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Authors: Silva, André Bastos da, Sales, Francisco Arlan de, Ferreira, Luciana Nobre de Abreu, Andrade, Juliana Ramos de, Souto, Wedson de Medeiros Silva, et al.

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Age and Fieldwork Experience Increase Brazilian University Students' Ability to Identify Wild Mammals

André Bastos da Silva[1], Francisco Arlan de Sales[1],
Luciana Nobre de Abreu Ferreira[1], Juliana Ramos de Andrade[2] (iD),
Wedson de Medeiros Silva Souto[1], and
Clarissa Gomes Reis Lopes[1] (iD)

Abstract

A lack of engagement with the natural environment can reduce awareness of issues surrounding environmental and biodiversity conservation. Therefore, to increase students' awareness, science teachers should develop activities related to biodiversity, bringing students into closer connection with the natural environment. This study evaluated the ability of 115 Brazilian university students' to identify native and alien wild mammals. Patterns in university students' ability to identify species were predicted by a combination of variables (university-level, age, gender, experience linked to countryside, family farming, fishing, and hunting). Students correctly identified alien mammals more frequently than native mammals. We found distinct groups of species in function of students' experience (university-level, age group, fishing, and hunting). In addition, we found that the correct identification of native species was mainly associated with older male students who go regularly to the countryside, and participate in activities linked to farming, fishing, and hunting. Our findings support those from previous studies that show fieldwork classes are essential to increase the contact of an increasingly urbanized society with the local natural environment. We suggest that inclusion of fieldwork is necessary for the development of university students' awareness regarding the richness of native mammal species and consequently, the importance of their conservation.

The tropics encompass the planet's greatest vertebrate biodiversity (Lima et al., 2009). Unsurprisingly, Brazil leads this region in terms of mammals total biodiversity (Quintela et al., 2020). This rich wild fauna plays an important role in maintaining ecosystems and in the food security and income for thousands of people (Burgin et al., 2018; Ripple et al., 2016; Souto et al., 2019; van Vliet et al., 2015). However, there is an ongoing process of biodiversity loss (Butchart et al., 2010) and, consequently, of the increasing difficulty of human contact with nature, especially in urban centers (Tavares et al., 2012). Loss of knowledge about biodiversity is an unhappy denouement of the rupture in the human-nature relationship (or *extinction of experience*;

Pyle, 2011), which can cause the non-appreciation of nature, and increase of biophobia (i.e., the fear of living things, aversion, and alienation from nature; Miller, 2005; Soga et al., 2020). In Brazil, for instance,

[1]Campus Universitário Ministro Petrônio Portella, Universidade Federal do Piauí, Teresina, Brazil
[2]Department of Botany, Universidade Federal Rural de Pernambuco, Brazil

Corresponding Author:
Clarissa Gomes Reis Lopes, Campus Universitário Ministro Petrônio Portella, Universidade Federal do Piauí, Bairro Ininga, CEP 64049-550, Teresina (PI), Brazil.
Email: claris-lopes@hotmail.com

it is already possible to find a bigger ability to recognize more exotic fauna (or alien, i.e., those species from other regions; Richardson et al., 2000) than the native one among elementary school students from locations with a high level of urbanization (Bizerril, 2004). On the order hand, frequent contact with nature decreases biophobia and increases people's knowledge of native biodiversity (Sampaio et al., 2018; Zhang et al., 2014). Thus, extinction of experience is a huge challenge for conservation (Colléony et al., 2017), and education strategies could play a central role in the increasing knowledge about nature (Soga et al., 2020).

The concern with the natural environment has reached significant proportions in various sectors of the society; therefore, the search for alternatives to improve people's sensitivity to the issue has been the focus in the most differentiated technical, scientific, and political forums (Sachs, 2002). In fact, environmental education and conservation should combine recognition and understanding of the local biodiversity, including these skills in formal, non-formal, and informal educational activities (Melo et al., 2021; Palmberg et al., 2015; White et al., 2018). However, no much is taught about native species in primary and secondary schools, and most material focus on a few species, usually alien (Melo et al., 2021). For instance, there is evidence of French children's knowledge and their consideration to protect animals which are mainly limited to virtual alien biodiversity (Ballouard et al., 2011), thus contributing to devaluate the local wildlife. It is common in Brazil to devalue the teaching of local biological diversity, so the richness of regional species is not used when trying to explain biodiversity (John, 2006).

Knowledge of aspects that historically constitute the natural environment of a community enables the development of people who can help identify, understand and create solutions to environmental problems, thus reflecting their educational and geographical origins (Vodouhê et al., 2010). To encourage such development, environmental education in formal course structure is increasing in Brazil (Brasil, 2012; Brazil, 2015). Yet, despite such advances, it remains necessary to encourage Brazilian universities to offer opportunities to increase elementary students' proximity to the natural environment, to encourage awareness and concern regarding the conservation of the natural environment (Bizerril, 2004). Strategies in environmental education should be developed carefully, as trying to increase awareness through fear has not been effective to sensitize people about the real importance of nature in their daily lives (Miller, 2005). Additionally, there is evidence that Nature Relatedness (emotions, values, and attitudes) may provide a motivational force towards nature protection and preservation (Nisbet et al., 2009). In this perspective, such strategies require science teachers to previously know regional and local fauna (Torkar & Bajd, 2006).

The main goal of our research was to assess the relationship of formal and informal educational factors on Brazilian university students' ability to identify wild mammals. Specifically, we seek to answer the following questions: How the university-level (i.e., classes of the first (beginners) and last (seniors) semesters of the course) influences students' ability to identify wild mammals? How do factors including age, gender, and experience linked to the countryside (i.e., farming, fishing, and hunting) influence their identification skills? The central hypothesis was that both the content offered by the formal course structure and the learning experience gained in countryside activities would contribute effectively to the development of knowledge regarding wild mammal identification.

Methods

Study Area and Sampling

We gathered data at the Federal University of Piauí (hereafter UFPI – "Universidade Federal do Piauí"), in Northeast Brazil, of which we selected the Undergraduate Course in Natural Science (hereafter CLCN – "Curso de Licenciatura em Ciências da Natureza"). This teaching course trains science teachers to work, mainly, in elementary and secondary schools (stages of Brazilian formal schooling; see Federal Law No. 9,394/96). Thus, the CLCN prepares students for a comprehensive view of the natural sciences including physics, chemistry, and biology. Furthermore, these sciences are articulated with pedagogical knowledge by so-called *integrative disciplines (*e.g., Teaching Methods in Science and Scientific Teaching in a Pedagogical Framework).

In order to compare university-level, we selected two distinct groups, i.e., students of the first (beginner = 65; who have not taken biology-based disciplines, and they were in first year of the course) and last (senior = 50) semesters of the course (fourth year). This total of participants (*n*) was calculated by the equation $n = N(1/E_0^2)/N + (1/E_0^2)$, where: N is the total of students enrolled (beginner = 117; senior = 105), and E_0^2 is the sampling error (10%) within a 95% confidence level (Barbetta, 2008). Thus, a total of 115 students participated in our survey (66 men and 49 women) aged between 17 and 54 years old (26.83 ± 8.00).

To avoid analysis bias regarding the presence of students from different university levels, especially beginner and senior students who were still taking introductory classes, the sampling process considered students who were present in the first day of classes of the prerequisite subject of the first term of the CLCN. We selected

beginner and senior students by a simple sampling without replacement from a list of students enrolled provided by CLCN coordination.

Data Collection

The applied procedures in this research were approved by the UFPI ethics committee (number 62606516.0.0000.5214). We conducted structured interviews (Bernard, 2006) between the 2nd and 1st semesters of 2017 and 2018 respectively. The questionnaire had 24 images of native Brazilian (12 printed images) and alien (12 printed images) wild mammals. The chosen alien mammals are usually observed in educational materials or media resources (advertisements, TV series, and movies), such as *Giraffa* sp. and *Equus quagga*.

To select native mammals, we included those animals among the most likely to be recognized by students. This selection reduces possible bias regarding the greater chance of recognizing charismatic alien species. Thus, we adopted the following selection criteria for native species: (a) use as food (e.g., bushmeat) of the mammals in Northeast Brazil; (b) mammals which do not exhibit extremely cryptic behavior; and (c) mammals hunted or captured frequently for being opportunistic predators of farmed animals (e.g., *Panthera onca* and *Puma concolor*).

With respect to the personal information, university students were asked whether they had previously lived or visiting the countryside regularly (hereafter "linked to countryside") and whether they used to family farming, fishing, or hunting. Finally, the university students answered the following questions for each mammal image: "Do you know this animal?" and then "What is its name?" Each species was considered correctly-identified-known when participant referred to a valid popular name locally used or available in the media resources.

Data Analysis

First, a Permutational Analysis of Variance (PERMANOVA) based on the Jaccard similarity index was used to examine whether the species identified correctly by students varied according to university-level (beginner or senior), age group (less than 22 years old, 22 – 29, and 30 or older), gender (male or female), and by linked to countryside (yes or no), family farming (yes or no), fishing (yes or no), and hunting (yes or no). This test was performed by the "adonis" function of the "vegan" package in R (Oksanen et al., 2019). We used the "betadisper" function of the "MVN" package to check the homogeneity of multivariate dispersions (Korkmaz et al., 2014). Second, we produced a biplot of constrained canonical redundancy analysis (RDA) using the Hellinger distance in the "vegan" package to view the species groups and associated factors. The multicollinearity test was checked by the "vif.cca" function, and the adjusted-R^2 was computed using "RsquareAdj" function.

Finally, Generalized Linear Models (GLMs) were fitted to predict university students ability to identify wild mammals. The response variables were the proportion of correct answers of general (model a), native (model b), and alien (model c) correctly-identified-known species. The predictors were the same factors used above in the PERMANOVA (except age that was used continuous data). Multicollinearity of these predictors was checked using the 'corvif' function. We used the "quasi-binomial" error family and "logit" link function after checking the ratio of the residual deviance to the residual degrees of freedom, which suggested underdispersed (Sidhu & Datta, 2015; Zuur et al., 2009). The "drop1" function was used to find the optimal model (Zuur et al., 2009), and the "exp" function to obtain the odds ratios (Ekstrøm, 2017). All the analyses were performed in R (R Core Team, 2020) using Rstudio Version 1.3.1093 (RStudio Team, 2020) at a statistical threshold level of $p < .05$.

Results

Profile and Ability of University Students to Identify Wild Mammals

Overall, most (98.26%) university students were from urban areas, and 89.56% had never lived in rural areas until the moment of the interview. Table 1 summarizes the profile of the interviewed university students.

The best-known wild mammals (species identified correctly by $\geq 80\%$ of students) comprised 17 species, of which five were native and 12 were alien species. Giraffe (*Giraffa* sp.) and the Brown-throated Sloth (*B. variegatus*) were the best-known species, both with 100% identification accuracy. On the other hand, the least known species (species identified correctly by $< 80\%$ of university students) were all native, such as the Spix's yellow-toothed Cavy (*Galea spixii*) and Collared Peccary (*Pecari tajacu*), correctly identified by 30.43% and 21.74% of university students respectively (Figure 1).

Factors That Influence University Students Ability to Identify Mammals

When we analyzed the influence of predictors on species composition, we found a formation of groups in function of university-level, age group, fishing, and hunting (Table 2). Pairwise comparisons showed that species linked to younger students significantly differed from the ones in older students. The tendency for species

correctly identified differ among university students was also observed in the RDA (global test: $F = 1.45$, $p < .01$; first two canonical axes: $F = 4.28$, $p < .01$; $F = 3.48$, $p < .05$, respectively).

The RDA biplot showed that the native species were mainly associated to male and oldest students who go regularly to the countryside, and practice activities linked to farming, fishing, and hunting (Figure 2). This last one, for example, played an essential role in the dispersion of the species including Collared Peccary (*P. tajacu*), Spix's yellow-toothed Cavy (*G. spixii*), and Paca (*Cuniculus paca*). Yellow Armadillo (*Euphractus*

sexcinctus), Puma (*Puma concolor*), and Crab-eating Fox (*Cerdocyon thous*) were linked to beginners students. On the other hand, Nine-banded Armadillo (*D. novemcinctus*) was associated to seniors ones, and is the species furthest from the center of the axis. In this position, all alien species and about 30% of native species were located.
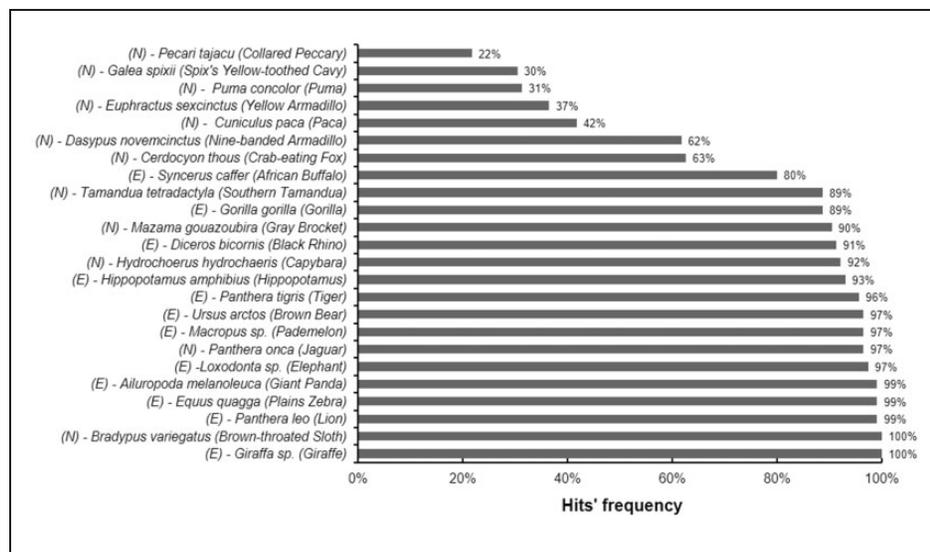
Table 1. Profile of Interviewed University Students From the UFPI CLCN.

	%
University-level	
Senior	43.48
Beginner	56.52
Gender	
Male	57.39
Female	42.61
Goes regularly to the countryside	
Yes	33.04
No	66.96
Involved in family farming	
Yes	50.43
No	49.57
Involved in fishing	
Yes	51.30
No	48.70
Involved in hunting	
Yes	28.70
No	71.30

Table 2. PERMANOVA Test for Species' Composition With 999 Permutations.

Variables	F. model	R^2
(a) University-level		
Global test	3.9779	.0340
(b) Age group		
Global test	2.1799	.0375
Pairwise comparisons		
2 *vs.* 3	−0.1251	−.0016
2 *vs.* 1	3.0315	.0388
3 *vs.* 1	3.6967	.0495
(c) gender		
Global test	0.9810	.0086
(d) Countryside		
Global test	0.4228	.0037
(e) Family farming		
Global test	1.4255	.0125
(f) Fishing		
Global test	2.2747	.0197
(g) Hunting		
Global test	2.2500	.0195

All square correlation ratios (R^2) were statistically significant ($p < .05$), except "2 *vs.* 3" pairwise comparison, and global test for gender, and linked to countryside and family farming. Legends: age group: less than 22 years old (1), 22–29 (2), and 30 or older (3).

Figure 1. Mammal Species Recognized Correctly by Interviewed University Students. Legends: native (N) and exotic (E) species.
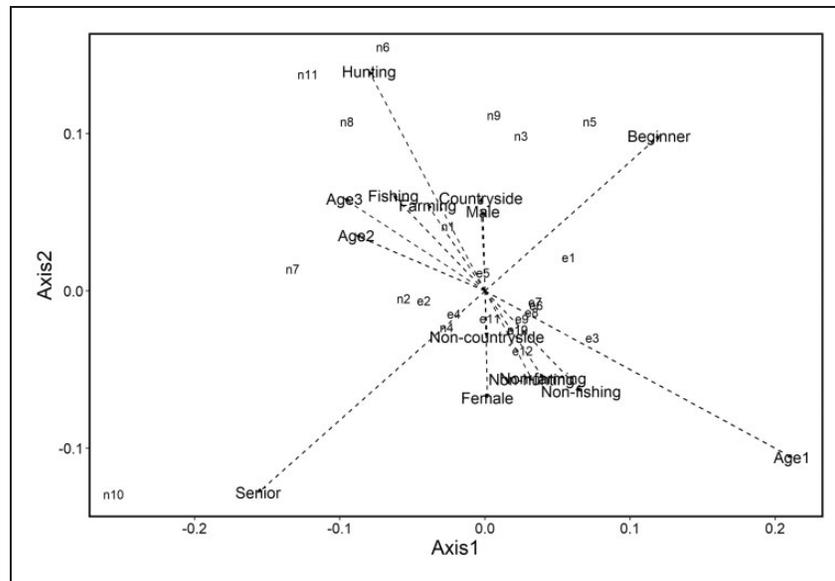
Figure 2. RDA Biplot of the Mammals' Species Groups by University Students' Variables. Legends: age group: less than 22 years old (1), 22 – 29 (2), and 30 or older (3); native species: *Mazama gouazoubira* (n1), *Hydrochoerus hydrochaeris* (n2), *Puma concolor* (n3), *Panthera onca* (n4), *Cerdocyon thous* (n5), *Pecari tajacu* (n6), *Tamandua tetradactyla* (n7), *Galea spixii* (n8), *Euphractus sexcinctus* (n9), *Dasypus novemcinctus* (n10), *Cuniculus paca* (n11), *Bradypus variegatus* (n12); and exotic species: *Panthera tigris* (e1), *Syncerus caffer* (e2), *Gorilla gorilla* (e3), *Loxodonta* sp. (e4), *Macropus* sp. (e5), *Hippopotamus amphibius* (e6), *Diceros bicornis* (e7), *Panthera leo* (e8), *Ursus arctos* (e9), *Giraffa* sp. (e10), *Equus quagga* (e11), *Ailuropoda melanoleuca* (e12).

The GLM results showed that older students as well as those linked to fishing and family farming affected the ability of general mammals' recognition more than younger students, who have not had a learning experience with such activities. Similarly, correct answer rates of native mammals were significantly affected by students linked to fishing and family farming. On the other hand, only students with fishing learning experience affected the ability of alien mammals' recognition (Figure 3; Table 3).

Discussion

In this study, we found that the profile of students from the CLCN affects the ability to identify wild mammals. For instance, the oldest students (consequently with more opportunity to know biodiversity; Soga et al., 2019) who practice activities linked to farming and fishing showed to have more likelihood to identify native species. Similarly, Sampaio et al. (2018) observed a greater knowledge about native animals among children who had contact with nature. In fact, the experiences people have with nature are considered a key factor to determine how they will establish connections with nature and how they will perceive it (Carvalho, 2014; Melo et al., 2021). Unsurprisingly, this does not seem to be the case of the surveyed area, given that 94.27% of the population lives in urban areas (Instituto Brasileiro de Geografia e Estatística (IBGE), 2010).

The growing urbanization promotes the extinction of experience, increasing biophobia (Miller, 2005; Zhang et al., 2014). This disconnection from nature may explain the prevalence of the ability to recognize alien species. For instance, the high percentage of familiarity with the Giraffe by interviewed students may be related to its broad exposure in social media such as wildlife documentaries and movies, as well as by the large number of stimuli that students receive, especially at primary and secondary schools (John, 2006). Giraffe, for instance, is one of the species used in almost every Elementary school's science textbook to explain natural selection.

Brown-throated Sloth and the Jaguar were the only native species among the ten best-identified mammal species. It is possible that the wide geographic distribution of these species, with their presence in several Brazilian phytogeographic domains, contributes to knowledge among students. For instance, the Jaguar is one of the best-known native species among university students from other Brazilian regions (de Melo et al., 2021). Besides, the Brown-throated Sloth is known as the world's slowest animal, so in simplified vocabulary, it is a synonym of a person who has no disposition to work.

The RDA biplot showed that native mammals associated with beginner and senior students are more accessible and more abundant in this region (Aziz et al., 2016; Randler et al., 2012). On the other hand, Paca, Spix's yellow-toothed Cavy, and Collared Peccary were native
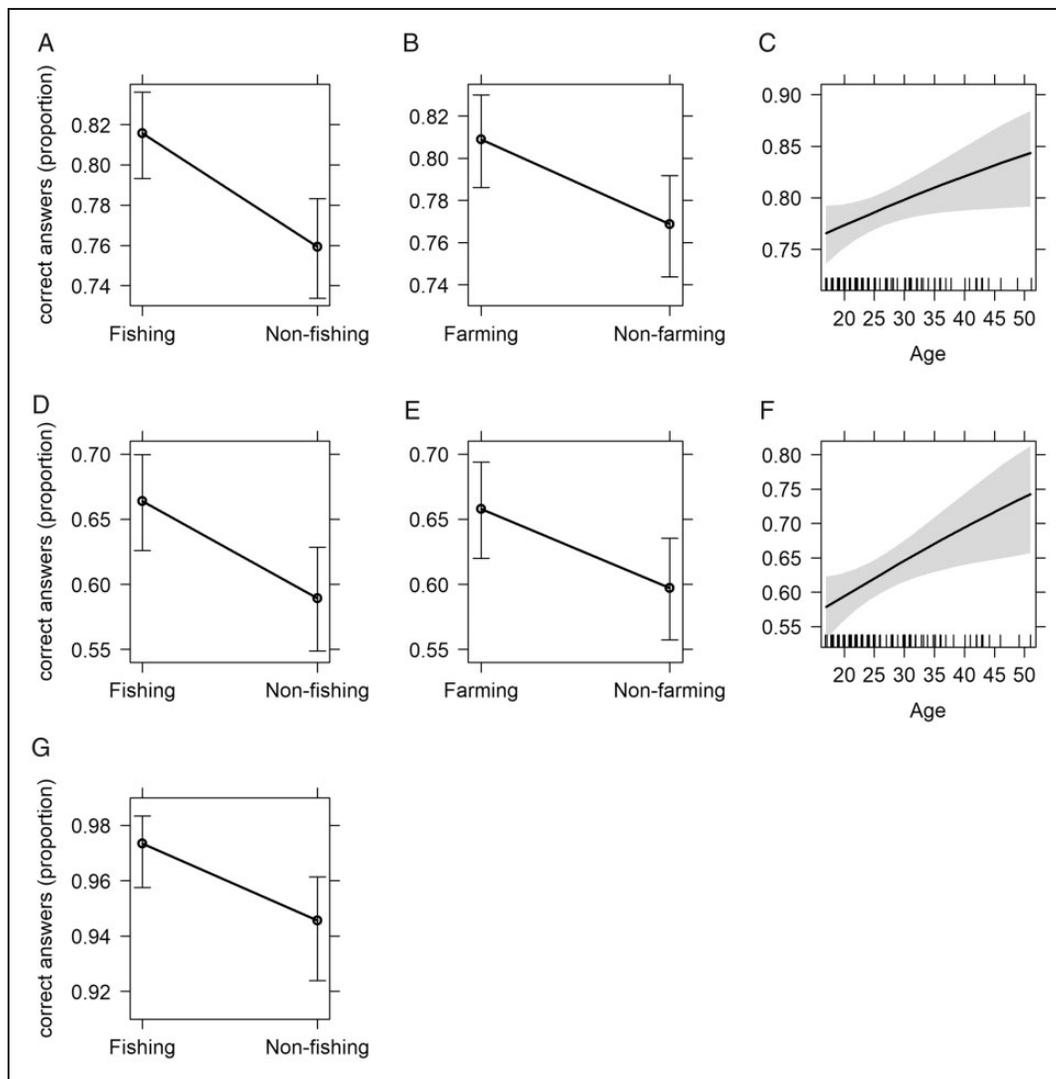
Figure 3. Patterns in Ability to Recognize Wild Mammals by University Students. Relationship between proportion of correct answers of general (a, b, and c), native (d, e, and f) and alien (g) wild mammals, and student features. See Table 3 for parameter estimates. All slopes were significant (p-value < 0.05). The black line represents the regression line of the relationship between the variables. The confidence interval is represented by range and gray area for factor (fishing and farming) and continuous (age) variables, respectively.

species linked to the university students who have direct contact with nature. In fact, these species suffer stronger hunting pressure (Alves et al., 2016) and, thus, it may be a factor that contributes to the students knowledge about native mammals. However, hunting implications include reduction or extirpation of native species local populations, which could lead to an inverse effect, i.e., erosion of knowledge, especially among the younger generations.

Despite the beginner and senior students know different species, university-level did not influence the ability to identify mammals. It shows, for instance, that the formal course structure is not contributing satisfactorily to the knowledge about native mammals. Similarly, undergraduate courses related to

Environmental Sciences (e.g., Agronomy, Biological Sciences, Ecology, and Veterinary Medicine courses) from other Brazilian regions do not seem to be contributing to this type of knowledge (de Melo et al., 2021).

In fact, most books adopted in colleges and universities in Brazil are translations of foreign books in which native fauna is not represented (Hickman et al., 2016; Kardong, 2016; Pechenik, 2016). Thus, the skills needed to identify native fauna are limited to the daily student experience outside the classroom or the professor's approach to the specific subject, which hinders to deepen this ability throughout the course. For instance, Wei et al. (2019) reported the difficulty of a Chinese primary and secondary school to take new approaches

Table 3. Effect of University Students Profile on Ability of Mammals' Recognition.

Variable	Coefficient estimate	SE	df	t value	Odds ratio	Lower CI	Upper CI
(a) Proportion of correct answers of general mammals							
Intercept	1.214614	0.204580	113	5.937 ***	3.3689950	2.256099	5.030859
Age	0.014743	0.006795	112	2.170 *	1.0148521	1.001426	1.028459
Farming (no)	−0.242451	0.099892	111	−2.427 *	0.7847022	0.6451714	0.9544093
Fishing (no)	−0.338614	0.100866	110	−3.357 **	0.7127574	0.5849018	0.8685617
(b) Proportion of correct answers of native mammals							
Intercept	0.226856	0.239845	113	0.946	1.2546493	0.7840832	2.0076245
Age	0.021860	0.007984	112	2.738**	1.0221004	1.006231	1.038221
Farming (no)	−0.260904	0.118408	111	−2.203*	0.7703551	0.6108012	0.9715871
Fishing (no)	−0.319243	0.119418	110	−2.673**	0.7266987	0.5750477	0.9183436
(c) Proportion of correct answers of alien mammals							
Intercept	3.6018	0.2446	110	14.725***	36.6623377	22.70043	59.21743
Fishing (no)	−0.7451	0.3046	109	−2.446*	0.4746773	0.2612922	0.8623587

Coefficient estimates of quasi-binomial GLM for the proportion of correct answers of general, native, and alien wild mammals are presented on a logit link scale as log odds ratio. Legends: standard error (*SE*); degree of freedom (*df*); confidence interval (CI); and significance codes (*p*): 0 '***' 0.001 '**' 0.01 '*' 0.05.

in science classes due to the heavy teaching load, a fact that has changed with the integrated science curriculum.

Additionally, there is an increasing need for the study of specific content to be done in a contextualized environment, allowing the university students to recognize the relevance of treating these contents from a local perspective. Thus, research related to the preparation of elementary school science teachers supports the need for integration of pedagogical knowledge content with the content of other specific subjects more related to the Environmental Sciences (Longuini & Nardi, 2004; Silva & Schnetzler, 2008). In this sense, the ideas conveyed by the results of this research should also be treated as part of the *integrative disciplines*, which could address contents including native fauna recognition, description, surviving characteristics, and how they should be presented to their future elementary school students. This approach could also emphasize the importance of fieldwork classes to develop science-teaching abilities, allowing increasing the learning experience in the countryside and natural areas. It would contribute to the training of university students who are aware and integrated with their natural environment reality.

Therefore, an all-embracing commitment to biodiversity dissemination and study is necessary through Environmental Education strategies, in which formal education is one of the instruments for the rupture, appropriation, and construction of culture (Paro, 2010). It is of utmost importance to encourage further works on the biodiversity issue in a planned manner so that learning promotes change. This subject has been discussed for years, but many people still do not acknowledge its importance. According to Silva (2009), environmental education, coupled with the continued educators' training, is highly essential for the development of critical thinking in human beings who are committed to the improvement of quality of life for present and future generations and who are sensitive to the need for environmental resources conservation.

Implications for Conservation

The activities related to the fieldwork are one of the main educational factors that influenced the ability of university students to identify native mammals. Thus, as society disconnects from nature, knowledge regarding native biodiversity is being lost. This is crucial for tropical countries, such as Brazil, which have immense biodiversity.

More effort is needed to disseminate and study biodiversity including educational strategies for university students, especially in science and biology, to be effective educators and awaken their future elementary school students to the importance of native fauna and, consequently, nature conservation. These strategies could stimulate contact with nature, not only by elementary school students but also by all the teachers and the entire school community, contributing to the development of critical thinking in human beings who are committed to improving the quality of life of present and future generations and who are aware of the need for environmental resources conservation.

Declaration of Conflicting Interests

Funding

ORCID iDs

Juliana Ramos de Andrade 🆔 https://orcid.org/0000-0002-5445-8872
Clarissa Gomes Reis Lopes 🆔 https://orcid.org/0000-0001-7290-4576

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