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Students (ages 6, 10, and 15 years) in six countries knowledge of animals

Abstract

This article considers the knowledge students (ages 6, 10, and 15 years) have of animals from a cross-cultural perspective. Students from six countries (Brazil, England, Finland, Iceland, Portugal, and the United States of America) were asked to free-list as many animals as possible and state where they had seen or learned about the animals. The results were analyzed and they indicate that 1) Students are aware of animals. 2) Students are more aware of mammals as examples of animals. 3) There is a globally shared folk biological knowledge of animals. 4) Students learn about animals during socio-cultural interactions. The educational implications are discussed.

Introduction

The Programme for International Student Assessment (PISA) is an international project that tests the science knowledge of 15 year olds (Organisation for Economic Co-operation and Development [OECD], 2007). In 2000, the PISA began a worldwide program to evaluate educational systems by assessing each country's achievement in the domains of reading, mathematics, and scientific literacy (see www.pisa.oecd.org). The OECD affirms the PISA evaluation through their belief that educational policy hinges

> *on reliable information on how well education systems prepare students for life* (OECD, 2010, p. 3)

and that

> *in a global economy, the yardstick for success is no longer improvement by national standards alone, but how education systems perform internationally* (p.3).

The PISA was given in 2000, 2003, 2006, and 2009. In 2006, the PISA assessed the environmental knowledge of 15 year olds in 57 countries worldwide by including 24 questions related to environmental science (OECD, 2007). The OECD expended the environmental knowledge questions and established the Environmental Science Performance Index (ESPI) as a measure of the knowledge students have of environmental concepts. The goal of the ESPI was to determine students' familiarity with environmental concepts and where students thought they had learned about the concepts. The 2006 ESPI results denoted

> *19% of 15-year-olds perform at the highest level of proficiency in environmental science* (p. 2)

and at this level

> *students can consistently identify, explain and apply scientific knowledge related to a variety of environmental topics* (p. 2).

However,

> *16% of students perform below this baseline level of proficiency* (p. 2),

which

> *is an important indicator of whether a country will have an adult population that has sufficient knowledge and understanding to respond to the environmental challenges* (p. 2).

The PISA states that for students to be informed citizens, act as environmental stewards, and have increased environmental literacy they must possess an understanding of scientific theories and the natural world. Therefore, the PISA results, in high and low scoring countries, become an interesting consideration as we establish the knowledge students in various countries have of animals. This is but one step in distinguishing and maintaining good educational practices and focusing on the aspects of teaching that improve students' knowledge of animals.

In the past decades, students' knowledge of animals has become a topic of concern to educational researchers (Aguirre & Orihuela, 2010; Bell, 1981; Bell & Baker, 1982; Braund, 1991; Eloranta & Yli-Panula, 2005; Huxham, Welsh, Berry, & Templeton, 2006; Patrick & Tunnicliffe, 2011, Prokop & Rodak, 2009; Ryman, 1974; Storm, 1980; Winkler-Rhoades, Medin, Waxman, Woodring, & Ross, 2010). Beginning in the 1980s, Kellert published a series of articles related to American citizens' attitudes and knowledge of animals. His overall findings of interviews with 3,107 Americans determined that suburban populations had a higher knowledge score than urban populations. Suburban adults over age 56 knew more than other age groups, and blacks had less knowledge of animals than other ethnic groups (Kellert, 1984). Moreover, Kellert found that males knew more about animals than females, especially when asked about rare and endangered species (Kellert & Berry, 1987). These findings are of interest today, as some research from the USA shows children and adults may be separated from the natural environment (Louv, 2005) and have a low level of environmental literacy and environmental concerns (Coyle, 2005).

Research Questions
The ESPI scores are international and provide an opportunity to open an international dialogue about the knowledge students have of their local environment, which includes their knowledge of animals. The literature about the knowledge students have of animals is diverse and has taken place in several countries. However, no single research study has investigated the knowledge students have of animals across several countries. Therefore, the questions that guided this study were: (1) What animals do students in six countries name? (2) Where do the students see or learn about animals? Our aim was to distinguish the knowledge students in six countries had of animals and reveal if there was a shared knowledge.

Limitations of the study
This study has limitations that restrict its generalizability. The data collection is limited to 27 students from each country. Therefore, the study may not be generalizable as a representation of all students within a country or grade level. However, studies in the knowledge students have of animals have been completed with similar numbers of participants (Tunnicliffe, Boulter, & Reiss, 2007; Setalaphruk & Price, 2007; Strommen, 1995; Tunnicliffe & Reiss, 1999). This study was completed in six countries by six different researchers. The original protocol was written and distributed in English and translated and completed by the country's researcher, hence these interviews may not have been completed in exactly the same manner due to individual cultural and linguistic differences (Villabi & Lucas, 1991). The interviews were conducted in the students' native language and the responses were subsequently translated back to English. This action may affect the validity and reliability of the study. None the less this study is an important indicator of students' knowledge of animals from six different countries and could act as a basis for further studies.

Literature Review
The impetus for this study arose from our curiosity about the ESPI scores, interest in the literature about students' knowledge of animals and the gaps in the literature as well as our professional interest in how children acquire biological knowledge and understanding. Since Kellert's studies in the 1980s, several studies have been completed to identify the knowledge students have of animals, but no research has been conducted that identifies their knowledge of animals in six countries. Drawing upon the work of Atran (1998) we define students' knowledge of animals as their folk biology knowledge and we believe that cultural influences are an important aspect in determining the folk biological knowledge shared by students from different cultures.

We believe that the knowledge students have of animals will influence their environmental literacy by directing their abilities to reason about environmental concerns as they relate to animals and allow them to draw connections to environmental experiences (National Research Council, 2011). Moreover, we are committed to the idea that the knowledge students have of animals and the knowledge that they bring to the classroom will influence their discourse about animals. The following literature review provides the theoretical framework for this study and describes the salient themes in the knowledge students have of animals.

Constructivist Theory
This study was framed by the constructivist theory which states that learning is an active process. Students glean information from their environment and interactions with family, friends, peers, teachers, media, etc. (Vygotsky, 1986) and use such socially negotiated interactions (Cobb, 1990) and prior knowledge to construct personal meaning (Driver & Bell, 1986, Rogoff, 1990). As children learn science they construct their understandings about the natural world through their own informal interactions, which guide and influence their conceptions as learners during formal education in schools (Duit, 1991). Therefore, the specific ideas students hold about the natural world are important when designing curriculum (Driver, Guesne, & Tiberghien, 1985a; 1985b) and assessing learning.

The understandings and concepts students have of the natural world are important in determining how educators might develop interactions with the natural world. Even though the students in this study are socially and culturally situated in six countries, the constructivist framework provides a lens through which we may view a student's ability to name animals.

Folk Biology Knowledge

The world is more urbanized and industrialized than ever, but people from all parts of the world come in contact with plants and animals. When people come into contact with an organism, they allocate the organism to a taxonomic category based on how they think about and understand the characteristics of the organism and its taxonomic criteria (Atran, 1998). The knowledge people use to place organisms into taxonomic categories is called folk biology. The influences of folk biological knowledge are important to science educators because the constructivist framework asserts that students build new knowledge on previous knowledge. When educators begin to develop students' knowledge of animals, they should take into account the folk biological knowledge students bring to the classroom. Folk biological knowledge is important in education because it is a socially shared belief about animals. As education becomes more global and students interact in a global world there may be a core folk biology belief that is shared across cultures (Atran, 1990). Determining the folk biological knowledge students have of animals could provide researchers with a commonly held underlying construct of animal (Wellman & Gelman, 1998).

Students' Knowledge of Animals and Cultural Differences

A basic familiarity with taxonomy and the names of rare and common organisms is a fundamental part of biology and environmental knowledge (Randler, 2008). Fundamental knowledge is cultivated as students construct contextual knowledge during their encounters with animals in natural and unnatural surroundings. Therefore, the contextual knowledge will influence the taxonomic knowledge of students (Braund, 1991). By asking students to name animals and where they have seen or learned about the animals, we will begin to define the contextual knowledge of students. If we can identify and outline a model of the contextual knowledge students have of animals, we may begin to mould the ability of students to taxonomically categorize animals. The following section summarizes the research completed in various countries.

Thirty students in Thailand, ages 8-14 years, were asked to free-list wild food animals. Students named a total of 86 local wild food animals including 22 types of fish, 20 types of insects, 19 types of birds, 8 types of amphibians, 7 types of shellfish, 7 types of reptiles, and 3 mammals (Setalaphruk & Price, 2007). Tunnicliffe, Gatt, Agius, and Pizzuto (2008) completed a study of 50 Maltese children ages 4-5 years in which the children were interviewed and shown photographs as probes to access their understanding of animals. When children were asked to name animals the answers consisted of exotic animals such as the tiger (34%), lion (30%), and crocodile (18%). The word bird was also used, but specific birds (species) were not named. In regard to birds, a study conducted by Prokop and Rodak (2009) found that students may be not be aware of local birds. They asked 154 Slovakian students (110 elementary, 44 university) to identify local birds while looking at pictures and listening to the birds' calls. Students were able to identify 39% of the local birds when they were shown a picture, but identified 45% of the local birds when they heard the song and saw a picture of the bird. Winkler-Rhoades et al. (2010) asked Native and European Americans in the USA, ages four years old to adult, to free-list all the animals they knew. Across the age groups participants named mammals most often and students also named birds, fishes and reptiles. Patrick and Tunnicliffe (2011) completed a study of 72 English and 36 USA students in which they asked participants, ages 4-10 years old, to free-list animals. Participants in both countries named mammals most often followed by birds, reptiles, fish, insects, amphibians, and arachnids. English students named molluscs and annelids, but American students did not.

In addition to free-listing and interviews, studies have asked students to illustrate their ideas of animals. In the USA, 40 six year olds were asked to draw a forest. The illustrations were exploited as interview prompts and participants were asked to name animals that lived in their drawing of the forest. The participants identified from 6 to 33 different organisms with an average mean of 14.60 per child. The students mentioned mammals most often and specified reptiles and amphibians least often (Strommen, 1995). Schwarz, Sevegnani, and André (2007) asked 395 Brazilian students, ages 6-14 years old, to draw the Atlantic Rainforest and write about the drawings. Students drew birds most often (52.2%), but 88.1% of the birds were drawn as scribbles in the sky. After birds, mammals were portrayed the second most often followed by reptiles, insects, and fish. Humans were present in 7.6% of the drawings. In England, 167 participants, ages 3-11 years old, were asked to draw their ideal rainforest (Snaddon, Turner, & Foster, 2008). Participants depicted mammals, birds, and reptiles most often, but under-represented insects and annelids.

The studies discussed above employed various data collection techniques and asked about animals in a variety of ways, but the results of the studies do provide an overall indication that students from different cultures are familiar with animals. The results imply that participants in most of the countries were more aware of mammals, except in Thailand and Brazil. Participants from England, Malta, and the USA appeared to have the most similar knowledge of animals. Students in Thailand were familiar with fish, insects, and birds, while students in Brazil named birds most often and fish least often. However, a comparison of the results across countries was not possible, because the studies were diverse and employed various methodological techniques.

Where Students Learn About Animals

Where students come into contact with organisms is important in identifying the ability of students to taxonomically categorize organisms. To resolve the question of where students come into contact with or learn about organisms, Tunnicliffe and Reiss (1999) interviewed 36 students (5-16 year olds) at each of two schools in the south of England. During the interviews, English students stated they learned about animals from home, direct observations, media, and books consecutively. A similar study was completed with fifty students (ages 4-5) who were interviewed, shown photos of animals, and asked where they had seen or learned about the animals (Tunnicliffe et al., 2008). In that study, family was mentioned more often than any other source of knowledge, but students also named media, books, and toys as places to see animals. Tunnicliffe et al. (2007) interviewed 24 English students (6-14 years old) about pigeons and asked them to draw pictures of pigeons. Students included observations and experiences they had with family and on the school grounds. In 2011, Patrick and Tunnicliffe asked 72 English and 36 USA students, ages 4-10 years, to free-list animals and state where they had seen or learned about the animals. The participants named home most often, but also named the media and natural areas as places to see or learn about animals. The zoo and school were named the least. These studies indicate that students have contact with or learn about animals at home, with family, on field trips, in the media, and while playing in nature.

Methodology

Participants

Table 1 identifies the six countries that participated in the study, the ages and socioeconomic status of the 162 students, and the type of community in which students lived. There were 27 participants from each of the following countries: Brazil, England, Finland, Iceland, Portugal and the USA. The six countries were chosen based on their mean ESPI scores (Table 2). Brazil, Iceland, Portugal, and the USA were chosen because their EPSI scores were lower than the average score of 500. England and Finland were chosen because their EPSI scores were higher than the average score. Each group of 27 participants consisted of six, ten, and fifteen year olds with nine students representing each age. The six and ten year olds were identified as important groups because they reflected the compulsory school age in all countries and 15 year olds were included because they represented the age group that

Table 1. Students' ages, socioeconomic status, and community in which they live.

Country	Age	Socioeconomic Status	Community
Brazil	6	high	urban
	10	low	urban
	15	low	urban
England	6	low	suburban
	10	low	suburban
	15	middle	suburban
Finland	6	middle	urban
	10	middle	urban
	15	middle	suburban
Iceland	6	middle	suburban
	10	middle	suburban
	15	middle	suburban
Portugal	6	high	rural
	10	high	rural
	15	high	urban
USA	6	low	urban
	10	low	urban
	15	high	urban

had been given the EPSI. Within each age group, teachers were asked to identify three students who were low, middle and high achievers and a mix of male and female. Researchers gathered the data at schools where they had previously established relationships. Therefore, the schools were not chosen based on specific localities or socioeconomic status, but were chosen based on their ability and willingness to participate in the study. The schools were in various locations (rural, suburban, and urban) and had differing socioeconomic status (low, medium, and high).

Interview

Prior to this study, a structured interview that included three questions and a free-listing task (Crowe & Prescott, 2003; Storm, 1980; Winkler-Rhoades et al., 2010) was tested in a pilot study. The pilot study included questions regarding where students learned about animals because the knowledge of students is influenced by the environment and social interactions (Cobb, 1990; Vygotsky, 1986). During the pilot study, we found that students were able to name animals and in general students were aware of where they had learned about or seen the animal. However, these answers did not define specific animal knowledge of students so we added a third section to the interview. Providing students with word prompts and allowing them to respond with answers offered a better overview of their animal knowledge. The word prompts included the animals students named most often in the pilot study, which were mammals, domestic animals, and birds. Conversely, students did not normally name invertebrates, nocturnal animals, or aquatic animals. Because we wanted to determine if students were aware of specific examples of these animals, we added them as prompts in question number three.

The resulting interview included a free-listing task, a question, and word prompts. All interviewers had an interview sheet with exactly what they should say during the interview. First students were asked to "Name as many animals as you can think of." Below this statement was a note to allow the participant one minute to answer. One minute was chosen as a time frame based on the work of Winkler-Rhoades et al. (2010) and the pilot study completed prior to this study. As the participant listed the animals the interviewer wrote down each animal name on the interview sheet. At the end of one minute the interviewer stopped the participant if they were still listing animals. For the second part of the interview, the interviewer started at the beginning of the list of animals provided by the participant and asked "Where did you learn about or see the (insert animal name here)?" This continued until the interviewer and the participant had addressed all the animals in the list. If a participant said "I don't know.", an answer was not recorded for where they had learned about or seen the animal. For the third part of the interview, the interviewer was provided a list of the prompts listed above and informed participants that "Now I will say a word or words and I would like for you to name an animal that is an example." "Name a (bird, small mammal, domestic animal, flying invertebrate, walking invertebrate, ground-dwelling invertebrate, nocturnal animal". "Name an animal that (lives in water, lives on water)." After each prompt the interviewer asked, "Where did you see or learn about (insert name of animal)?" Iceland did not provide participants with the prompts and Finland did not ask participants to name where they had seen or learned about the animals named during question number three.

The interview was written in English and each interviewer was responsible for translating the interview into their native language. Prior to the interviews parental and school consent were obtained. During the interview each participant was taken to the school library and interviewed separately. The interviews were recorded to ensure that the data could be re-evaluated if needed. The researchers told the participants that they were interested in determining students' ideas concerning animals, this was not a test, and they were free to say they did not know the answer. If participants had difficulty with biology terms such as invertebrate, the interviewer explained the term as necessary during the interviews, e.g. invertebrate was described as an animal without a backbone.

Analysis of Data

The animal categories were determined *a priori* based on an updated version of Storm's (1980) clusters (farm animals, city animals, and exotic animals) and categories determined by Patrick and Tunnicliffe (2011) (exotic, endemic, domesticated for pleasure, and farmed). Additionally, the animals that were free-listed were divided into the scientific classes: Mammals, Birds, Reptiles, Amphibians, Fish, Arthropods (Arachnids), Arthropods (Insects), Molluscs, and Annelids. The responses of students as to where the animals were seen or learned about were identified *a posteriori* based on their answers. After the data from all countries was tabulated, the categories were deemed to be Places of Informal Education, Media, Shop/Store, School, Outside/Street, Home/Garden/Yard, and Natural Area.

The researchers from each country were asked to count the data and record it in an Excel file. The Excel file from each country was merged into one file and the totals were tabulated using Excel. In the free-listing and location/source the answers were counted separately. For example, if a participant named the following animals and stated where they had learned about or seen them as: cat–home, fish-pond, dog-home, blue jay-home, seagull-beach, and elephant-zoo, they received the following counts: 3-Home, 1-Place of Informal Education, 2-Natural Area. Place of Informal Education refers to zoos, aquariums, farms, etc. Natural areas are parks, beaches, mountains, fields, ponds, etc. The answers to the word prompts were coded once for the animal named and location. Therefore, none of the answers for the word prompts would have a count of more than 27, because 27 students were interviewed. If a student answered, 'I don't know' the answer was not coded. Because of a lack of extensive data a quantitative analysis was not possible.

Results

Animals Named

The total number of different animals named by participants from each country is shown in Table 2. Students in Portugal named 550 animals, which was more than any other country and Brazil named 113 which was the least. Finland, Iceland, England, and the USA named 366, 343, 340, and 301 animals respectively.

Figure 1 shows the categories (exotic, endemic, pet/domestic, farmed) in which the animals named during the free-listing were grouped. We found that English students named the most exotics (164 animals) and Portuguese students did not name any exotics. However, Portuguese students named 370 endemic animals, which is far more than Finnish (157 animals), American (134 animals), Icelandic (125 animals), and Brazilian (69 animals) students. In all countries students named pets. The Portuguese students named 116 examples of pets, while students in, Iceland (73 animals), the USA (69 animals), Finland (65 animals), England (56 animals), and Brazil (11 animals) were less likely to name pets. Farm animals were named less often than any other group.

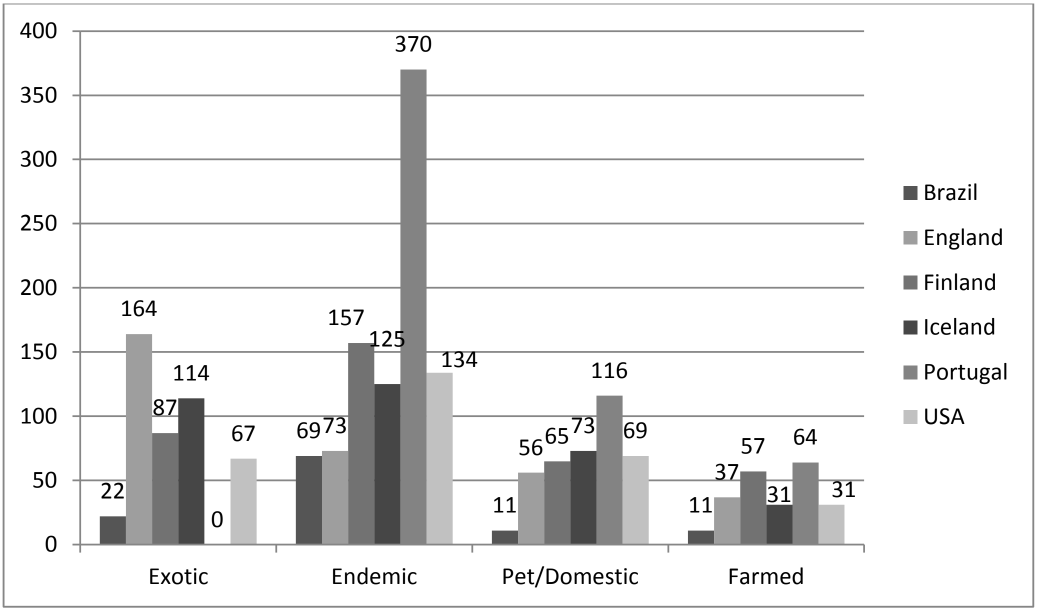

Figure 1. The number of animals named for each category during the free-listing.

The students' free-listing of animals, shown in Table 2, was grouped by scientific class. Mammals were named most often by all countries (Finland 319 mammals, England 244 mammals, Iceland 233 mammals, Portugal 199 mammals, USA 199 mammals, Brazil 63 mammals) and the second most named class for all countries was birds. Portuguese students named 169 birds, noticeably more than students in Iceland (58 birds), the USA (35 birds), England (28 birds), Brazil (26 birds), and Finland (23 birds). Amphibians were named less than any other vertebrate by all countries and reptiles were named more often by students in the USA than any other country. Portuguese students did not name an amphibian, but they named 39 fish which is more than any of the other countries. Vertebrates were named more often than invertebrates, but students did name arachnids, insects, mollusks, and annelids. In the invertebrate classes, Portuguese students named insects (84 insects) and annelids (45 annelids) most often and more than the other countries. However, students in Finland did not name an arachnid. Students in the USA did not name any mollusks or annelids and students in Brazil and Finland did not name a mollusk.

Table 2. The mean ESPI score (OECD, 2007) for each country, total number of animals named during the free-listing, and number of animals named for each scientific class during the free-listing.

	Brazil	England	Finland	Iceland	Portugal	USA
EPSI Score	430	504	543	490	475	491
Total Animals Named	113	340	366	343	550	301
Mammals	63	244	319	233	199	199
Birds	26	28	23	58	169	35
Reptiles	8	20	11	5	2	26
Amphibians	1	4	2	4	0	7
Fish	6	12	6	23	39	16
Arthropods(Arachnids)	1	5	0	4	4	9
Arthropods(Insects)	1	23	2	11	84	9
Mollusks	0	3	0	2	8	0
Annelids	7	1	3	3	45	0

When students were prompted to name specific animals (Figure 2), students in Brazil (27 students), England (27 students), and Finland (27 students) most successfully named a domestic animal and all 27 students in England named a bird. Moreover, Portuguese (25 students), American (24 students), and Finnish (24 students) students were successful at naming birds. Brazilian students (11 students) were less likely to name a bird. Even though all countries free-listed mammals more than any other class, students in the USA (15 students) and Brazil (6 students) had difficulty when prompted to name a mammal. English students named flying, walking, and ground-dwelling invertebrates more often than the students in the other countries. Students in Brazil did not name a nocturnal animal and students in the USA did not name a walking invertebrate or an animal that lives on the water. Portuguese students named invertebrates that live in the ground (21 students), but were less likely to name flying (14 students) and walking invertebrates (9 students).

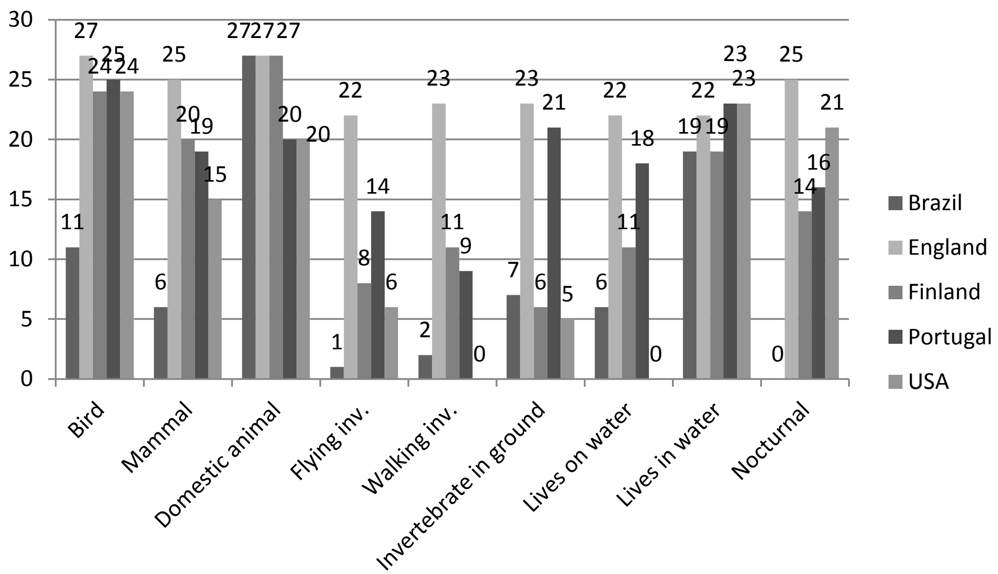

Figure 2. *The number of students (n=27) who successfully named an animal when word prompts were used.*Iceland did not participate in this part of the interview.*

Locations for Seeing or Learning About Animals

The graph in Figure 3 illustrates where students stated they had seen or learned about the animals they mentioned during the free-listing. Brazilian students (90 comments) and Finnish (64 comments) students stated they learned about or saw the animals most often at Places of Informal Education and English (122 comments) and Icelandic (116 comments) students identified the Media as most important. American (84 comments) and Portuguese (83 comments) students named Home most often as a source of information or place to see animals. American, Finnish, English, and Portuguese students believed they learned about or saw animals the least often at School.

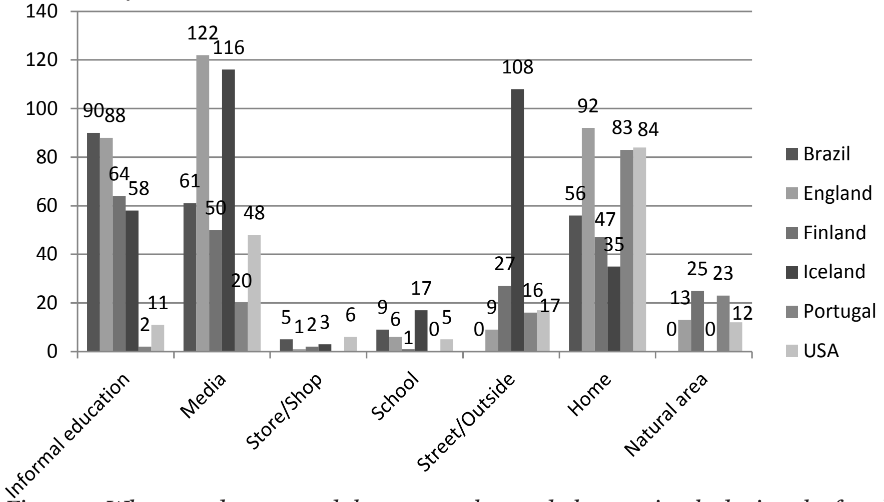

Figure 3. Where students stated they saw or learned about animals during the free-listing.

The graph in Figure 4 represents the answers students gave when provided with a prompt and asked to state where they had seen or learned about the animal. The 27 Brazilian students named the media and in the Street/Outside as a place to see or learn about animals. Moreover, English (27 students), Portuguese (27 students), and American (23 students) students named Home and the 27 Portuguese students named the Street/Outside. Brazilian students did not mention Home, Places of Informal Education, or School as a place to see or learn about animals. Students in England were the only group to mention Shop/Store (2 students).

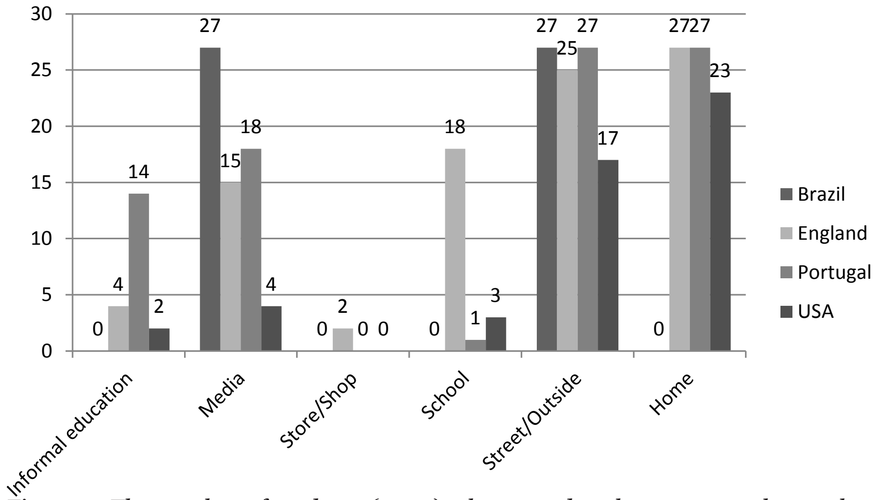

*Figure 4. The number of students (n=27) who named a place to see or learn about animals when provided with a prompt. *Iceland and Finland did not participate in this part of the interview.*

Discussion

Animals Named

Even though the participant numbers in this study were small, the findings support the idea that there is a common folk biological knowledge held across cultures (Winkler-Rhoades et al., 2010). The participants from all countries were aware of animals, but they used simple terms and rarely named specific animals within a species. For example, instead of saying *striped bass* participants used the generic term *fish*. The use of simple terms allowed for similarities in naming to occur across the countries. The terms rabbit, mouse, dog, cat, duck, fish, owl and bat were given as examples in all countries. The frequent use of the words cat and dog during the free-listing may be due to an increase in pet ownership across the world (PRWeb, 2010). Moreover, mammals were by far the most frequently mentioned class of animal in all countries. This may indicate that students in all countries equate animals with mammals, instead of thinking broadly when hearing the term *animal* (Bell & Baker, 1982). The cross-cultural identification of animals as mammals may be in part due to the fact that mammals are normally larger and more conspicuous than other animals, are discussed more often in the media, and become the basis for children's toys and books. Birds were the second most commonly cited animal in all countries and students used the names canary, pigeon, and hawk most often. Birds may be mentioned often, because birds are plentiful, seen on a daily basis, noticeable, and live in the vicinity of the students' homes. Participants in five of the six countries seldom named invertebrates, which may be due to the size of invertebrates (Lindemann-Matthies, 2005) or because students were not sure if invertebrates were animals. A student in England, when mentioning a fly, questioned "I don't know...is this right? Is this an animal?" Additionally, a 15 year old in the USA, when asked to name an invertebrate that lives in the ground stated, "Worms live in the ground, but I don't think they're animals."

Even though there are cultural differences between countries that influence the knowledge students have of animals, they do have similar knowledge. The findings imply that the students were aware of some of the more common animals that live in their country and that everyday real-life encounters were important in determining their concepts about animals (Braund & Reiss, 2006; Patrick & Tunnicliffe, 2011). From a folk biology perspective, these commonalities suggest that the students shared a common perception of the word animal.

Locations for Seeing or Learning About Animals

In England and Iceland the media, such as television, books and the internet, were the greatest source of knowledge or place to see animals and was the second most named source in Brazil, Finland, and the USA. Television programs such as *Wild at Heart*, a drama series about a vet based in Africa, were commonly cited by English students as sources of knowledge. Additionally, David Attenborough's' television programs about wild-life were very popular in Iceland. In the USA, students named the cable channel *Animal Planet* as a place to learn about or see animals. These findings indicate that students may obtain information *second hand* instead of through *first hand* encounters with real animals. According to Barker (2002), the use of media, such as books, videos, or the internet, in lieu of opportunities to see or interact with animals is prolific in primary schools. As teaching trends move away from traditional biological education that focuses on whole organisms to focusing on physiology, genetics and molecular biology (Greene, 2005), student/animal interactions and animal related information have declined. Consequently, students of all ages are less likely to have real-life, hands-on experiences with animals at school (Lock, 1997). The participants in this study did not often recall seeing or learning about animals at school. The exception was when students in England were asked where they learned about the animals when given the prompts.

Even though there were cultural differences between the countries, the participants *first hand* experiences such as informal everyday encounters with friends or family, in the garden, at home, and walking to school were similar. This finding supports the belief that learning is an active process and students gain knowledge from their environment and interactions with family, friends, peers, teachers, media, etc. (Vygotsky, 1986). If students across cultures are constructing understandings about the natural world through similar informal interactions within their culture and these interactions influence their formal education (Duit, 1991), then it is important to identify the informal interactions and the cultural influences that shape the learning.

Educational implications

Our findings are important in terms of teaching students about animals and developing curriculum. The personal experiences and *first hand* encounters of students are vital as they construct their knowledge of animals. However, naming only vertebrates when prompted suggests a fairly limited understanding of the word "animal" (Bell, 1981). Therefore, from an early age children should be introduced to a wide range of animal species, especially those with which they are less familiar. Teachers may provide *first hand* experiences by taking students to zoos and natural areas, having animals in the classroom, and spending time on the school grounds. Utilizing examples of local animals and spending time outdoors when teaching about animals, instead of relying on textbooks and second-hand sources, will support incidental learning (Malone and Tranter, 2003). If students know more about animals, they are more likely to notice animals in their local environment. In turn, student awareness will stimulate an appreciation of the wide variety of fauna in their local community (Lindemann-Matthies, 2006). Therefore, formal learning experiences that draw from examples in the local environment could also provide students with an enhanced knowledge of biodiversity. This may aid in altering students' attitudes towards the conservation of species that are not necessarily regarded as high profile or lovable (Greene, 2005; Lindemann-Matthies, 2005; Lindemann-Matthies and Bose, 2008).

As national curricula and pedagogical approaches are developed the results of this study should be considered. The results could be used to support a need for curriculum that more explicitly designates what students should learn about animals and teacher training that takes into consideration using the school grounds as a way to introduce students to the local fauna (Erävuoma & Minkkinen, 2002). Even though science has universal laws and theories, the exemplification of the laws may be better dealt with using contextual and culturally specific examples. Contextual and cultural examples are especially pertinent when teaching biology because habitats and species vary greatly even within the same country.

The results are of interest to test developers who construct probes for international surveys such as the PISA or EPSI. The folk biological knowledge of the students in the six countries appears to be influenced by similar cultural experiences such as visits to natural areas and places of informal education, time with parents and friends, and interactions within the local environment. During the EPSI test-takers were asked to choose from school, media, friends, family, or internet as sources of information about given environmental issues. Students were allowed to choose as many sources as desired. School was the answer chosen most often followed by the media, internet, family, and friends. If students stated that they relied solely on school as a source of information, their ESPI score was lower than other students. Students who 1) reported mainly learning from family and friends or using solely the media as the main sources of knowledge or 2) checked several sources of knowledge scored higher on the ESPI. Even though the students in this study named home as the most important source of information and place to see animals, we found similar results to the EPSI. Students who named more than one source of information also named more animals than students who named only one source.

We conclude that: 1) Students are aware of animals. 2) Students are more aware of mammals as examples of animals. 3) There is a globally shared folk biological knowledge of animals. 4) Even though cultural differences exist, students learn about animals during sociocultural interactions. To ensure that students are aware of animals and the natural environment educators must consider the sociocultural implications of learning.

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