Towards an educational program for promoting children's awareness of urban bird diversity

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ABSTRACT

This paper reports on the educational program "Something's flying around us" that took place in the Zoological Museum of the University of Patras, based on constructivism, under the citizen science project "Ornithopolis". The aim of the program was to support primary school pupils in identification of bird species and to enhance their awareness about urban bird diversity using exhibits and dioramas of the museum. Overall, 112 pupils were involved in the program. Pre- and post-program children's knowledge and ideas about eleven selected bird species that are common in the Mediterranean urban areas were tested. After the implementation of the educational program bird identification skills of the pupils increased significantly. Besides, most participants seemed to be enthusiastic about birds and acknowledged their value for the ecosystem, while they also stated that they enjoyed the program. Our study indicates that educational programs in zoological museums can efficiently increase biological and ecological knowledge of pupils and have a positive impact on the attitude towards biodiversity.

KEYWORDS

Biological education, educational role of museums, zoological museum, environmental awareness, urban birds

RÉSUMÉ

Cet article rend compte du programme éducatif "Quelque chose vole autour de nous" qui s'est déroulé au Musée de Zoologie de l'Université de Patras, sur la base du constructivisme, dans le cadre du projet de science citoyenne "Ornithopolis". Le programme visait à aider les élèves du primaire à identifier des espèces d'oiseaux et à les sensibiliser à la diversité urbaine des oiseaux à l'aide d'expositions et de dioramas du musée. Au total, 112 élèves ont participé au programme. Les connaissances et les idées des enfants avant et après le programme concernant onze espèces d'oiseaux sélectionnées communes dans les zones urbaines de la Méditerranée ont été testées. Après la mise en œuvre du programme éducatif, les compétences *des élèves en matière d'identification des oiseaux ont considérablement augmenté. En outre, la plupart des participants semblaient être enthousiastes à propos des oiseaux et reconnaissaient leur valeur pour l'écosystème, tout en affirmant qu'ils appréciaient le programme. Notre étude indique que les programmes éducatifs dans les musées de zoologie peuvent efficacement augmenter les connaissances biologiques et écologiques des élèves et avoir un impact positif sur l'attitude envers la biodiversité.*

MOTS-CLÉS
Education biologique, rôle éducatif des musées, musée zoologique, sensibilisation environnementale, oiseaux urbains

THEORETICAL FRAMEWORK

"*The beginning of wisdom is the study of names*"
Antisthenes the Athenian (445-360 BC)

The lack and shrinkage of green spaces is especially prominent in cities of southern European countries such as Greece, where one of the most pressing current environmental problems is the uncontrollable and inadequate urban development (Leontidou, Afouxenidis, Kourliouros, & Marmaras, 2007; Papadatou-Giannopoulou, 1991). Consequently, a lack of green spaces in urban environments and increased disconnection from nature can lead to an impoverished quality of life and increased stress levels (Corraliza, Collado, & Bethelmy, 2012), a phenomenon which has been described by the term "Nature Deficit Disorder" (Louv, 2005).

Moreover, research in didactics of biology has shown that children have misconceptions about various biological concepts (Bell, 1981; Trowbridge & Mintzes, 1988). Children usually have problems when classifying and identifying animals (Bell, 1981; Randler, 2009). For example, they often incorrectly classify vertebrates as invertebrates (Braund, 1998), or birds as non-birds (Prokop, Kubiatko, & Fančovičová, 2007; Trowbridge & Mintzes, 1988). In addition, elementary school pupils have serious problems with bird identification (Kubiatko, Usak, & Pecusova, 2011), and even science students show various misconceptions regarding the classification and behavior of birds (Cardak, 2009). This is crucial, as knowing the names of species leads to recognition of diversity, which in turn increases affinity for nature and enhances environmental awareness (Barker & Slingsby, 1998; Schlegel & Rupf, 2010). Misconceptions seem to be rather resistant, even after typical school teaching (Kattmann, 2001; Zghida, Lamrani, & Janati-Idrissi, 2019). Thus, it is needed to find new ways to help children understand biological categories (Allen, 2015; Trowbridge & Mintzes, 1988) through the design of alternative learning (Valanidou, Ergazaki & Gasparatou, 2019; White, Eberstein, & Scott, 2018). At the same time, however, another study reveals not so much the misconceptions of children when identifying animals, but the manner in which they prefer to do so. For example, Tunnicliffe & Reiss (1999), who explored how school children aged from 5 to 14 years recognize, identify, and group animals, indicate that the great majority of pupils gave anatomical (morphological) reasons rather than behavioural ones or reasons based on habitat for identifying and naming the specimens. The combination of these types of research is likely to lead to formal and non formal educational interventions to promote children's awareness of urban bird identification, naming and diversity.

Science museums, including zoological museums, are suitable environments for learning (Sturm & Bogner, 2010), and natural history museums seem to be particularly effective for biology education and teaching morphology of species (Kimble, 2014). In the last few decades, a trend can be observed in science museums to redesign their material, in order to make it more effective in communication, as well as to create privileged relationships with formal education (schools and universities) as a part of their new educational policy (Diamond, 2000; Filippoupoliti, 2012; Friedman, 2010). Particularly in Greece, the need for communicative and educational renewal of zoological museums is even greater, since the existing museums are still mainly object-based exhibitions and their educational role remains largely trapped in the traditional type of visits (Lord & Lord, 2002).

A visit to a zoological museum, together with educational activities carried out in situ, seems to make a significant contribution to the transformation and progress of cognitive representations of children for the concept of classifying animals (Gkouskou & Koliopoulos, 2011; Koliopoulos, Gkouskou, & Arapaki, 2012). It has been pointed out that the appropriate design of a multisensory educational environment contributes to building children's critical thinking and provides them with tools for analyzing and interpreting the world to understand the past and the present (Black, 2005), so that they can contribute to scientific culture formation as well (Koliopoulos, 2017). Building on the principles of the constructivist approach of teaching, we first identify pupils' ideas about specific concepts, then introduce new knowledge by asking pupils questions to develop dialogue and find cognitive conflicts in order to revise their original ideas. Teachers need to carry out outdoor activities in the school campus, by taking children outside to look at and locate plants and animals (Patrick & Tunnicliffe, 2011), but also zoological museums and especially dioramas provide pupils the opportunity for oriented observation and focusing on the morphology of species (Tunnicliffe Lucas, & Osborne, 1997; Tunnicliffe, Gazey, & Gkouskou, 2019).

This study addresses the question whether it is feasible to design an educational teaching intervention using the exhibits of a zoological museum that could effectively support primary school pupils in (a) obtaining identification skills for bird species occurring in their local environment, and (b) enhancing their awareness towards the natural environment and biodiversity around them. Specifically, we investigate: a) pupils' pre-program knowledge of bird species in the urban environment, b) pupils' attitude towards birds, c) whether specific sociodemographic factors or pupils' pre-program perception of birds have an effect on pupils' pre-program knowledge of bird morphology, and d) pupils' perception of the educational program.

METHODOLOGICAL FRAMEWORK

Overview of the study

The current study reports on the design and implementation of an educational program about promoting children's awareness of urban bird diversity entitled "Something's flying around us". The educational program was addressed to primary school pupils and took place in the Zoological Museum of the University of Patras (http://zmup.upatras.gr). The over 60 display cabinets of the exhibition showcase a large number of mounted (or otherwise preserved) animals, mainly representing the Greek fauna. These give the visitors the opportunity to familiarize themselves with wild animals of their area and obtain information about them. The museum attempts to showcase the animals within their natural environments, using carefully created likenesses of those environments and dioramas within the display cabinets.

The educational program was carried out by the authors in six 1-1.5 hour sessions that took place in four consecutive school days. To evaluate participants' initial knowledge and perceptions about birds, and consequent learning and development, respectively, a quasi-experimental pretest-posttest design using questionnaires was used. Pupils were asked to fill in the questionnaires individually. The questionnaire was first piloted with pupils with a similar profile and the feedback was used for elaborating the initial phrasing or format of the items.

Participants

The participants were 112 third and fourth graders (age 8-10), attending two schools in the Greek city of Patras. They were selected conveniently (Creswell, 2012), since their teachers volunteered to facilitate our study. Before starting the procedure, the authors informed them about the study, and asked for their own assent to participate (Cohen, Manion, & Morrison, 2007). The children were already familiar with group work.

The "Ornithopolis" project

The educational program entitled "Something's flying around us" is part of the citizen science project "Ornithopolis" conducted in the city of Patras. "Ornithopolis" has two major aims: a) to enhance the knowledge of citizens about local biodiversity, exemplified by urban birds, in order to contribute to increased environmental awareness; b) to encourage citizens to participate in collecting scientific data on the distribution of birds, which, in turn, may lead to a better understanding of local urban biodiversity patterns.

Choice of organisms and the educational program

Birds were chosen as a proxy for biodiversity, as they are charismatic (Ducarme, Luque, & Courchamp, 2013) and popular organisms, very common in cities and quite easy to observe and identify. Furthermore, the urban and suburban bird community of Patras had been studied before (Tzortzakaki et al., 2018); hence, the authors already had a good knowledge about species distributions within the study area. The aim was for pupils to get acquainted with eleven selected bird species common in the city of Patras, through a sequence of activities and visual (and for some species also audio) material. The birds chosen were: Feral Pigeon (*Columba livia*), Collared Dove (*Streptopelia decaocto*), Barn Swallow (*Hirundo rustica*), Starling (*Sturnus vulgaris*), Robin (*Erithacus rubecula*), Goldfinch (*Carduelis carduelis*), Magpie (*Pica pica*), Hooded Crow (*Corvus cornix*), Blackbird (*Turdus merula*), House Sparrow (*Passer domesticus*) and Great Tit (*Parus major*). These species were selected based on a) their abundance – and thus the possibility of encountering them – in the study area, b) ease of recognition (species that are difficult to distinguish or species with a cryptic behavior were excluded), and c) information on children's pre-project bird knowledge obtained from the pilot project.

The design of the educational activities was based on the constructivist approach of teaching (Driver et al., 1994; Leach & Scott, 2003) already mentioned in the "Theoretical Framework" section. In our case, this approach is based on assumptions according to which younger children can build precursor science representations compatible to science models conceptual representations and having a limited range of application (Ravanis, 2000). It has been noted that the construction of these representations can be possible within the interventions of teaching, where the teaching objectives have been based on the cognitive obstacles or the general cognitive abilities of children of this age. The teaching activities based on this approach are designed so as to use the cognitive capabilities constructively or/and removing the cognitive obstacles that children have(for the representations and cognitive obstacles children have about identification and naming of animals see the section "Theoretical framework"). The proposed teaching intervention, therefore, emphasized mainly on activities that aim (a) at the ability of the children to distinguish birds from other animal classes and (b) at using children's interest to the morphological characteristics of the samples through a systematic observation of zoological exhibits and related visual material (Guichard, 1998).

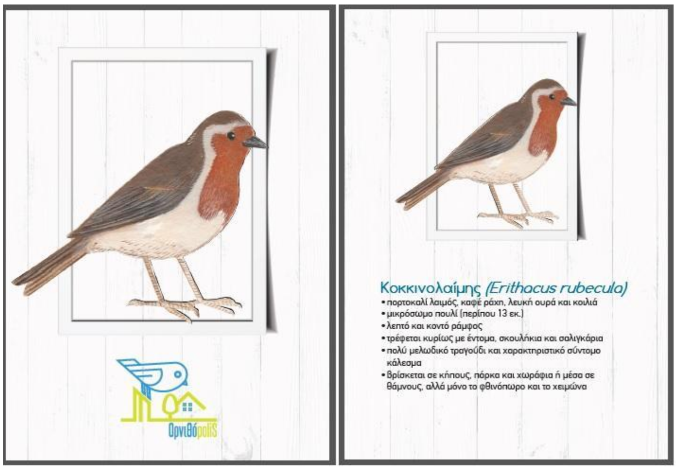
The program was divided into five steps (Table 1). After the introductory parts (Table 1: activities 1-3), children were divided into four smaller groups. They had to collaborate and locate some of the presented species in the museum's dioramas. Afterwards, they were divided into two groups, each of which was given a set of cards. Each dual-sided card had only the figure of a bird on the one side, while both figure and basic data concerning the features of the bird (shape, colour, size, nesting, etc.) were on the other side (Figure 1). Each team chose one of the cards, held it hidden and received ten questions from the rival team, which was trying to guess the species by inquiring the features of the bird displayed on the card. The process was repeated by the opposing team.

TABLE 1

Overview of the educational program: the objectives, role of the educator and pupils' activities

Activity	Educational Objectives	What the educator does	What the pupils do
1st	• Familiarization with the type of the museum and its content • Distinction of birds as a taxonomic group (class) of animals	• Inquiring questions, e.g. "What does a Zoological museum include?" or "What animal classes do you know?"	• Understanding of the type of the museum and its exhibits • Differentiation of birds as a separate animal class
2nd	• Getting in touch with the general characteristics of birds	• Auxiliary questions • Viewing visual material (slide show)	• Observing the features by viewing visual material
3rd	• Identification of the already known species • Acquaintance with the names and morphological characteristics of the eleven selected species	• Auxiliary questions • Viewing visual and audio material	• Observing bird characteristics and matching with the correct names
4th	• Getting in touch with the exhibits at the museum showcases and dioramas • Detection of the corresponding museum specimens	• Formation of four smaller groups	• Discussion • Identification of the appropriate displays and verification of the correct observations
5th	• Stabilization of names and morphological characteristics of the eleven species	• Auxiliary questions • Formation of two groups	• Game with cards with sketches of the eleven birds

FIGURE 1



An example of a card used in the group game

Description of questionnaires

Pre- and post-program questionnaires were used to assess (a) sociodemographic factors, (b) pupils' initial knowledge and perceptions about birds, (c) learning progress throughout the educational program and (d) their perception about the program. Questionnaires were partly based on an already tested tool (White et al., 2018) and were adapted to the current research question, the cultural background and informed by the qualitative pilot study.

Questionnaires were handed out in the museum directly before the start of the educational program. A small introduction was given by the museum educator on how to answer questions (e.g. avoiding multiple answers on Likert-Scale questions) and children were asked to fill in the questions independently before and after the educational program. Children were allowed to ask for help in understanding questions. Pre- and post-program questionnaires were anonymous but matched through a unique ID number assigned to each child. Post-program questionnaires were filled in directly after the completion of the program, before children departed from the museum. For each questionnaire (pre and post), children were given maximally 15 minutes.

The pre-program questionnaire was split into three sections: (a) sociodemographic variables (age, gender and whether they live in a house with a garden), (b) perception towards birds, i.e. frequency of observing birds outside, liking or fearing birds, being disgusted by birds and the perceived importance of birds in the environment (all measured on a five-point Likert scale ranging from 1 = not at all to 5 = very much), (c) assessment of initial knowledge about birds, featuring colour illustrations of the male adult of the eleven selected bird species, by asking the pupils to write the common name next to each bird picture.

The post-program questionnaire featured three sections: (a) children were again asked to identify the same bird species as in the pre-program questionnaire, based on the same illustrations; (b) two questions on the educational program: perceived benefits/impacts of the program (multiple answers possible) and perception of the program (five-point Likert scale question), and c) two free-text questions on what they liked and disliked most about the program.

Data processing and analysis

Data were transcribed manually from the paper-based sheets into a spreadsheet and data quality checks were performed. The school was derived from the unique ID, anonymized and added as an additional factor to the dataset. Answers on gender and home environment (i.e. existence of garden) were also treated as factors. Likert-scale questions were coded as 1–5.

Bird identification was scored from 0 to 2 (0 = missing answer, 1 = correct, 2 = incorrect). Partially correct answers, which identify only the broader group of the species (genus or family), were linguistically only possible for two cases in Greek (Barn Swallow vs. House Martin; House Sparrow). In these cases, broader terms were also counted as correct. Spelling was ignored if the name could be understood. Where two or more common names exist for a bird (e.g. due to regional prevalence of a term), both names were counted as correct, provided they were unambiguous.

Descriptive statistics were used for the exploration of each sociodemographic variable (gender, age, home environment and school).

To assess pupils' knowledge before the program and to assess their learning progress, the total number of correct pre- and post-program answers was calculated per child and the data were compared via a paired Wilcoxon signed-rank test.

Two Generalized Linear Models (GLMs) including only main effects were built to investigate the effect of children's sociodemographic variables and their perception towards birds (determined through the pre-program questionnaire) on a) their pre-program knowledge of bird species, using the number of correct pre-program answers per child as a response variable, and b) their learning progress, i.e. the post-program knowledge of bird species, using the number of correct post-program answers per child.

In the former case, the number of pre-program correct identifications was considered as an additional covariate to account for the effect of the children's initial knowledge about birds. Identification scores were converted to probabilities (i.e. percentage of correctly identified birds) and a quasi-binomial distribution with a logit link function was used. Prior to model construction, collinearity among independent variables was tested by calculating Variance Inflation Factors (VIFs) using the *car* package in R. No correlations were found (VIFs < 1.62) and all variables were used in the model. A global model was built and then non-significant variables were sequentially dropped using the *drop1* function in R and the model was re-fitted each time (Zuur et al., 2009). This was repeated until only significant terms remained in the model. The significance threshold was set at $\alpha = 0.05$ for all statistical tests.

All analyses were performed in R version 3.5.2 (R Core team, 2018). Additional libraries used were *tidyverse* for data cleaning, preparation and plotting (Wickham, 2017), car (Fox & Weisberg, 2019) for calculating VIFs and *galluvial* (Brunson, 2018) for additional plotting options.

RESULTS

Sociodemographic structure and perception towards birds

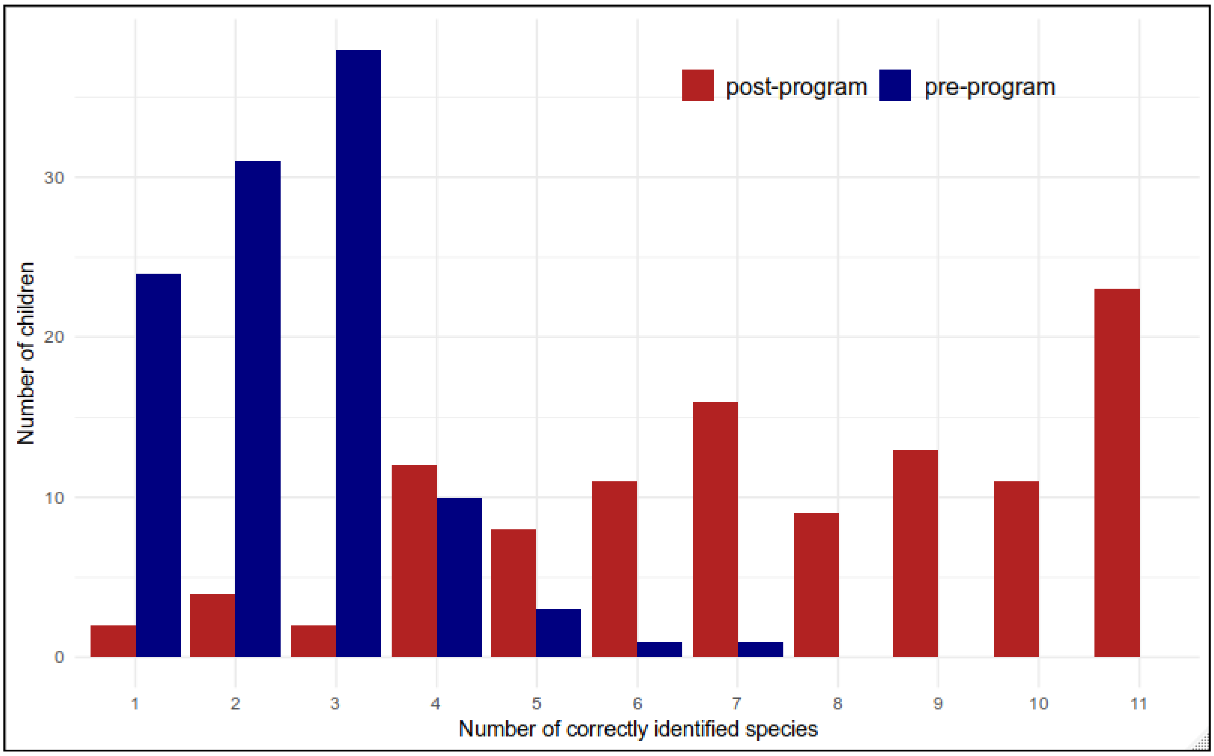
Overall, 112 children from six classes in two schools participated in the study. The sample was slightly female-biased (61.6%) and one school was slightly over-represented (66.1%). All children were from a similar age group (8 years: 20.5%, 9 years: 54.5%, 10 years: 25%). The majority of children stated they had a garden at home (64.3%). No bias towards any of the factors was observed within each of the groups.

The majority of children stated that they often or very often observed birds outside (61%). Most children said they liked birds much or very much (88%), whereas one child stated they were afraid of birds and two said they were disgusted by birds. Almost all children (97%) stated that birds play an important or very important role in the environment.

Bird identification

Pre-program knowledge of common urban bird species was very limited in most children. The majority of children (83.04%) could not identify more than three species correctly, while very few children (4.5%) knew more than five species (Figure 2). Four children did not identify any species correctly. The only species that were identified correctly by 50% or more of the children were the Swallow (counting any answer of hirundines as correct, even if not the exact species), the Robin and the Feral Pigeon. Almost all other bird species were identified incorrectly or not at all, even very common and/or conspicuous species, such as the House Sparrow, the Collared Dove, the Hooded Crow and the Magpie, or even the Goldfinch, which is often held as a pet in cages (Figure 3).

FIGURE 2

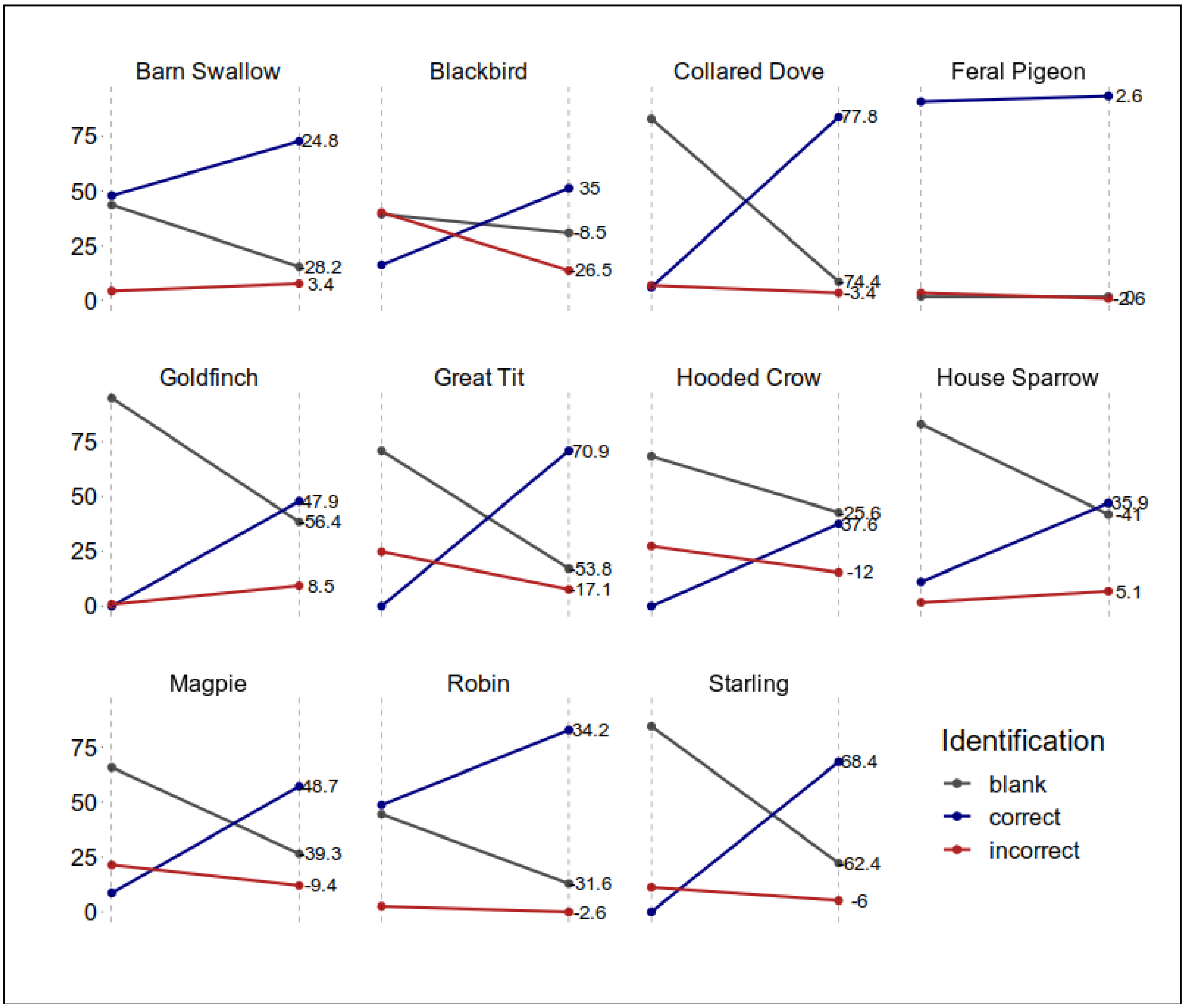


Number of children (y-axis) who could identify a certain number of birds correctly (x-axis).

In the pre-program questionnaires, the majority of answers (across all questionnaires) was left blank (64.5%), 21.8% of the answers were correct and 13.7% of the answers were incorrect. After the program, the number of empty answers decreased to 24.5%, the correct answers increased to 67.7% and the incorrect answers decreased to 7.7%. While most of the answers that were left blank before the program were answered correctly afterwards, some of them were answered incorrectly. A very small percentage of previously correct answers were left empty or answered incorrectly after the program (Figure 4).

For specific birds, the percentage of correct identifications increased >50% after the program (Collared Dove, Great Tit, Starling), while for others the number of incorrect answers also increased (Barn Swallow, Goldfinch, House Sparrow) (Figure 4). The only species that still received more empty answers than correct ones after the program was the Hooded Crow.

FIGURE 3



Progress of children's bird species knowledge before and after the educational program, for each bird species. Y-axis: percent of answers; x-axis: before (left) and after (right) the program. Values on the right of each graph: % change. Colours: red: incorrect answers, blue: correct answers: grey: no answer given.

The paired Wilcoxon signed-rank test indicated that the number of correctly identified bird species was significantly higher after the educational program than it was before (V=30, $p<0.05$; median pre-program: 2, median post-program: 7.5).

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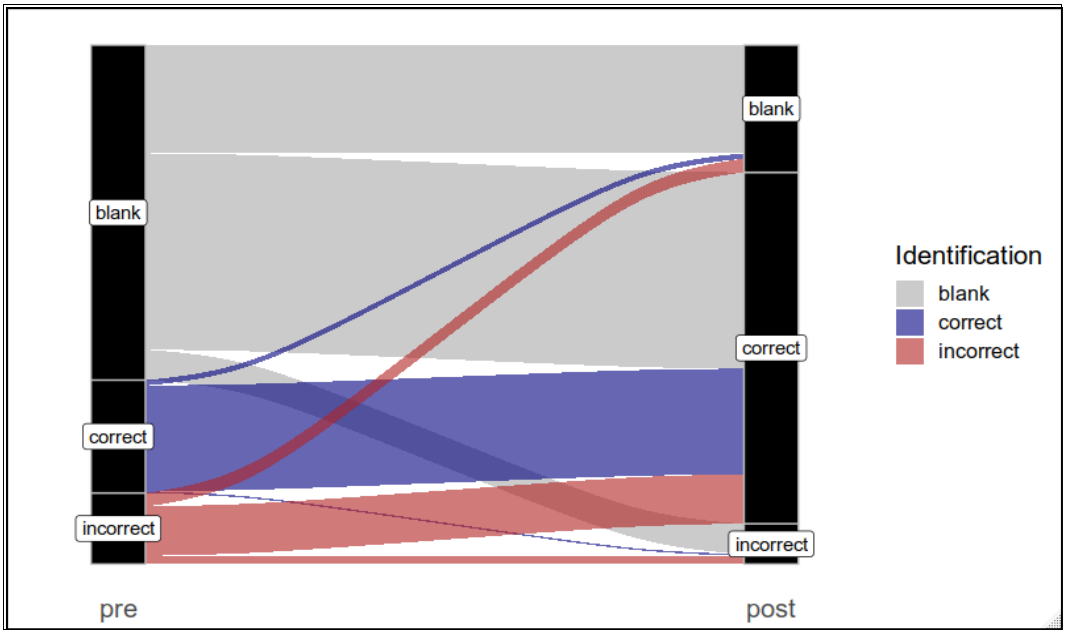
FIGURE 4



Alluvial plot showing the progress of bird identification: number of correct, incorrect and blank answers before (left) and after (right) the program. Most answers that were left blank before the program were answered correctly after the program, although some were answered incorrectly (grey lines/areas). A few previously incorrect (red) or correct (blue) answers were left blank after the program, while the majority of incorrectly identified birds were correctly identified afterwards.

The GLM for the pre-program knowledge indicated that none of the tested variables played a role in children's ability to identify bird species correctly (Table 2). However, the pre-program identification knowledge influenced their learning process, i.e. the post-program ability to identify birds (Table 3). The model also suggested that girls showed more learning progress than boys and their identifications were significantly more often correct than those of boys.

TABLE 2

Summary of the GLM for pre-program bird identification (n = 112, quasi-binomial distribution with logit link function). None of the variablesissignificant.

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	-1.592	1.099	-1.448	0.151
Age	0.082	0.107	0.766	0.445
Gender (male)	0.097	0.134	0.728	0.469
Garden (present)	-0.113	0.136	-0.834	0.406
School (School A)	0.172	0.144	1.192	0.236
Watching birds	0.003	0.073	0.040	0.968
Liking birds	0.026	0.088	0.295	0.768
Fear of birds	-0.106	0.117	-0.907	0.367
Disgust at birds	-0.100	0.106	-0.949	0.345
Importance for environment	-0.072	0.072	-1.008	0.316

TABLE 3

Summary of the GLM (final model) for post-program bird identification (n = 112, quasi-binomial distribution with logit link function). Both previous bird knowledge and gender had a significant effect on correct post-program bird identification.

	Estimate	Std. Error	t value	Pr (>|t|)
(Intercept)	0.065	0.251	0.258	0.797
Pre-program scores	4.336	1.086	3.991	0.000
Gender (male)	-0.562	0.223	-2.520	0.013

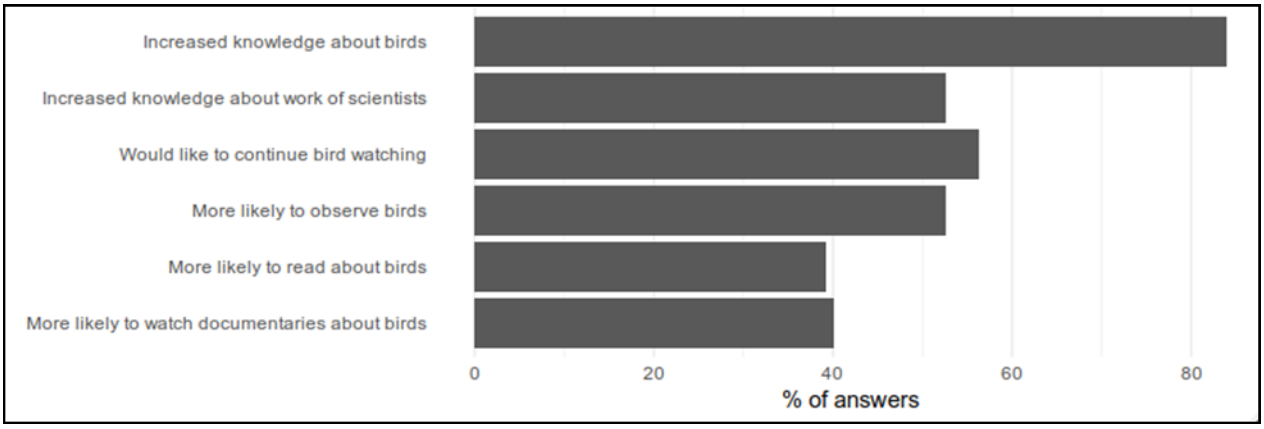
Perception of the educational program

The majority of pupils stated that they enjoyed the educational program much or very much (did not like at all: 0%, did not like it: 2.7%, found it acceptable: 4.5%, liked it: 25.0%, liked it very much: 67.9%).

Concerning the perceived benefits and impacts of the program, 83% of children stated that they increased their knowledge about birds and 52.7% said that they increased their knowledge about the work of scientists. About half of them stated that they would like to continue bird watching and that it was likely for them to observe birds outside, but only around 40% said it was likely that they would actively seek more information on birds through books or television documentaries (Figure 5).

The overall positive perception of the program was also expressed by children in their own words. Most children (75%) explicitly expressed details about their experiences as a free-text answer to the question “What did you like most about the program?”: *“I loved that I saw birds that I had never seen before”, “I loved learning birds that I hadn’t known”, “I loved most when I learned the characteristics of birds”, “I liked most that I learned about birds and now I know how to watch them quietly without scaring them”, “I liked most learning things about the Collared Dove, because I have heard it at my grandparents’ home, but I always wondered what it was called. And I am very pleased that I finally learned it!”*. They also commented positively about the museum as an environment, e.g. *“I loved to see the stuffed animals”, “I liked that we could see the birds behind glass”, or “I liked the birds, the sharks, the snakes and everything else”*. In contrast, as an answer to the question “What did you like least about the program?”, none of the pupils commented negatively on the program, only on specific birds, e.g. *“I liked the Feral Pigeon least of all birds”*.

FIGURE 5



Percent of agreement to each option of the question “What do you think you have gained from the educational program?”

DISCUSSION

Alienation from nature is a phenomenon that can be observed in many western societies and is often due to urban lifestyle and lack of access to green spaces (Fuller et al., 2007; Miller, 2005). This is often reflected in an inability to identify and name the species in people's immediate environment and has been observed across countries and age groups. Balmford, Clegg, Coulson and Taylor (2002) found that primary school children in the UK could not classify more than 50% of local wildlife taxa into broader groups, while in the same age group fewer than 20% of children in the UK could identify common species such as the sparrow and the earwig (Huxham, Welsh, Berry, & Templeton, 2006). This pattern was found to persist even in undergraduate students aiming to become biology teachers for primary schools: in four Baltic countries, students could not identify more than 12 out of 18 common local plant and animal species, with students in Lithuania scoring extremely low with an average of 2.6 species identified correctly (Palmberg et al., 2012).

The same disconnectedness from nature and inability to recognize even very common species also became obvious in Greek pupils in the present study. Only 4.5% of the participating pupils knew more than five of the eleven bird species that were shown to them in the images and museum dioramas, although these are typical and abundant species of urban areas, while the majority could only identify maximally up to three species correctly.

This is in contrast with the positive attitude towards birds and a self-proclaimed environmental awareness, which became obvious from the pupils' answers to the questionnaires that they filled in before the educational program. Although 88% of the pupils said they liked birds and 61% stated that they often observe birds outside, this seems to be a non-engaging type of observation, as they do not seem to show enough interest in their surrounding nature to inquire about species identity. Thus, a real desire to engage with and learn was absent before the program. This positive attitude towards birds or the fact that most participants live in houses with gardens, where common bird species are quite abundant, did not play any role in pupils' initial knowledge, as was indicated by the Generalized Linear Model (GLM) for the pre-program bird identifications. In addition, neither age nor gender nor school was found to have a significant effect on the proportion of the correct answers, thus, the pre-program knowledge of birds was idiosyncratic and not affected by any of the tested variables.

Our results clearly demonstrate that after the completion of the educational program children's ability to correctly identify bird species increased significantly. Furthermore, the GLMs indicated that existing pre-program bird knowledge played a highly significant role in identifying birds correctly after the program as well. However, even participants with very limited previous knowledge seemed to obtain new skills very efficiently. The improvement of identification skills was also acknowledged by the children themselves, as most of the pupils (80%) answered that they increased knowledge about birds, while more than 50% said that they would like to continue bird watching. The fact that female participants achieved higher scores in bird identification in the post-program tests seems, however, not to be universal, as the literature is inconsistent about the effect of gender in similar studies (Randler, 2008; Tuncer, Ertepinar, Tekkaya, & Sungur, 2005).

Using a natural history museum as an educational environment, in combination with the constructivist approach and multi-sensory elements, such as sound or video, seems to provide improved learning opportunities for children in a similar manner to art museums, where the museum environment has been found to positively contribute to the cognitive progress of children (Levent & Pascual-Leone, 2014; Ramey-Gassert, 1997). Especially for elementary school pupils birds' sounds help them to identify birds more successfully than when they only are provided with visual features (Prokop & Rodák, 2009). In our study, the benefits of this educational environment and approach were reflected in an improvement in the identification of specific species for which an additional element of presentation (sound/video) was used, i.e. for the Collared Dove, the Great Tit and the Starling. The number of correct identifications of these species increased much more in the post-program questionnaire than those of most of the other species.

The children in our study were clearly invigorated by learning more about the nature around them. They enthusiastically participated in the activities of the program and recalled from memory birds of which they had not known the name, or others whose name or voice they had heard without knowing how they looked. Generally, they expressed great interest to continue nature-related activities, as it became also apparent from answers from the questionnaires: 56.2 % of children stated that they desired to continue to watch birds outside, while fewer than 40% of children were interested in learning about birds through books or television. Thus, the active immersion into and a first-hand experience of nature seems to be a defining factor. This was supported by the fact that teachers informally reported back that pupils had requested follow-up activities related to birds, such as bird watching or construction of artificial nests. Thus, a lasting effect could be observed. An understanding and relatedness to nature is a basic requirement for environmental awareness and a deeper sense of conservation of the natural world. A lack of knowledge leads to emotional non-investment; thus, knowing the primary components of ecosystems (i.e. the species) is crucial for a holistic understanding of ecosystem processes, as this leads to a desire to protect nature (e.g. Cox & Gaston, 2015; Hacking, Cushing, & Barratt, 2018; Lindemann-Matthies & Bose, 2008; Randler, 2008). An intense and extended environmental education is therefore crucial in children's education. However, species identification skills often cannot be performed in schools, as teachers themselves often do not know species in their environment (Palmberg et al., 2012). In addition, it has been found that museums are highly suitable as an education environment (Gkouskou & Koliopoulos, 2011; Koliopoulos et al., 2012). Although university museums can nowadays be considered as multifunction platforms (Chen, 2000) and can perform as fundamental social agents (Ntinou & Vafeiadou, 2000), the design of effective educational programs is still a challenge. However, we showed here that a 90-minute program in a natural history museum is suitable to efficiently teach children iconic species of their environment.

Our study did not test the retention of the learned knowledge, but this was not the primary aim. The program was designed as a first step in directing children's attention again to the natural world around them through providing them the opportunity to observe some species which they often had already seen. Learning the names of objects around us is the first step to gaining a deeper understanding. Antisthenes quote "The beginning of wisdom is the study of names" can be interpreted as a way of connecting to the world around us: "I can distinguish and name an element of the world, so I can study it and get to know it. Therefore, I can come to love it, and what I love, I will protect". This is also emphasized by Kimble (2014), who state that "learning" does not necessarily include "memorizing", but the important aspect of this first contact is the association between a name and a species, as well as by Barker & Slingsby (1998), who state that "Ecology is about much more than identifying species, yet it surely begins by recognizing that there are different species and attempting to give them names". In present times, where terms of the natural world are disappearing from children's minds and dictionaries (Kesebir & Kesebir, 2017; Macfarlane, 2017), the step of being able to give a name to a species and thus recognize its identity – and acknowledge biodiversity – is basic but crucial.

Our findings highlight that children can benefit from short-term environmental education programs which engage them in environmental activities. Active participation and constructivist approach, ideally in an inspiring environment such as a university natural history museum, can subsequently strengthen children's experience with nature in urban settings and their knowledge about species around them. At the same time a museum and informal science learning environment engages pupils with the scientific process and thus, ultimately promotes conservation.

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