inductive content analysis (Elo & Kyngäs, 2008). This was done by both authors reading through responses to each question multiple times, and for each sub-question, independently suggesting a set of categories, which could be useful when attempting to identify common themes in the respondents’ expressed views.

The two sets of proposed categories were then discussed and negotiated by the authors and reduced to a single set of categories both researchers agreed upon. All the responses were then assigned by each of the authors independently into the agreed categories. Due to the mutual understanding of the categories, there were very few mismatches in assigning responses. The few mismatches were then further discussed until the classification of all responses was fully agreed upon.

The categories were potentially interrelated and in cases when one individual response included views belonging to several different categories, the response was designated to each of them. Only a very few responses failed to fit into any of the final categories. These were largely responses that answered something other than the question asked. Quotations from the original responses were selected as descriptive examples for each category. The quotations shown are translations from Norwegian.

Results

Average species identification scores

The species identification skills of students in the beginning of their studies were relatively poor. Students in group A could on average identify only 28.2% of the species in the A*pre* test (Figure 1 and Table 2). Only 5% of the students could identify more than 60% of the species and 35% could identify less than 20% of the species (Figure 2).

However, five months after passing their obligatory species exams, the group A students could on average identify 75.4% of the species (A*ret5* test) (Figure 1 and Table 2). As many as 75% of the students could identify more than 60% of the species and only 1% could identify less than 20% of the species (Figure 2). To pass the obligatory species exams the students must get a minimum score of 80% correct identifications and therefore the score of 75.4% after five months can be considered as a high retention.

Students in group B, could on average identify 83.8% of the species three months after passing their obligatory species exams (B*ret3* test), which is also a high retention (Figure 1 and Table 2). In the second retention test, which was conducted 28 months after passing

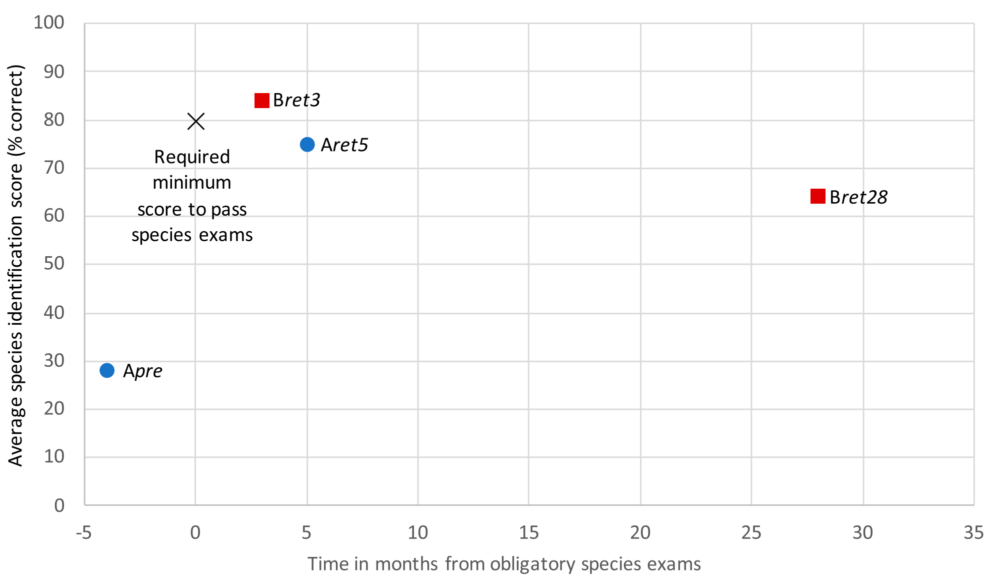

Figure 1. The average species identification score (% correct identifications) for all four tests (A*pre*, A*ret5*, B*ret3** and B*ret28*), plotted against time. Zero on the *x*-axis marks the timing when the students had passed all their obligatory species exams. To pass the exams the students were required to achieve a minimum score of 80% correct identifications (marked by × in the plot). *The B*ret3* test included only 14 species, whereas the other tests included 18 species.

Table 2. Descriptive statistics of species identification scores (% correct answers) in the four different tests showing an overall score as well as scores for different species groups.

		All species	Intertidal	Plants	Birds
Apre ($n = 96$)	Mean (SD)	28.2 (16.8)	25.2 (16.8)	34.2 (23.4)	25.2 (25.3)
	Min–Max	0.0–83.3	0.0–83.3	0.0–100.0	0.0–83.3
Aret5 ($n = 92$)	Mean (SD)	75.3 (18.3)	83.6 (17.5)	61.8 (25.5)	80.4 (23.6)
	Min–Max	16.7–100.0	33.3–100.0	0.0–100.0	0.0–100.0
*Bret3** ($n = 90$)	Mean (SD)	83.8 (15.1)	87.0 (16.9)	78.4 (22.7)	86.3 (22.8)
	Min–Max	35.7–100.0	16.7–100.0	20.0–100.0	0.0–100.0
Bret28 ($n = 70$)	Mean (SD)	63.6 (20.2)	70.2 (21.2)	56.9 (27.5)	63.6 (25.7)
	Min–Max	11.1–94.4	16.7–100.0	0.0–100.0	0.0–100.0

*The *Bret3* test included only 14 species, whereas the other tests included 18 species.

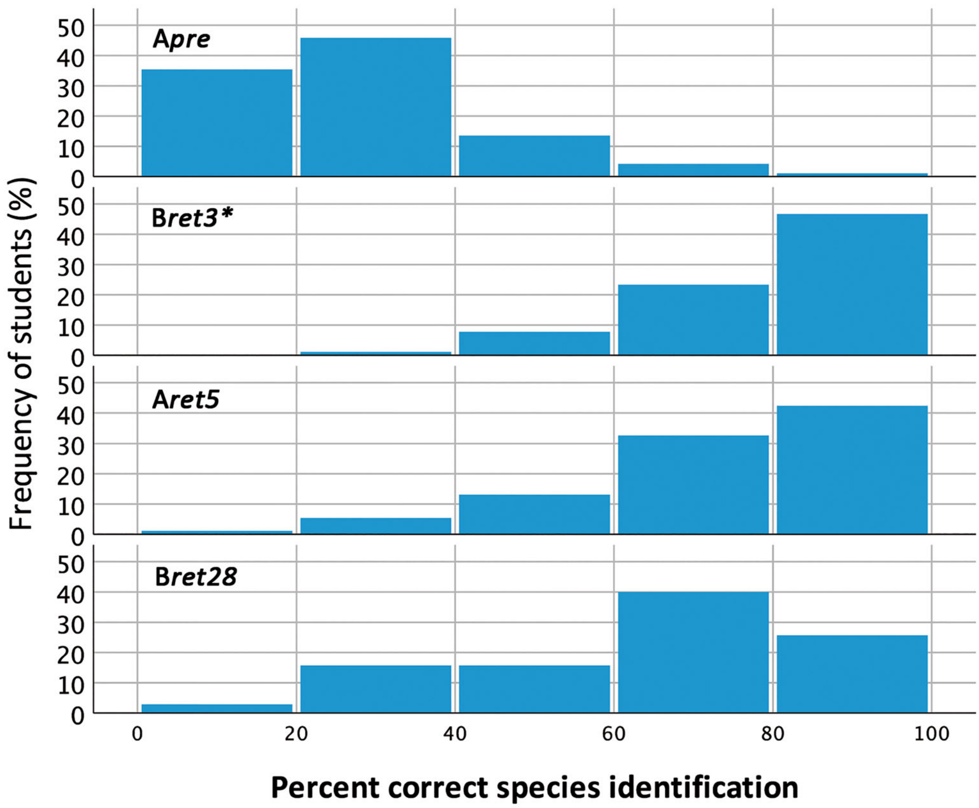

Figure 2. The students' species identification scores for all four tests (A*pre*, A*ret5*, B*ret3** and B*ret28*) grouped in five categories by score (% correct answers) and plotted against frequency of students (%) in each category. *The B*ret3* test included only 14 species, whereas the other tests included 18 species.

the obligatory exams, the students in group B could on average still identify 63.6% of the species (B*ret28* test) (Figure 1 and Table 2). As many as 66% of the students could identify more than 60% of the species and only 3% could identify less than 20% of the species (Figure 2).

A one-way between-groups analysis of variance (ANOVA) was conducted to investigate if there were significant differences in species identification scores between the four tests (A*pre*, A*ret5*, B*ret3* and B*ret28*). There was a statistically significant difference at the $p < 0.05$ level in species identification scores for the four tests: $F(3, 343) = 197.9$, $p < 0.0001$. Post-hoc comparisons using the Tukey HSD post-hoc multiple comparisons showed that mean scores for all four groups were significantly different from each other.

Species identification scores at species level

As seen in Table 2, there were some differences in the species identification scores between the three species groups. When looking at the identifications scores at the species level (Figure 3), only two species are well known by the students in the beginning of their studies (A*pre* test). These are blue mussel (94.8% correct identifications) and Norway spruce (79.2% correct identifications). All other species are correctly identified by less than half of the students. However, when looking at the scores of the students who were on their final study semester (B*ret28* test), only three species have less than 50% correct identifications. Two of these, rosebay willowherb and white-throated dipper, were also among the three least known species in the A*pre* test.

Students' use of species knowledge in kindergartens (Q1)

Most of the students who were on their final study semester (B*ret*28) answered that they have had use for species knowledge during their practice periods in kindergartens: 69% of the students answered yes to question Q1 and 31% answered no ($n = 68$). Of the 47 students who answered yes, as many as of 43 students (91%) also described how they have had use for species knowledge (open-ended follow-up question of Q1). The answers varied somewhat in character according to what the students had chosen to describe. Some answers described types of organisms and others described situations or the physical environment in which the students had used species knowledge. One answer often included more than one of the description types.

Of the 30 answers, which included a description of the physical environment, 26 students answered that they have had use for species knowledge while on nature excursions, and only four answered that they have had used species knowledge within the kindergartens' premises. Of the 31 answers that described types of organisms, 12 mentioned plants and 19 mentioned animals (birds were mentioned in 14 occasions).

As many as 35 students described more in detail the situations in which they have had use for species knowledge. Through content analysis, we identified three common themes in the students' descriptions and accordingly designated the responses to the following three categories:

(1) *Finding or seeing something*: The students have had use for species knowledge when they (children and/or students, sometimes not specified) had found or seen an organism. As many as 21 answers (49%) described such situations. An example of such an answer is: *When we have been on excursions to the forest and children have found different leaves and such.*

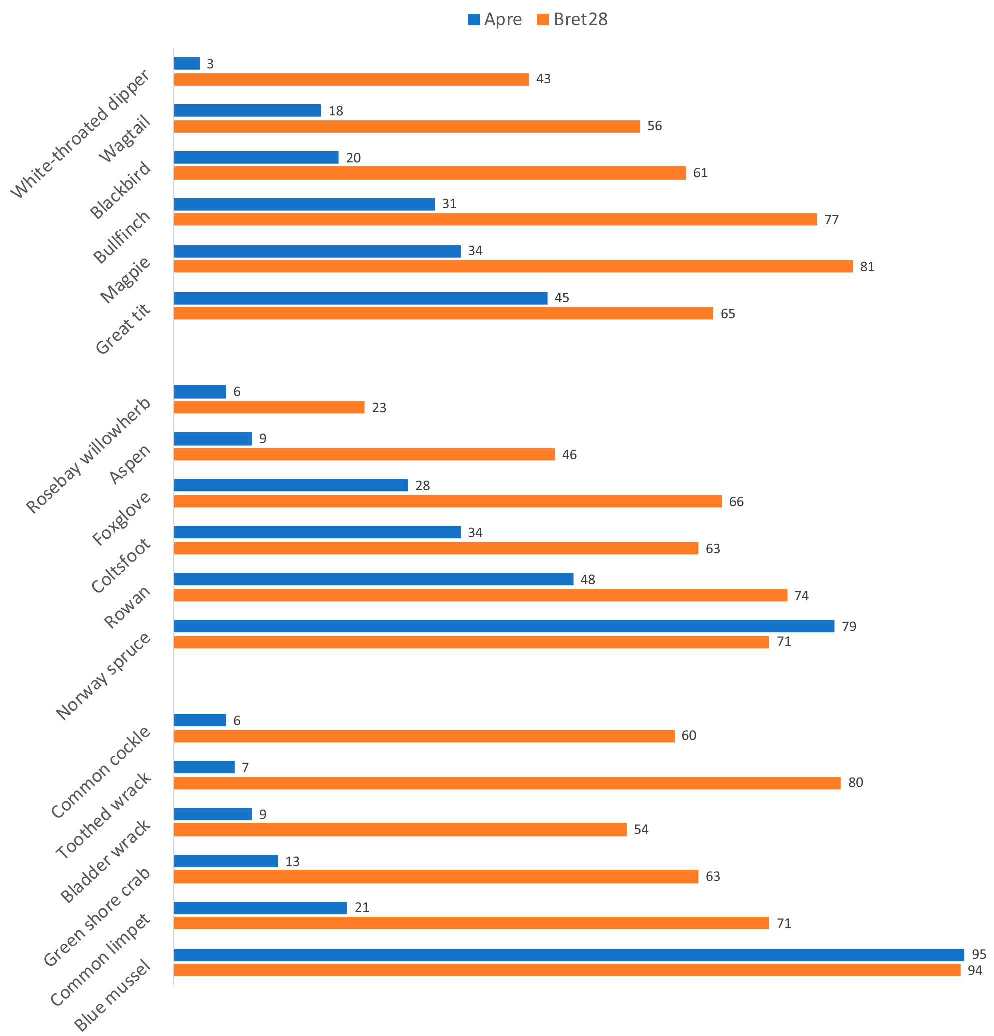

Figure 3. The percentage of correct identifications for each species in the *Apre* test (column above) and the *Bret28* test (column below), sorted from lowest to highest scores for the *Apre* test ($n_{Apre} = 96$, $n_{Bret28} = 70$).

(2) *Children ask questions*: The students had needed species knowledge when children had asked questions about plants or animals. Sixteen answers (37%) described such situations. An example of such an answer is: *Children are curious. They ask what the different species are called.*

(3) *Organised activities*: The students had used species knowledge during organised, teacher-led activities with focus on different plants or animals. Only eight answers (19%) described such situations. An example of such an answer is: *When we made bird food and watched the birds that came and ate it.*

Students' views on the importance of species knowledge for EC teachers (Q2)

As many as 81% of the students considered species knowledge important (scored as *very important* or *important*) for EC teachers, 16% ranked it as *less important*, whilst only 3%

answered *don't know* ($n = 70$) (Figure 4). None of the students answered that species knowledge is *not important* for EC teachers. In total 60 students (86%) also explained their answer (open-ended follow-up question of Q2). Through content analysis, we identified six common themes in the explanations and accordingly designated the answers to the following six categories:

(1) *To be able to talk to the children about nature*: Answers in this category argued that species knowledge is important, because it is important that teachers can talk to the children about nature and the children get a possibility to learn about the different species. The statements did not elaborate why learning about nature is important. As many as 21 answers (35%) were included in this category. An example of such an answer is: *Because we must have the knowledge to be able to pass it on to children.*
(2) *To be able to answer children's questions*: Answers in this category argued that species knowledge is important, because it is important that teachers can answer children's questions about nature and the different species. Fourteen answers (23%) were included in this category. An example of such an answer is: *Because on nature excursions it is important to be able to answer the children when they have questions.*
(3) *To encourage and foster curiosity*: Answers in this category argued that species knowledge is important, because it gives teachers a possibility to encourage and foster children's curiosity and wonder about nature. These statements had a wider perspective in encouraging curiosity than simply answering children's questions, for example by discussion and exploration together with children. Statements arguing that knowledge makes things more exciting were also included here. Fifteen answers (25%) were included in this category. An example of such an answer is: *Some knowledge is important to be able to foster children's curiosity with knowledge of the different species. But also stories about different types of species.*
(4) *To develop a relationship with nature*: Answers in this category argued that species knowledge is important for EC teachers, because knowledge of species enables children to develop a relationship with nature. Eight answers (13%) were included in this category. An example of such an answer is: *Knowledge is important so that children can develop a relationship with nature.*
(5) *For practical reasons*: Answers in this category argued that species knowledge is important, because teachers should know if some species are either useful or dangerous (for example edible or poisonous). Only four answers (7%) were included in this category. An example of such an answer is: *To know what is poisonous and what is not. So that nobody gets hurt.*

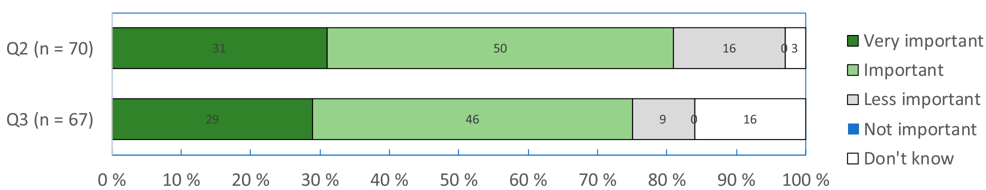

Figure 4. Distribution (in percentages) of the students' opinions about the importance of species knowledge for EC teachers (Q2) and the importance of species knowledge for sustainable development (Q3). Sample sizes differ due to three students leaving Q3 unanswered.

(6) *Information can be found in books or apps*: Answers in this category argued that species knowledge is less important, because there are books and/or apps available where the information can be found. Some of these answers pointed out that this is something teachers can do together with the children. Only six answers (10%) were included in this category. An example of such an answer is: *If you are out on a nature excursion and the children find something that you do not recognise, then you usually have a book in the kindergarten that you can use. Take what you found with you to the kindergarten and find out what it is.*

Students' views on the importance of species knowledge for sustainable development (Q3)

As many as of 75% of the students considered species knowledge important (scored as *very important* or *important*) for sustainable development, 9% ranked it as *less important* and 16% answered *don't know* ($n = 67$) (Figure 4). None of the students chose the alternative *not important* for this question. Of the 52 students who considered species knowledge important for sustainable development, 28 students (54%) also explained their answer (open-ended follow-up question of Q3). Through content analysis, we identified four common themes in the students' explanations and accordingly designated the responses to the following four categories:

(1) *To understand nature*: Answers in this category argued that species knowledge is important for sustainable development, because it creates awareness of different species, understanding of nature and/or understanding of nature's interrelatedness. As many as 15 answers (54%) were included in this category. An example of an answer in this category is: *It can be important to know how different ecosystems work and influence each other.*
(2) *To understand how to take care of nature*: Answers in this category argued that species knowledge is important for sustainable development, because it helps us to learn and understand how we can take care of nature and/or why nature preservation is important. Six answers (21%) were included in this category. An example of an answer in this category is: *It is important to know that we must take care of nature in order to preserve the different species.*
(3) *To develop a relationship with nature*: Answers in this category argued that species knowledge is important for sustainable development, because it enables us to develop or foster a relationship with nature and/or respect for nature. Ten answers (34%) were included in this category. An example of an answer in this category is: *The children develop a relationship with nature. That is good.*
(4) *To develop a desire to protect nature*: Answers in this category argued that species knowledge is important for sustainable development, because it stimulates the will or desire to protect and take care of nature. Six answers (21%) were included in this category. An example of an answer in this category is: *When you know the different species, you develop a relationship to them and you start caring for them. Then you also get a desire to protect them* (this answer was also designated to category 3).

Quantitative interrelationships between test scores, Q1, Q2 and Q3

When comparing the quantitative results from the questionnaire with each other and with the test scores of the students in their final semester (B*ret28 test*), some noteworthy relationships appear. Students who report having had use of species knowledge received on average 20% better identification scores on their species test compared with students that reported that they hadn't had use of species knowledge (Student's *t*-test, $t = 4.0$, $p < 0.0001$, mean test score of 71% ($n_{\text{used}} = 47$) compared to 51% ($n_{\text{not used}} = 21$)). The former group of students also tended to rank both the importance of species knowledge for EC teachers (Student's *t*-test, $t = 5.8$, $p < 0.001$, mean Likert score of 3.4 ($n_{\text{used}} = 47$) compared to 2.5 ($n_{\text{not used}} = 19$)), and the importance of species knowledge for sustainable development, higher than students in the latter group (Student's *t*-test, $t = 2.8$, $p < 0.007$, mean Likert score of 3.4 ($n_{\text{used}} = 36$) compared to 2.9 ($n_{\text{not used}} = 18$)).

There was a statistically significant positive relationship between how well the students scored on the species identification and how high they ranked both the importance of species knowledge for EC teachers (Spearman rank correlation, $r(70) = 0.196$, $p = 0.04$) and the importance of species knowledge for sustainable development (Spearman rank correlation, $r(67) = 0.203$, $p = 0.04$). Furthermore, there was a significant positive relationship between how high the students ranked the importance of species knowledge for EC teachers and how high they ranked the importance of species knowledge for sustainable development (Spearman rank correlation, $r(67) = 0.250$, $p = 0.02$).

Discussion

Species identification skills

The relatively poor ability of the students to correctly identify common species upon entering university corresponds well with previous studies indicating that today's children and adults have poor knowledge of species (see introduction). However, the students' species identification skills were significantly enhanced by their first-year science course and seemed to remain high throughout the 3-year study, even though the studies did not include any further lessons in species knowledge. Two years and four months after passing their obligatory species exams, the third-year students (B*ret28* test) still recognised more than twice the amount of species than the first-year students when entering university (A*pre* test). Although the student group in these two tests was not the same, the results can be viewed as comparable, due to the compatibility of the second semester retention results of both groups (Figure 1 and 2), and the fact that both student groups followed the same study plan at the same institution.

Palmberg et al. (2015) investigated species identification skills of primary student-teachers from Finland, Norway, Sweden and Lithuania. These students had taken their obligatory courses in science at least half a year before taking part in the study. The Finnish students had on average 64%, the Norwegian 57%, the Swedish 52% and the Lithuanian 14% correct identifications in a simple species test. When looking at these results, the Norwegian EC student-teachers' average five month retention score of 75% and average 28 months retention score of 64% in our study are remarkably high. The level of difficulty of the species tests in these two studies can be considered relatively similar, since both studies used photographs of 18 common, local species in the species test (four of the species were actually the same). The results are, however, not directly comparable, due to differences in the species selection as well as differences in the students' study programme.

In another recent study, Kvammen and Munkebye (2018) investigated the species identification skills of Norwegian primary student-teachers' attending a science course with focus on species knowledge. They report an average species identification score of 87% immediately after the end of the course and an average 17 month retention score of 53%. However, the species selection in their two tests were not identical, and a complete set of the species involved is not reported. Consequently, these methodological challenges make it difficult to conduct comparisons with the present study.

There are relatively large differences in how well individual species were recognised by the students in our study. Several explanations for this can be thought of, such as how conspicuous the visual characteristics are which distinguish the species from other similar species or, as Randler (2008) discusses, how much information about the visual appearance of the species is revealed by the species name. In our results, the species blue mussel and spruce stand out from the others, being the only species well known by nearly all students when they entered university (Figure 3). The species name of the blue mussel, referring to the colour of the shell (also in Norwegian), may have been of help in the identification. However, compared to the other species in the test, blue mussel and spruce can be considered to have the most practical relevance in relation to modern Norwegian traditions and this might explain why the students were familiar with them. Blue mussel is commonly used as food and spruce is the species used as the Christmas tree in Norway. This large variation in how well different species were identified in our study, underlines the importance of caution when comparing species identification scores from different studies.

The importance of species knowledge

Possible reasons for the relatively high levels of retention in this study may be found in the third-year students' questionnaire answers. It appears that the students have experienced species knowledge as relevant while working with children during their practice periods. Most of the students (69%) reported that they have had use for species knowledge in kindergartens. These students also seem to be better at species identification in their final semester and appear to rank species knowledge as more important than the ones who have not had use for it. This suggests that students who experience situations where species knowledge is useful, will use and maintain this knowledge and consequently view it as important for their work. This is supported by the observed positive correlation between students' rank of the importance of species knowledge and their final semester test score.

It is, however, noteworthy that the vast majority of the students (81%) viewed species knowledge as important (*very important* or *important*) for EC teachers and none of the students thought that species knowledge is not important at all (a complete lack of *not important*-responses to Q2). This shows that even students who had not use of species knowledge, still considered it important to some extent. A typical argument for viewing species knowledge as *less important* was that it is only important to know the very common species by heart, as books can be used to identify other species. Furthermore, one should also consider that the level of an individual students' species knowledge might have influenced how well the student recognised the pedagogical possibilities available.

It is evident that the students most often associated the need for species knowledge with spontaneous learning situations during nature excursions including first-hand experiences with plants and animals, and to a lesser extent with organised teacher-led activities within the kindergartens premises. It is also apparent that many of these situations were initiated by children, i.e. the children found or saw something, which made them curious and inspired them to ask questions. Many of the students also seem to reflect on the importance of being the knowledgeable other in children's exploration of nature. In addition to pointing out the importance of being able to answer children's questions, many expressed the importance of being able to follow up and foster children's curiosity through discussions and further explorations, which, as they saw it, also requires species knowledge.

These views are in line with the findings of Waters and Maynard's (2010) in their study of child-initiated interaction with teachers in a local natural park area. They report on how diverse elements the children discovered in the environment, such as loose parts (e.g. plants, stones and sticks), varied environmental features, wildlife and familiar landmarks, stimulated the children to draw the teachers' attention to these items and to ask questions. Waters & Maynard emphasise the valuable learning potential in such child-initiated engagement in the environment that offers teachers the opportunity to both recognise and value the child's experience and offer themselves as a more knowledgeable partner in the experience. In a later secondary analyses of the same material, Waters and Bateman (2015) looked more closely into how such situations offer opportunities for sustained shared thinking and co-construction of knowledge. Their findings illustrate the importance of teachers possessing appropriate content knowledge which enable them to respond to the child in a way which is meaningful to both participants and to sustain the interactions.

On the other hand, in one-third of the answers arguing for the importance of species knowledge for EC teachers, the students considered it important for teachers generally to be able to talk to children about nature and tell them about the different species. According to Bae (2018), both teacher-initiated and child-initiated interactions are important when exploring nature with children, since in addition to following up children's own discoveries in nature, EC teachers also have an important role in making children aware of interesting things in nature that they do not necessarily notice or discover on their own.

Most of the students in this study see a connection between species knowledge and sustainable development. When explaining how they view this connection, the students on the one hand describe the importance of species knowledge for understanding (*to understand nature* and *to understand how to take care of nature*), and on the other hand argue that species knowledge is important for evoking feelings and fostering values (*to develop a relationship with nature* and *to stimulate a desire to protect nature*). The importance of species knowledge for developing a relationship with nature, was identified as a common theme in answers for both Q2 and Q3, and the students who argued for such a view in Q2, often expanded their answer in Q3 by arguing that developing a relationship with nature stimulates the desire to take care of nature.

Palmberg et al. (2015) found that approximately half of the primary student-teachers in their study (55%) viewed species knowledge as important for citizens today and 86% thought that species knowledge is important for sustainable development. Also in our study, the majority of the students (75%) viewed species knowledge as important for sustainable development and as many as 81% viewed it as important for EC teachers. When comparing these two studies, some differences can be seen in the ways the students argued for the importance of species knowledge. Palmberg and co-workers conclude that several of the arguments in their sample included ecological and conservational views, and arguments such as good general education as well as a professional interest were also present. However, most of the primary student-teachers seemed to value the species pragmatically, for example emphasising that it is important to know if something is edible or poisonous. In our study, only very few students expressed such pragmatic views in their arguments. Species and species knowledge were more often seen as something important for developing a relationship with nature.

The differences between the primary student-teachers' answers and the answers of the EC student-teachers in our study, when arguing for the importance of species knowledge for sustainable development, are interesting. Although the study programmes in the different teacher educations differ, ecological literacy and understanding its connection to sustainability should be an emphasis in any teacher education (Wolff et al., 2017). As Wolff and co-workers (2017) discuss, teachers must understand how nature and natural phenomena relate to social structures and be trained in ethical reasoning. They also point out that sustainability is a complex issue and ecological aspects of sustainability include, in addition to knowledge and understanding, emotional aspects and values.

Play and exploration in natural environments are by several researchers considered as an important foundation for sustainability education, since it provides children with opportunities to become familiar with the natural world and build personal and meaningful relationships with it (e.g. Barratt, Barratt Hacking, & Black, 2014; Beery & Jørgensen, 2018). Barratt et al. (2014) express specific concerns on today's children's reduced opportunities for direct contact with nature and stress the responsibility of early childhood institutions in providing all children, regardless of their background, regular opportunities for outdoor play. However, the adults accompanying the children should possess both the knowledge and skills to facilitate the diverse learning possibilities that exist in nature. This emphasises both the importance of assuring that early childhood institutions have educators with professional training, as well as the responsibility of EC teacher education of providing student-teachers with the necessary competences.

Conclusion

Our study provides novel insights into the species identification skills of EC student-teachers and their views on the importance of species knowledge. To our knowledge, there has neither been any studies on retention of students' species identification skills over such a long time span. We hope that this study, through the voices of students, can illustrate the importance of species knowledge as a part of EC teacher education. Although the first-year students in our study were not initially very familiar with common, local species, most of the third-year students argued clearly, and often through their own experiences of working with children, that species knowledge is something they considered important for EC teachers. Many students also recognised the connection between species knowledge and sustainable development and expressed some understanding of the emotional aspects and value-dependency of sustainability.

In our study, it is apparent that many of the situations, in which the students felt that they needed species knowledge, occurred spontaneously during nature excursions and were initiated by children. This illustrates the necessity of knowledge and understanding of local nature for EC teachers. As one of the students simply, yet precisely, described: *As a child, I was always curious, so I know how much fun it was when my dad could answer my questions.* It is fundamental that EC teacher education provides students the necessary knowledge and skills to recognise and facilitate the variety of learning possibilities that exist when exploring nature with children. EC teachers must be confident in talking with children about the different species they encounter and provide children possibilities of learning about them.

> But there is an old kind of magic of finding what is missing, and for summoning what has vanished. If the right spells are spoken, the lost words might return. (Macfarlane & Morris, 2017)

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