International Journal of Science Education

ISSN: (Print) (Online) Journal homepage: https://www.tandfonline.com/loi/tsed20

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To cite this article: Claudia Melis, Gabriella Falcicchio, Per-Arvid Wold & Anna Maria Billing (2021) Species identification skills in teacher education students: the role of attitude, context and experience, International Journal of Science Education, 43:11, 1709-1725, DOI: 10.1080/09500693.2021.1928326

To link to this article: https://doi.org/10.1080/09500693.2021.1928326

Published online: 23 May 2021.

INTERNATIONAL JOURNAL OF SCIENCE EDUCATION
2021, VOL. 43, NO. 11, 1709–1725
https://doi.org/10.1080/09500693.2021.1928326

Species identification skills in teacher education students: the role of attitude, context and experience

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ABSTRACT

Knowledge about local species and a positive attitude towards all living organisms are important to motivate the next generations to protect biodiversity. We compared local species identification skills and declared attitude towards invertebrates across genders in Italian and Norwegian students in teacher education. We focused on Norway and Italy for this comparative study, because of their different teaching traditions and relationships with outdoor education. We found a significant difference in local species identification skills between Italian and Norwegian students, who could identify 21% and 57% of the species, respectively. Overall, females had a more negative attitude towards invertebrates than males. However, Norwegian women had a more positive attitude towards invertebrates than Italian women did. Our result could reflect both differences in time spent in nature and teaching programs between countries. We also found a positive correlation between species identification skills and declared interest towards invertebrates. We discuss several approaches that could help to address this issue, in order for future teachers to become more aware of the risk that their biophobic attitude is transferred to the next generation with negative effects on biodiversity conservation.

ARTICLE HISTORY
Received 26 February 2021
Accepted 5 May 2021

KEYWORDS
Biology education; biophobia; pre-service teachers; comparative study

Introduction

Biodiversity encompasses genetic, species, and ecosystem diversity (Secretariat of the Convention on Biological Diversity, 1992). Conserving biological diversity is essential, because of the intrinsic value of nature (Cafaro & Primack, 2014) and because a complex natural environment, where many species coexist, is the foundation of all ecosystem services (Gascon et al., 2015). These are utilitarian and aesthetic values, such as food, clean water, climate regulation and recreation, and are defined by the Millennium Ecosystem Assessment as 'the benefits people derive from ecosystems' (Millennium Ecosystem Assessment, 2005).

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As a consequence of human activities, such as massive release of greenhouse gases, pollution, habitat destruction and overexploitation (Hooper et al., 2005; IPBES, 2019), our planet is experiencing a biodiversity crisis with a forecasted mass extinction of up to 1 million plant and animal species in a short time span (IPBES, 2019). Therefore, it is now as ever crucial that the next generations have the necessary knowledge and motivation to conserve biodiversity. In fact, we cannot expect people to care about the natural environment and make responsible decisions if they cannot recognise at least the common organisms around them (Bebbington, 2005). In other words, we cannot care about and protect what we do not know (Balmford et al., 2002).

Biodiversity conservation is also an important point of the 2030 Agenda for Sustainable Development, where the Sustainable Development Goal 15 is dedicated to 'protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss' (UN General Assembly, 2015).

For these reasons, it is crucial for young people to learn about biodiversity, starting from local diversity. Also, it is essential that teachers have a firm knowledge of biodiversity (Skarstein & Skarstein, 2020; Wolff & Skarstein, 2020) and that they are able to pass it on to children together with a positive attitude towards all living beings. Several studies investigated species identification skills, which are an important component of knowledge about species or 'species literacy' (Hooykaas et al., 2019; Skarstein & Skarstein, 2020). A study conducted in the Netherlands found for example that a substantial part of the laypeople had rather poor species identification skills relative to native species (Hooykaas et al., 2019).

Moreover, biodiversity education should not only focus on organisms that are closer to humans, charismatic or cute, but should also include less popular and neglected taxa (Ballouard et al., 2011; Balmford et al., 2002; Kellert, 1993), such as invertebrates. Other neglected taxa, despite their importance and prevalence in ecosystems, are plants and fungi. For example, a study conducted in the UK found that 86% of A-level students (aged 16 and above) could only name three or less flowers out of a sample of ten (Bebbington, 2005). The phenomenon of 'plant blindness' i.e. the inability to notice plants or appreciate their importance, has been investigated by many studies (Allen, 2003; Amprazis et al., 2019; Knapp, 2019).

People's emotions towards wildlife may be crucial for decision-making in biodiversity conservation (Castillo-Huitrón et al., 2020). According to the biophilia hypothesis (Wilson, 1984), humans possess an innate tendency to seek connections with nature and other forms of life. However, if children grow up in urban environments with little contact with nature, this 'extinction of experience' might increase their feeling of fear and disgust towards living organisms, named 'biophobia', and negatively affect future biodiversity conservation (Soga et al., 2020; Zhang et al., 2014). A study conducted in Japan found that biophobia in children was negatively associated with how often they visited nature and their knowledge of invertebrates (Soga et al., 2020). It is therefore important that children interact with nature and cultivate this connection from a young age (Kahn & Weiss, 2017).

On the other hand, the idea that fear and phobic response to certain natural stimuli might arise from our evolutionary history and be adaptive has been already formulated by Charles Darwin (Darwin, 1877). Many studies have shown that most

humans tend to find insects and other invertebrates to be scary and disgusting (Bjerke & Østdahl, 2004; Kellert, 1993; Lorenz et al., 2014; Prado et al., 2020; Soga et al., 2020). Kellert (1993) found that laypeople and farmers view most invertebrates with aversion, fear and ignorance. In a study conducted in Norway on attitudes towards different animal species, the least preferred animals were insects (except butterflies) and other invertebrates, such as snails, and women disliked invertebrates more than men (Bjerke & Østdahl, 2004). Similarly, according to an Italian study conducted on kindergarten children, invertebrates were the least preferred group among children (Borgi & Cirulli, 2015). A recent study conducted on pre-service teachers in Spain showed that their lack of interest for insects was influenced by their negative emotions (Prado et al., 2020).

Disgust has been explained as an avoidance mechanism that evolved to prevent the ingestion of rotten food or faeces (Darwin, 1872; Rozin & Fallon, 1987). Moreover, the disgust that people have for invertebrates is similar to that associated with pathogens (Davey, 1994; Kellert, 1993; Lorenz et al., 2014). Nevertheless, insects and other arthropods, like pathogens, are small and can occur in large numbers, and many invertebrate species are involved in crop damages and transmission of diseases, as parasites or disease vectors, or are associated with lack of hygiene (Kellert, 1993; Lorenz et al., 2014). This aversion, and the apparent lack of a sense of identity and consciousness among invertebrates (Kellert, 1993), negatively affects the conservation efforts towards them (Cardoso et al., 2011; Clark & May, 2002).

There is also a clear gender difference in fear and disgust towards invertebrates, which is stronger for women (Curtis et al., 2004; Fredrikson et al., 1996; Schienle et al., 2005). For example, in a study conducted in Sweden, animal phobia was almost four times more frequent in women with respect to men (Fredrikson et al., 1996).

Even within the European context, there are rather huge differences in outdoor life traditions and in how much teaching curricula for mandatory school focus on species literacy and particularly species identification skills. For example, in Scandinavia outdoor life (*friluftsliv* in Norwegian) is a very important cultural value, rooting in the romantic movements that aimed at bringing Scandinavians 'back to nature', that started in the eighteenth century as a reaction against industrialisation and urbanisation (Gelter, 2000). This cultural value of closeness to nature and tradition for being outdoor is already present in the curricula for early childhood education in Norway (Directorate for Education and Training, 2017) and it is part of the national identity, whereas it is absent outside Scandinavia. Italy and Norway are also rather different in gender equality. According to the Global Gender Gap score, an index to measure gender equality, Norway is ranked third, whereas Italy is ranked at the 63rd place among the 156 countries covered by the index (World Economic Forum, 2021). Previous studies have shown that differences between genders tend to correlate with national indicators of genders equality (Guiso et al., 2008); we might therefore expect differences in disgust between genders to be stronger in Italy than in Norway.

In comparative research, different outcomes are often explained in terms of differences in context conditions (Esser & Vliegenthart, 2016), we therefore investigated species identification skills in two European countries with contrasting outdoor life traditions and focus on species literacy to highlight how these different traditions might

influence knowledge on local species, attitude towards invertebrates and, in turn, biodiversity conservation.

In this study, we compare local species identification skills in Italian and Norwegian students in teacher education and explore their attitude towards invertebrates. We try to answer the following questions:

(1) Do species identification skills and attitude towards invertebrates differ between countries?
(2) Do species identification skills and attitude towards invertebrates differ between genders?
(3) Is there a correlation between attitude towards invertebrates and species identification skills?

We also discuss how the lack of interest and disgust towards invertebrates could be addressed in teaching programs to prevent future teachers passing on their biophobic attitude for invertebrates to the next generations with negative consequences for biodiversity conservation.

Methods

Norwegian study context

Mandatory school

In Norway, a minimum of ten years of mandatory school (from the age of six years) and three years in high school is necessary to access early childhood education. The natural science curriculum for primary education mentions at several grade levels the learning of biodiversity (Norwegian Directorate for Education and Training, 2013). More specifically, one of the aims upon completing the second year of primary school is that pupils should be able to 'recognize and describe some plant and animal species from the local environment and sort them in groups'. Moreover, in the seventh year of primary school, the pupils should be able to 'describe the characteristics of some plant, fungal and animal species and arrange them systematically' (Norwegian Directorate for Education and Training, 2013).

Bachelor in early childhood education

The Queen Maud University College for Early Childhood Education (QMUC, Trondheim) has students from all over the country. The course in Natural Sciences consists of sixty-one hours of teaching in ecology, biological diversity, sustainable development, health, and astronomy. The course includes both theoretical and practical teaching, as well as nature excursions.

Italian study context

Mandatory school

Also in Italy, a minimum of ten years of mandatory school (from the age of six years) and three years in high school is a prerequisite to access both the Department of Philosophy and Educational Science (Bari University, Italy). These Departments have students from

the whole region, but mainly from the province of Bari. The Italian curriculum for primary school (6–10 years), includes the recognition of the 'main characteristics and ways of life of animal and plant organisms', among the objectives to be achieved by the end of the five years (Ministry of Education University and Scientific Research, 2012). The term 'biodiversity' is mentioned only once in the Italian national curriculum, which, among the learning objectives to be achieved by the end intermediary school (13 years), quotes 'respect and preserve biodiversity in environmental systems.' (Ministry of Education University and Scientific Research, 2012).

Bachelor in philosophy and educational sciences

The Bachelor in Philosophy does not require an admission test and the students undergo a course in science history and philosophy of science; the courses consist of theoretical teaching, without excursions in nature. Although the Bachelor in Philosophy does not have teaching as primary purpose, many students pursue a teaching career. The Bachelor in Educational Science requires instead an admission test; it does not give access to teaching positions in the kindergarten and primary school (for which the Master in Primary Teacher Education is required). However, it gives access to teaching in the afterschool classes, including adult classes. The course does not include excursions in nature, environmental education, or science teaching.

Participants and data collection

In September 2018, before the course in Natural Sciences began, we asked four classes of students in early childhood education at QMUC ($n = 103$) to fill out a volunteer questionnaire regarding their previous knowledge of Natural Sciences. The average age of the Norwegian students in our sample was 21.8 years (±2.73). An almost identical questionnaire, translated into Italian, was presented in April 2019 to Italian students ($n = 105$), whose age was on average 21.8 years (±1.77). Of these 105 students, 78 were from the Bachelor course in Pedagogy and 27 were from the Bachelor in Philosophy.

To ensure anonymity, we did not collect personal data, except for gender information, and hence could not link the questionnaire with the students' identity. This prevented us from collecting data on other context variables, such as social class, upper secondary education and municipality, which might have allowed explaining more of the variation in the data.

Although the Norwegian and Italian sample are not entirely homogeneous with respect to future professional aims, being the Norwegian sample made of future kindergarten teachers and the Italian sample made of teachers in afterschool classes, both samples include students in the same age class and academic stage who are potentially future educators for the next generations of children.

Questionnaire

The questionnaire included, among other questions, one multiple-choice question about students' opinion of bugs, which was formulated as 'What do you think about bugs in general? (Spiders, Insects, Isopods, and similar)'. For this question, we used a five point Likert scale with the response options: very interesting, interesting, medium interesting, little interesting, and very disgusting. During our teaching in the classroom and in

nature, we have experienced many students who met invertebrates with reactions of disgust. For this reason, we chose to include this attitude in the Likert scale, although disgust and interest might coexist, by letting the student choose which attitude dominated their relationship with invertebrates. The questionnaire included also a species identification test based on ten species, five plants, and five animals (Table 1).

We asked the students to identify the species to the best of their knowledge. The questions were formulated as 'What is this? If you do not know the species, write which (taxonomic) group it belongs'. We chose the species according to a gradient in expected familiarity to the students, among the 100 species that the students in early childhood education have to learn for the final written exam in Natural Sciences. For example, based on our experience as examiners, we expected most of the students to be able to identify the pine *Pinus* sp. and the lingonberry *Vaccinium vitis-idaea* amongst plants, because these are very common wild plants in Norway. We also expected them to be most familiar with the crab *Carcinus maenas* and the spider *Araneus* sp., amongst animals. The test was first developed for the Norwegian context and then Italian experts in Biology were consulted to adjust it to the Italian context. In the Italian questionnaire, since the hepatica *Hepatica* sp. and the lingonberry are not common species in nearby nature, we replaced them with a wild rose *Rosa canina* and a field marigold *Calendula arvensis* (Table 1), which are comparably common.

The dataset included 105 questionnaires from Italy and 101 questionnaires from Norway (after removing two samples without gender information). In total, 171 females (90 from Italy and 81 from Norway) and 35 males (15 from Italy and 20 from Norway) participated in the study.

Data analysis

For each of the ten pictures of plant and animals species, we first noted the classification given by the students. Based on this classification, we could assign to each student a different score ranging from zero to ten. For the plants, we gave a zero score if the student left the question unanswered or provided a name of another species, and one point if the student was able to identify the plant by writing the common Italian or Norwegian name (e.g. lingonberry, pine, and hepatica). Whereas, for the fern and horsetail, we gave one point if the student was able to identify the group, since species identification at a more accurate level is difficult based on a picture only. Accordingly, for the animals,

Table 1. List of plant and animal species included in the identification test in Italy and Norway.

	Common English name	Latin name	Italy	Norway
Plants	Horsetail	*Equisetum* sp.	x	x
	Fern	*Phegopteris* sp.	x	x
	Pine	*Pinus* sp.	x	x
	Hepatica	*Hepatica* sp.		x
	Lingonberry	*Vaccinium vitis-idaea*		x
	Marigold	*Calendula arvensis*	x	
	Wild rose	*Rosa canina*	x	
Animals	Centipede	*Scolopendra* sp.	x	x
	Crab	*Carcinus maenas*	x	x
	Spider	*Araneus* sp.	x	x
	Carabid beetle	*Carabus violaceus*	x	x
	Bumblebee	*Bombus* sp.	x	x

we gave one point if the student was able to identify at least the group with the common name (e.g. spider, crab, beetle, and bumblebee).

Statistical analyses

Analyses were done in R (R Core Team, 2013). Since our sample did not meet the assumptions of normality and size for parametric tests, we used Mann–Whitney *U*-tests to assess differences between groups (countries and genders) in species identification score and attitude towards invertebrates; all tests were two-tailed. We fitted a linear regression to the data, to test whether sex, declared attitude towards bugs, and the interaction between these two variables were associated with the number of correctly identified species. This regression analysis was carried out separately for the Italian and Norwegian datasets, because we were interested in detecting the effect of gender and attitude within countries. The final model was selected by model reduction, starting from the model: Species literacy ~ Attitude towards bugs + Sex + Attitude towards bugs: Sex, where only explanatory variables with significance $p < 0.05$ were retained in the model.

Results

Species identifications skills

In both countries, the majority of students recognised spider and crab, whereas very few students were able to identify the scolopender (Figure 1). Many students (30% in Italy

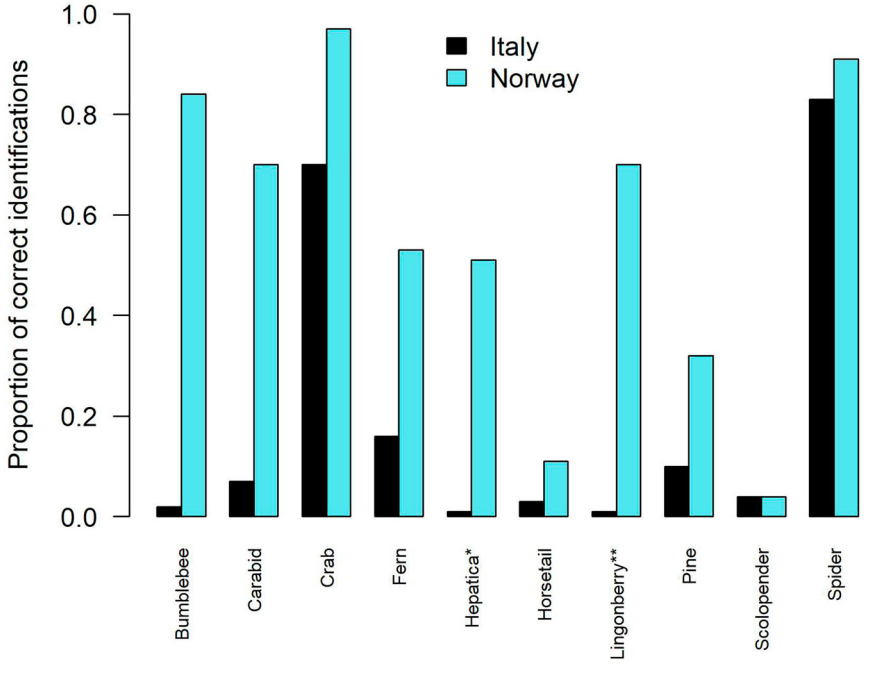

Figure 1. Proportion of correct identifications for each species/taxonomic group by students in Italy and Norway. * Replaced by marigold in the Italian questionnaire. ** Replaced by wild rose in the Italian questionnaire.

and 80% in Norway) identified the scolopender as 'millipedes', which is the common name for another class (Diplopoda). There was a large difference between countries in the identification success of bumblebee and carabid, with far better identification skills observed among the Norwegian sample (Figure 1). Many Italian students (48%) identified the carabid as a cockroach *Blatta orientalis*, which in Italian is called 'scarafaggio' and belongs to another order (Blattodea) than beetles (Coleoptera).

Figure 2 shows the percent distribution of the species identification score according to gender and country. The median species identification score was significantly higher for Norway than Italy (Mann–Whitney $U = 6064.5$, $n_1 = 105$, $n_2 = 101$, $p < 0.001$), whereas there was no significant difference between males and females (Mann–Whitney $U = 4283.5$, $n_1 = 39$, $n_2 = 171$, $p > 0.05$).

Attitude towards invertebrates

Overall, the median declared attitude towards bugs was around the second level of the Likert scale ('not interesting'), for Italy, and around the third level ('middle interesting'), for Norway. However, when taking gender into account, there was a significant difference within the Italian sample, where the median declared attitude towards bugs was one ('very disgusting'), for women, and four ('interesting'), for males (Mann–Whitney $U =$

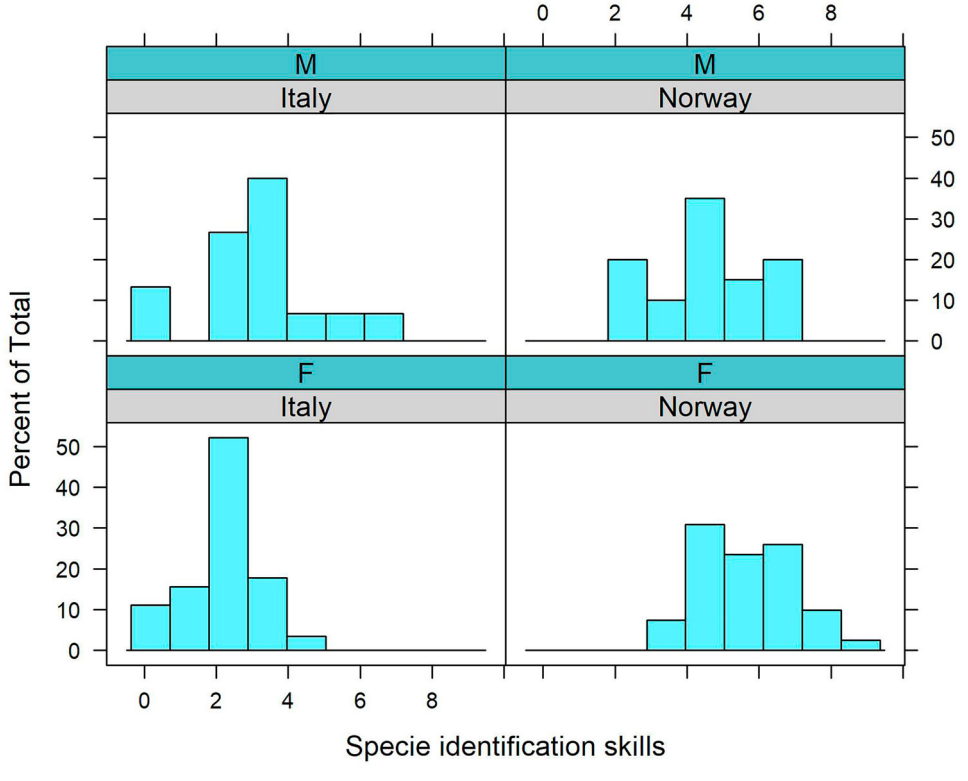

Figure 2. Percent distribution of students according to species identification skills and gender in Italy and Norway.

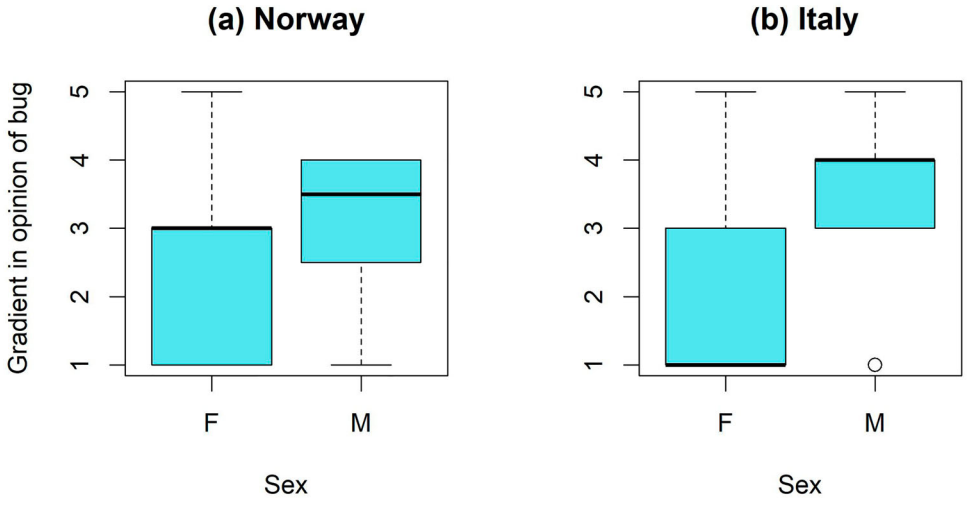

Figure 3. Boxplots (with median and quartiles) showing the difference in declared opinion of bugs for students according to sex in (a) Norway and (b) Italy.

1090, $n_1 = 14$, $n_2 = 90$, $p < 0.001$). This difference was less evident in the Norwegian sample (Figure 3).

By looking at the percent distribution in attitude towards bugs according to sexes and countries (Figure 4), it is possible to notice that both in Italy and Norway, females had a worse declared attitude towards bugs than males (Mann–Whitney $U = 5535.5$, $n_1 = 39$, $n_2 = 111$, $p < 0.001$). The pattern in attitude towards bugs was more similar according to gender than according to nationality. Moreover, in Norway, about 30% of females found bugs 'very disgusting', while in Italy more than 50% did so (Mann–Whitney $U = 7760.0$, $n_1 = 81$, $n_2 = 90$, $p < 0.01$).

Relationship between species identification skills and attitude towards invertebrates

For the Italian dataset, the explanatory variable Sex was the only variable retained in the final model after model reduction. According to the model, being male had a positive effect on species identification skills (Score in species identification = 1.89 + 0.978 (Male)). This model was highly significant ($p < 0.001$), but explained a modest amount of variation in the data (7% circa).

For the Norwegian dataset, the final model included both Attitude towards bugs and Sex as explanatory variables, where being male had a negative effect on identification skills and a positive attitude towards bugs had a positive effect. This model was also highly significant ($p < 0.001$) and explained 16% circa of variation in the data (Score in species identification = 4.96 + 0.3958 (Attitude towards bugs) – 1.460 (Male)).

Figure 5 shows the two regression models: Species literacy ~ Attitude towards bugs, plotted for Norway and Italy and for the two genders (in black, line and points for females and in blue, line and points for males). From this figure, it is possible to see

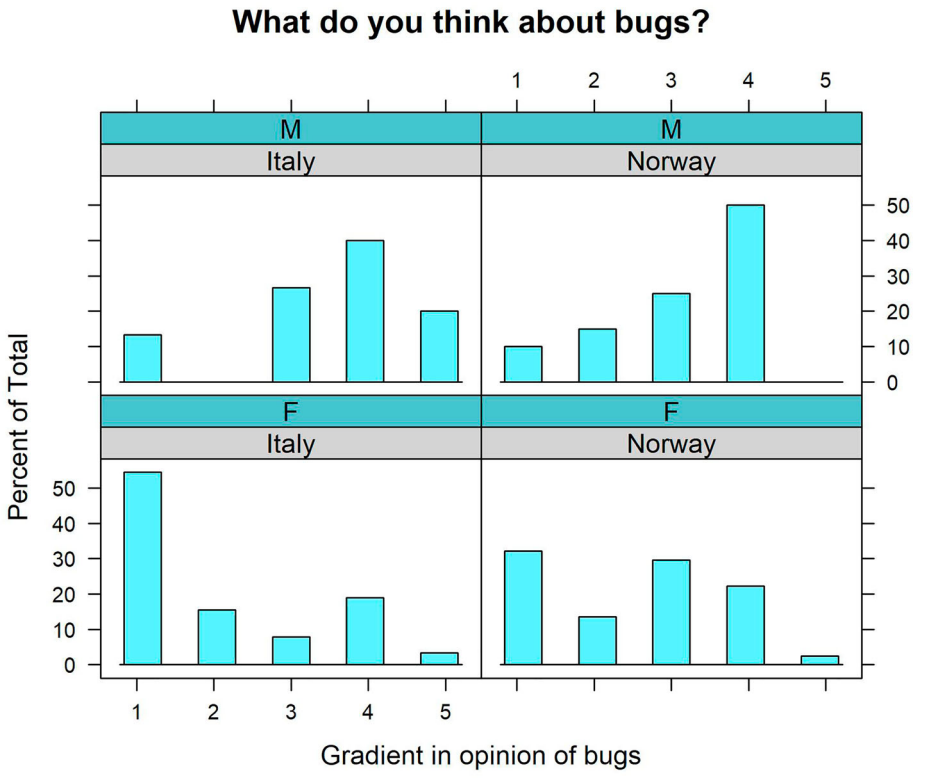

Figure 4. Percent distribution of students according to declared opinion of bugs and gender in Italy and Norway.

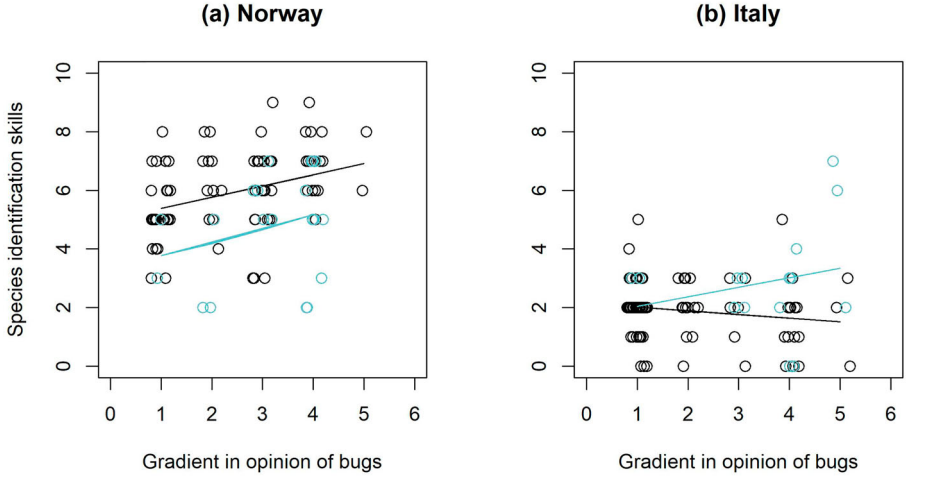

Figure 5. Linear regression models explaining the score in species identification in relation to the gradient in opinion of bugs for (a) Norwegian and (b) Italian students. In black, females and in blue, males.

that the relationship between attitude towards bugs and gender is more obvious in Norway and less evident in Italy, especially for females.

Discussion

Species identification skills

The results of our study showed a significant difference in local species identification skills between Italian and Norwegian students, where Italian and Norwegian students could respectively identify 21% and 57% of the species. For comparison, a Norwegian study conducted on early childhood student teachers found that, before starting the Natural Sciences course, the students were able to identify less than 30% of 18 local species of plants, birds, and intertidal organisms (Skarstein & Skarstein, 2020). However, after the course, this situation changed and the students maintained the local species knowledge acquired in their first year of early childhood education throughout the three years of study. In a Finnish study, the early childhood student teachers were able to identify 66% of the 18 local mammals, birds and plants included in the test, before starting the course in Natural Sciences (Wolff & Skarstein, 2020). Although it is not straightforward to compare species identification skills across different studies, due to the different samples of species, the Norwegian students in our sample had a similar score to that reported for Finnish students. On the other hand, Italian students showed the lowest identification skills.

This result could reflect both differences in time spent in nature and teaching programs between countries. Time spent in nature is likely to be an important factor explaining species identification skills, because children start to learn about species diversity by observing plants and animals in the neighbourhood (Wolff & Skarstein, 2020). Spending time outdoor in contact with nature on a regular basis as a child may promote respect and appreciation for nature and even motivate for environmental action as adult (Chawla, 2007). Balmford et al. (2002) showed that young children (aged 8) have a great capacity to learn to recognise creatures, being able to recognise nearly 80 of 150 types of Pokemon (although they were much less able to identify common natural wildlife types).

Different degrees of urbanisation could also contribute to create this pattern (Soga et al., 2020); in fact, Bari municipality has 2700 inhabitants per km^2 (Urbistat, 2019), five times more than Trondheim municipality, which has a density of 530 inhabitants per km^2 (Statistics Norway, 2020). However, many students come from other municipalities to study and we did not collect information about their origin. On a national level, the difference in population density between the two countries is even larger (205 in Italy vs. 15 in Norway) (The World Bank, 2020).

Moreover, outdoor life (*friluftsliv* in Norwegian) is part of Norway's national identity and it is an important value in education since preschool (Gelter, 2000; Nilsen, 2008). Spending at least one day a week in nature engaging in outdoor activities, exploring and learning (*uteskole*) is normal in Norwegian primary schools. By the end of mandatory school, Norwegian students should be able to manage outdoor life and spend time outside independently of weather conditions. The competence aims for the seventh grade quote, for example, that the pupils should be able to 'orientate oneself using maps

in familiar terrain, tell about local outdoor life traditions and participate in various outdoor life activities under varied weather conditions' (Directorate for Education and Training, 2006). Whereas the competence aims for the eighth grade quote that a pupil should be able to 'orientate oneself by using maps and compasses in varied terrain, practice outdoor life in different natural environments, plan and carry out trips for different seasons, also with spending the night outside' (Directorate for Education and Training, 2006).

On the contrary, the teaching programs for mandatory school in Italy hardly mention outdoor life. Usually, time spent outdoors is longer in kindergarten, and it disappears entirely in primary and secondary school. Each school adopts its habits with respect to play and recreational time, in relation to the availability of spaces and auxiliary personnel. In general, the concept of indoor school is prevalent in Italy, and even breaks take place within the school walls, sometimes in the same classroom and it is not rare that children, as they grow up, are required not to get up from the bench even during breaks.

In recent years, outdoor education has received more attention (Agostini et al., 2018). In general, however, the widespread mentality of both teachers and parents is still anchored to a school model that keeps children away from the natural environment and from those activities, such as taking a walk or cultivating a garden, which are considered only playful or even a waste of time compared to 'real' learning.

Attitude towards invertebrates

Our study also confirmed the tendency for women to be less interested and more disgusted by invertebrates, which has been widely described by previous studies (Bjerke & Østdahl, 2004; Curtis et al., 2004; Curtis et al., 2011; Fredrikson et al., 1996; Gunnthorsdottir, 2001; Lorenz et al., 2014; Prado et al., 2020). This gender difference in attitude towards invertebrates seems to be the product of both evolutionary and cultural adaptations related to the traditional caring role of women, looking after the children and the household. In fact, from an evolutionary point of view, we would expect women to feel greater disgust due to their higher parental investment (Trivers, 1972). Although women who already had children demonstrated lower disgust sensitivity than childless females (Prokop & Fancovicova, 2016). However, our results also showed a difference between Italian and Norwegian women, where Italian women had a more negative attitude towards invertebrates than Norwegian ones. This might be a consequence of the presence of venomous Arachnida in Italy, such as the black widow spider (Garb et al., 2004) and several species of scorpions, which are absent in Norway. Moreover, in Italy, the species of *Vipera* sp. are more numerous and poisonous than the ones found in Norway. However, there was no difference in attitude towards invertebrates between Norwegian and Italian males. If disgust is part of the cultural construction associated with genders, both males and females might adopt their attitude according to gender roles expectations (Butler, 1986). These results could also rely on differences in education (within the family) in Italy between genders. In general, male children are freer to explore outdoor and play with animals and dirt, and start from a younger age than girls (Soori & Bhopal, 2002).

Relationship between species identification skills and attitude towards invertebrates

We also found a positive correlation between species identification skills and declared interest towards invertebrates. Similarly, a German study found that disgust correlated negatively with biology competence in students (Randler et al., 2013). This correlation explained only a small amount of variation in the data and was especially evident for Norwegian students of both sexes. On the contrary, the correlation was present only in males for Italian students, because females did not show enough variation in their opinion of invertebrates. The fact that the species identification test included both invertebrates and plants might have biased the results, because the interest towards invertebrates might not affect the ability to identify plants.

These results support the finding that children's biophobia is negatively associated with their frequency of nature experiences and perceived knowledge of invertebrates in Japan (Soga et al., 2020). This association between knowledge and attitude is probably due to the effect of time spent in nature on both knowledge and attitude towards invertebrates.

Similarly, an American study found that students who had a higher level of knowledge about bees also had a more positive attitude towards these insects, probably because they engaged in gardening and lawn-care activities (Silva & Minor, 2017).

Gender-role stereotypes might also have affected the results of our questionnaire. According to gender-role stereotypes, men are not supposed to fear small creatures, whereas females are allowed to fear harmless animals such as mice and insects (Kirkpatrick, 1984).

Both genders might have declared a more positive or negative attitude towards invertebrates than the actual one, because they answered in a socially desirable way, reflecting gender-role stereotypes. A fear survey on college students showed that males were more likely than females to declare lower fear for fearful stimuli when their heart rate (an independent measure of fear) was not monitored (Pierce & Kirkpatrick, 1992).

Limitations of the study

One limitation of our study is the limited sample size. Moreover, although we tried to choose common local species, the sample of species might have influenced the results. A larger number of species might also have allowed a better comparison between countries.

Implications and suggestions

Future research should include a larger sample of countries along a gradient in gender equality and tradition in outdoor education to try to disentangle the effect of these two factors. Collecting more detailed background data, such as social class, upper secondary education and municipality of origin, might allow explaining more of the variability in species identification skills and attitude towards invertebrates.

Our results are of concern, considering that the students, disgusted by organisms that are fundamental for ecosystems, are future teachers, who will accompany generations of

children. Attitude towards nature can be passed on to future generations, as biophobia in children associated with family members' biophobia (Soga et al., 2020).

Moreover, given the actual biodiversity crisis and the need for an education increasingly focused on the conservation of biodiversity, these poor species identification skills, could have negative consequences.

To address this challenge, we could adopt different approaches. The first would be to increase time spent exploring nature at school. Particularly, attitude towards invertebrates could improve by participating in excursions to observe them and engaging in games with bugs as a theme (Westgarth-Smith, 2004). Activities that involve handling invertebrates have as well shown to improve attitude towards them (Prokop & Fancovicova, 2017; Randler et al., 2012). Several smartphone apps are also available to help identifying species and keeping track of observations, such as inaturalist (https://www.inaturalist.org/). This app, in addition to providing good taxonomic and natural history information for many organisms, increased also interest for nature in biology students (Unger et al., 2020). Another possibility would be to recruit more males in teacher education, which would require an active recruitment policy. The Norwegian government for example wants to increase the number of men who choose a career as early childhood education and care (ECEC) teachers (Emilsen et al., 2020). Increasing the salary for these professions would also probably make them more attractive for men. A positive attitude, appreciation and care towards all living organisms should be a requirement to pursue teaching education. Finally, students in teacher education who are disgusted by invertebrates should get help in becoming familiar with these species and address their negative emotions, as pointed out by other studies (Prado et al., 2020), or at least made aware of their model role as adults, who should not transfer further their biophobic attitude to future generations.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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