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RESEARCH ARTICLE

The impact of winter feeding of birds on pro-environmental attitudes and knowledge of pupils in elementary schools

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ABSTRACT

Feeding wild birds is one of the most popular forms of interaction between wild animals and humans. This relatively simple method can be applied in the educational process in primary schools through active learning in the field, which serves to improve the pro-environmental attitudes of pupils. The aim of the research was to verify the effect of winter bird feeding on the behavior and knowledge of pupils in selected primary schools. We were interested in whether there are differences between respondents who feed birds in winter and those who do not in terms of their gender, grade, place of residence (apartment, house), and school location. We were also interested in the motivation to feed birds and its origin. The results of our research confirmed that winter bird feeding has a positive effect on respondents' knowledge (p = 0.0101). Pupils attending schools in village areas had a higher tendency to feed birds (p = 0.0005). This was similar for housing type, as respondents living in houses were more likely to feed birds (p = 0.0011). The effect of gender was negligible in our research (p = 0.2965).

Keywords: attitudes; pro-environmental education; birds; feeding

1. Introduction

It's difficult to determine exactly when bird feeding started, but it is certain that initially, feeding served the purpose of hunting and subsequently consuming birds. Regular bird feeding aimed at their protection, however, developed only in the 20th century. Significant declines were recorded during the periods of the First and Second World Wars and immediately after their end, with resurgence starting in the 1960s[1]. Due to the constant transformation of the environment by humans, whether through intensive agriculture, construction, transportation, or light pollution, the possibilities for many bird species to obtain food have significantly worsened, leading to their decline. Because of this disruption to the natural habitat of birds, it is highly advisable to provide them with appropriate feeding during the winter[2]. Bird feeding is, among other things, a successful and valuable way to aid in species conservation and, consequently, the preservation of nature itself[1]. Winter feeding can, in some cases, make a significant difference for birds, as it is invaluable assistance in preventing food shortages that could lead to their exhaustion and death[3]. Providing nutritious food during harsh winters improves the physiological condition of otherwise undernourished birds[4], as well as promotes

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earlier reproduction and higher rates of successful fledging[5]. On the other hand, unprofessionally prepared bird food can lead to the spread of various diseases, such as salmonellosis[6]. Furthermore, there is mention of the preference for dominant species through winter feeding[4], along with the claim that only species remaining in the vicinity of their nesting areas during the winter benefit from feeding. Overwintering birds are therefore in better condition for the following breeding season, start nesting earlier, and migratory species face more significant challenges in finding suitable nesting sites upon their return. However, it should be noted that the majority of migratory birds still lack suitable nesting conditions in human gardens[6]. For these reasons, it is necessary to follow the correct procedure for bird feeding, which involves maintaining proper hygiene of feeders, choosing suitable bird food, and timing the feeding appropriately.

With winter feeding of birds, it's advisable to start in the autumn, mainly for the birds to get accustomed to the feeder and also to self-feeding. During the autumn, you should begin by providing small amounts of food, as there is still plenty of available natural food in the wild. With the appearance of the first frost and snow, birds will automatically come to the feeder since they have become accustomed to the food source introduced during the autumn[7]. Not all bird species have the same preference for food, so a combination of various types is suitable. Seeds used for bird feeding contain a significant amount of fiber, which, despite being indigestible, plays a crucial role as it supports intestinal peristalsis. In addition to fiber, these seeds also contain varying amounts of proteins, carbohydrates, fats, and minerals, which, thanks to their easy digestibility, generally constitute a highly energetic diet. All types of cereals belong to starchy seeds. Especially wheat, buckwheat, barley, corn, and oats should be used for feeding[6]. Seeds of grasses and wild herbs are also suitable, such as dandelion seeds (*Taraxacum*), shepherd's purse (*Capsella bursa-pastoris*), chickweed (*Stellaria*), or plantain (*Plantago*), which are rich in vitamins[6]. Don't forget millet either, as its stalks can be hung individually[8]. Insect-eating species, which have a harder time finding food during the winter months, must seek an adequate replacement. You can find it in the form of fat balls and other products with a high fat content at feeders[6]. Also, dried insects are a particularly welcome, although not very frequently offered, food on feeders. It's usually purchased at pet supply stores, as producing it in large quantities at home can be quite challenging[1].

Apples are the most commonly offered fruits, especially favored by thrushes and blackbirds. Dried raisins are also used for feeding, but due to their high sugar content, they should be given in small quantities only[6]. Human food is particularly unsuitable for birds because it lacks sufficient nutrients and contains too many additives such as various spices, salt, preservatives, and stabilizers. Pieces of bread or any sweet pastries, including cakes[1], offered by people are also unsuitable as they can cause digestive problems in birds, including potentially lethal fermentation processes[6]. Despite the unsuitability of bread as bird food, it is widely used, as indicated by research from Cardiff, where up to 90% of households use bread to feed birds[9]. It's also advisable to avoid offering various leftovers of cooked meat or sausages[1]. However, the effects of bird feeding are not limited to free-living animals and also have significant positive social consequences for people engaged in this activity[10,11]. Feeding wild birds is one of the most popular forms of interaction between wildlife and humans, especially in urban environments[12].

For people, it becomes a kind of reconnection with nature, which they don't have as much contact with in cities[13]. Observing birds at feeders is much easier than in the wild. It provides many opportunities for education, for both children and adults. Knowledge about individual species, their behavior, and many ecological connections deepens. Engaging children can teach them responsibility in preparing, dosing, and cleaning the feeders through bird feeding. Additionally, in "young observers," bird feeding can spark an interest in bird conservation[6], as it has been found that people who feed birds and directly observe potential environmental issues can take action to address these problems[14]. It's also worth mentioning the positive

impact of bird watching at feeders on seniors or people with reduced mobility, as it calms them and brings joy to their lives[6]. There are several studies, which deal with the feeding of birds, the factors that affect it. These studies also identify the impact of bird feeding on changing people's attitudes towards nature. Some studies also address the influence of gender on bird feeding[13,15]. Their results show more positive attitudes among girls, e.g., in the study by Bjerke et al. girls were more active in feeding birds ($F = 5.81$, $p = 0.02$) and were more likely to read books about animals than boys ($F = 5.27$, $p = 0.02$)[16].

Short-term and long-term educational activities that utilize various forms of formal and informal education are a common practice in environmental education. Teachers and researchers often use them for their potential to achieve positive cognitive and affective educational outcomes[17,18]. Many authors point out the advantages of a constructivist approach in teaching, including active student engagement, the acquisition of key competencies, creativity, the construction of one's own reality, cooperation, organization, and more[19–23].

Education and pro-environmental behavior are also linked to influencing pupils' attitudes. The development and formation of attitudes are significantly influenced by the quantity and quality of information individuals possess. According to Stern[24], environmental values and attitudes are key to the development of pro-environmental behavior. Childhood experiences and memories can partly explain environmental attitudes. When observing over 200 environmental educators from around the world, it was found that the strongest and most significant predictor of pro-environmental behavior was the amount of childhood experiences in nature, gardens, and similar environments[25]. Many authors have demonstrated the positive impact of active student learning on pupils ' attitudes and knowledge[26–29].

The aim of the research was to test the impact of winter bird feeding on the attitudes and knowledge of selected elementary school students in the Slovak Republic. We investigated the pupils' attitudes towards winter bird feeding and their knowledge on the topic. We were interested in whether attitudes and knowledge would differ between pupils who feed birds during the winter and those who do not, as well as various influencing factors such as gender, grade level, place of residence (apartment or house), school location, and the age of the respondents. Furthermore, we were interested in the motivation for bird feeding and its origins.

2. Materials and methods

2.1. Participants

The research sample consisted of pupils from two primary schools in Slovakia. Specifically, these were pupils in the fifth, sixth and seventh years of primary school. Pupils primarily cover bird-related topics in the 5th, 6th, and 7th grades. For this reason, these specific grades were included in the research. The municipal school was represented by the primary school with kindergarten on Gogolova Street. Topolcany and the rural school was represented by the primary school with kindergarten in Prasice. The age structure of the respondents was 10 to 13 years, the average age of the respondents was 11.84 years. The selection of the respondents was random, a total of 144 questionnaires were collected at both schools. 74 girls and 70 boys participated in the survey. We divided the research sample into two groups, those respondents who had experience of feeding birds and those who had never fed birds. According to Bartlet et al.[30], the number of respondents is sufficient for determining differences with a sample of 118.

2.2. Questionnaire and analysis

The research method chosen to determine the impact of winter bird feeding on pupils' attitudes and knowledge was a questionnaire consisting of twenty questions. In the initial part of the questionnaire, we approached the respondents and asked for their cooperation in completing the questionnaire, assuring them of

the anonymity of the survey and the strictly scientific use of the results. In the initial part of the questionnaire, the questions focused on the age, gender, year of school and residence of the respondents. These questions were followed by 20 questions. The first five questions were aimed at ascertaining the respondents' experience with feeding. These were followed by questions on motivation to feed birds. The next 6 questions were knowledge questions and the questionnaire also contained 15 pictures of specific bird species to test the respondents' ability to ideate bird species. The last questions were about the risks of bird feeding and involvement in bird feeding in the school environment. The validity of the final version of the research tool was verified through two researchers with extensive experience in educational research.

The questionnaire was distributed anonymously in biology classes. Distribution was handled by the respective biology teachers, pupils agreed to complete it, and we subsequently obtained informed consent from parents to test their pupils. All data considered under questionnaire number only, no identification of respondents was used. The research was conducted in the 2022/2023 school year in the months of March and April.

After the questionnaires were collected, the data were tabulated with each row representing one respondent. Responses to the questions were numerically scored, with the highest score given to the required or correct response. Subsequently, we tested the normality and reliability of the data set, and the statements were categorized according to factor analysis in Statistica, version 12. We excluded from the analysis 7 questions that showed a low level of correlation with the other questions. Statements related to behavior had a dichotomous rating, the answers were scored 0 and 1, respectively; the average of the scores obtained for these 5 questions constituted the behavior dimension. This dimension includes, for example, questions such as: do you get used to going for walks in the countryside? Do you keep pets in your home? Knowledge was represented by 6 questions. In this dimension, for example, we asked the question, what constitutes the food of birds in the wild? The mean score for correctly identifying 15 bird shrews formed a separate dimension: species identification.

Data analysis was carried out in Statistica, version 12. To detect differences according to the factors considered between groups that feed or do not feed birds, we used the non-parametric test Kruskal-Vallis ANOVA, with chi-square test calculation. We then used non-parametric Sperman rank correlations to examine the correlation of bird feeding with the dimensions of interest (behaviour, knowledge and bird identification).

3. Results

3.1. School location

By comparing the results in bird feeding experience between primary school pupils from the city and primary school pupils from the village, we found that pupils attending school in the village fed birds more often than those from the city (**Figure 1**). This difference showed a statistically significant threshold (Chi-square = 12.09650, $p = 0.0005$).

School location was also statistically significantly correlated with the results found by comparing the three dimensions; **Table 1** shows the results of these comparisons.

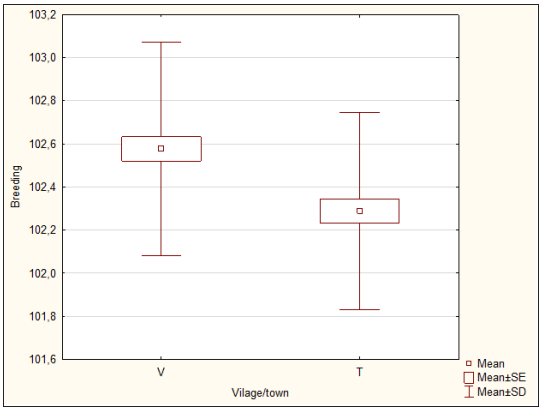

Figure 1. Differences in bird feeding by pupils in different types of schools.

Table 1. Correlation between school location and studied dimension.

	Valid	**Spearman**	***t*(*N*-2)**	***p*-value**
	N	***R***		
Vilage/town & Behaviour	144	−0.487978	−6.66196	0.000000
Vilage/town & Knowledge	144	−0.375906	−4.83397	0.000003
Vilage/town & Identification	144	−0.463317	−6.23009	0.000000

3.2. Gender

Differences in bird feeding between sexes were not demonstrated (**Figure 2**) (Chi-square = 1.089730, p = 0.2965), nor was there a correlation between sex and the observed dimensions.

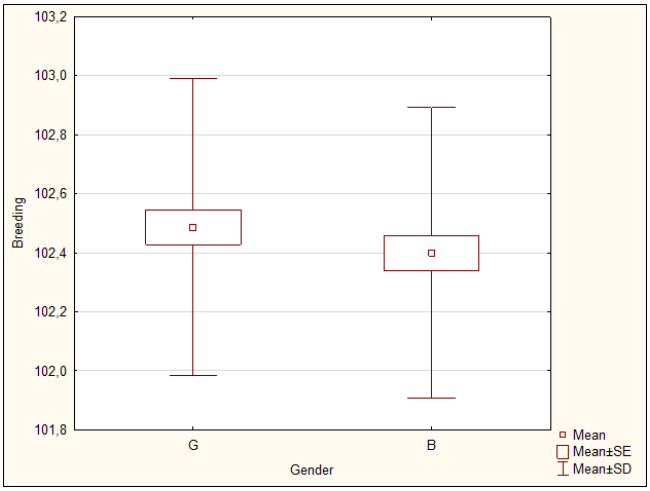

Figure 2. Differences in bird feeding between genders.

3.3. Grade level

In **Figure 3**, we show the differences in bird feeding between years of the surveyed sample of respondents. The figure shows, and the statistical test confirms (Chi-square = 6.095455, p = 0.0475), that students in the lower grades show a higher willingness and interest in feeding birds. Verifying the correlation of school year and the observed dimensions, we found a positive correlation between the behavioral dimension and bird feeding (**Table 2**).

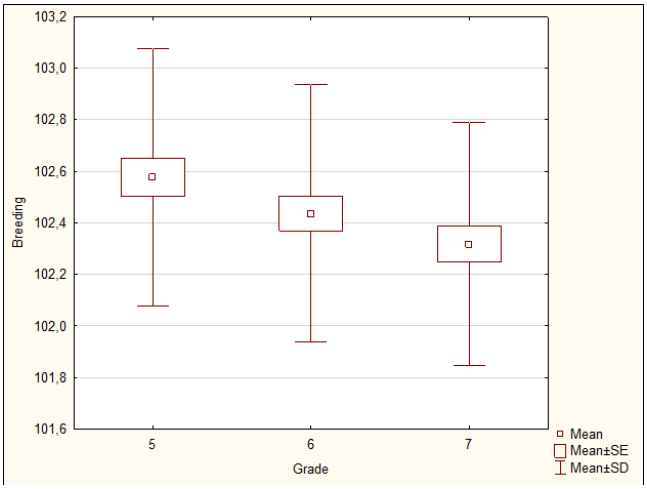

Figure 3. Differences in bird feeding between grade levels.

Table 2. Correlation between grade level and studied dimension.

	Valid	**Spearman**	***t*(*N*-2)**	***p*-value**
	N	***R***		
Grade & Behaviour	144	−0.187524	−2.27496	0.024406
Grade & Knowledge	144	−0.103803	−1.24367	0.215670
Grade & Identification	144	0.038900	0.46390	0.643428

3.4. Housing type

In a further analysis, we looked at differences in bird feeding by respondents' housing type place. We demonstrated highly statistically significant differences between respondents living in flats and those living in houses (Chi-square = 10.62717, p = 0.0011, **Figure 4**). Out of the total number of respondents included in the survey, 44.4% feed birds. The rate of winter bird feeding by pupils living in single-family houses is 55.1%. Only 27.3% of children living in apartment buildings feed birds.

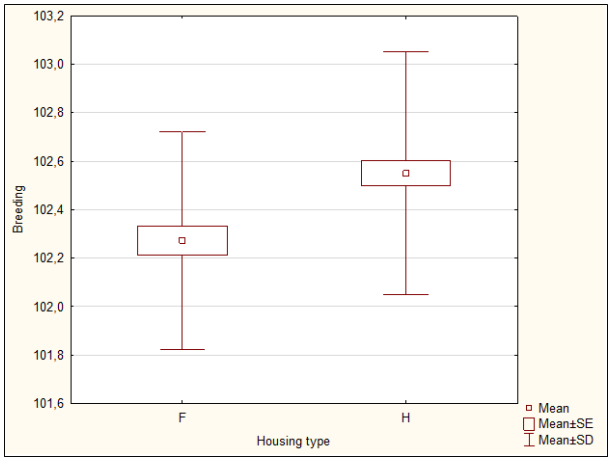

Figure 4. Differences in bird feeding by pupils from different housing types.

Verifying the correlations of the results of the observed dimensions and the type of housing of the respondents, we found a positive correlation with the behavioral dimension and the identification of bird species. For the knowledge dimension, the demonstration of correlation was at the limit of statistical significance (**Table 3**).

Table 3. Correlation between pupils housing types and studied dimension.

	Valid	**Spearman**	***t*(*N*-2)**	***p*-value**
	N	***R***		
Housing type & Behaviour	144	0.518265	7.22134	0.000000
Housing type & Knowledge	144	0.153032	1.84532	0.067074
Housing type & Identification	144	0.260510	3.21536	0.001613

3.5. The motivation for bird feeding

We further explored the input into bird feeding, demonstrating the positive influence of the family on bird feeding. The initial motivation for starting bird feeding by pupils primarily came from parents (36%) and grandparents (23%). The influence of teachers and school ranked fourth (13%), with personal initiative leading (17%). The cumulative influence of media (newspapers, books, television), neighbors, or friends reached only 11% (**Figure 5**).

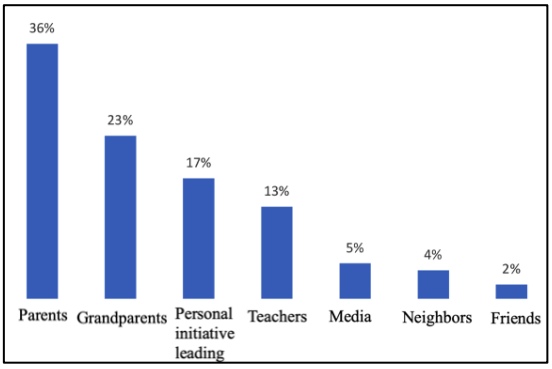

Figure 5. Comparison of various influences on pupils' initiation of bird feeding.

3.6. The influence of bird feeding on knowledge

We have demonstrated significant differences in the knowledge of pupils. Respondents who engaged in bird feeding during the winter achieved higher levels of knowledge compared to pupils who did not feed birds during the winter (Chi-square = 6.612524, p = .0101) (**Figure 6**). Even greater differences exist among pupils in their ability to identify different bird species. Respondents who fed birds showed better identification skills compared to those who did not feed birds ($p \leq 0.001$).

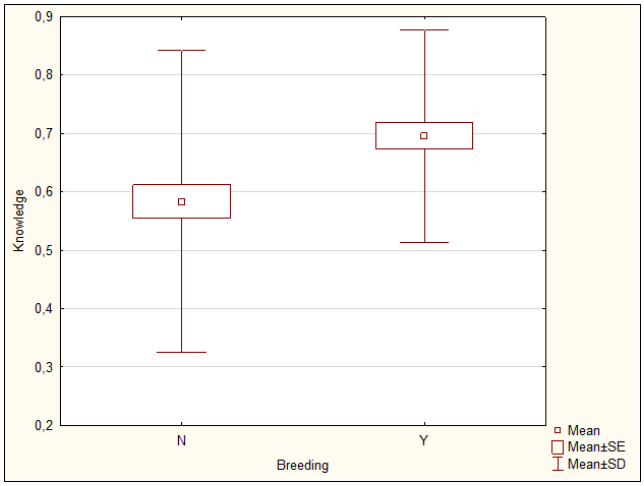

Figure 6. Differences in level of knowledge according to respondents' bird feeding experience.

In terms of the dimension of species identification, pupils most commonly identified the great spotted woodpecker (*Dendrocopos major*) (20.8%), the blue tit (*Cyanistes caeruleus*) (20.2%), and the blackbird (*Turdus merula*) (19%). The house sparrow (*Passer domesticus*) (13.8%), the Eurasian jay (*Garrulus glandarius*) (7.9%), the European robin (*Erithacus rubecula*) (6.7%), the European goldfinch (*Carduelis carduelis*) (3.9%), the grey-headed woodpecker (*Picus canus*) (2.2%), the Eurasian nuthatch (*Sitta europaea*) (2.2%), the common starling (*Sturnus vulgaris*) (1.3%), and the Eurasian wren (*Troglodytes troglodytes*) (1%) followed. Pupils had the most difficulty identifying the crested tit (*Lophophanes cristatus*) (0.7%) and the Eurasian nuthatch (*Sitta europaea*) (0.3%). Pupils were completely unable to recognize the common linnet (*Linaria cannabina*) (0%) and the European goldfinch (*Carduelis carduelis*) (0%).

Pupils not only perceive the benefits of winter bird feeding but also recognize the potential risks. Of the respondents, 53.5% considered bird feeding exclusively positive, while 46.5% acknowledged the possible negative effects of winter bird feeding. The pupils identified the provision of inappropriate food (29.9%) as the most significant risk, which could lead to bird mortality, followed by overfeeding (25.4%). The presence of pests or parasites was perceived as problematic for only 3%.

4. Discussion

In our study, we demonstrated a positive effect of feeding birds during the winter on the level of knowledge. This finding is consistent with research[31] that suggests that pupils who engage in bird feeding have better abilities to identify different bird species. Even greater differences exist among pupils in their ability to identify different bird species. Respondents who fed birds showed better identification skills compared to those who did not feed birds.

Our claims are also supported by the findings of Sotáková[27], who observed an improvement in pupils' attitudes at both primary school levels through short-term educational activities. Yasin[32] reports a positive influence of organizing activities and pro-environmental activities in schools on pupils' environmental literacy. Jose et al.[33] suggest the importance of experiential and active learning for long-term educational outcomes. Palmer[25] found that the strongest and most significant predictor of pro-environmental behavior was the amount of childhood experiences in nature, gardens, and similar settings that respondents had.

The positive impact of short-term education has also been confirmed by Kvasničák et al.[34], who found a positive influence of a 5-day short-term course on pupils' knowledge, and Easton and Gilburn[35], who found a positive impact of a 10-day course on pupils' knowledge and attitudes.

In our analysis of the collected data, we demonstrated that pupils attending village primary schools achieve better results in behavior ($p < 0.001$), knowledge ($p = 0.000$), and bird species identification ($p < 0.001$) compared to pupils attending town primary schools. Similar conclusions were reached by Chen et al[36], Hinds and Sparks[37], Rauwald and Moore[38], Huddart-Kennedy et al.[39].

In further analysis, we focused on the relationship between the type of residence and the dimensions we observed (behavior, knowledge, and species identification), showing an impact on the behavior dimension ($p < 0.001$) and the ability to identify species ($p = 0.001$). The type of residence has a positive effect on pupils' behavior. Pupils living in single-family houses feed birds more frequently. Out of the total number of respondents included in the survey, 44.4% feed birds.

The rate of winter bird feeding by pupils living in single-family houses is 55.1%. Among children living in apartment buildings, only 27.3% feed birds. The type of housing has a significant impact on winter bird feeding by elementary school pupils, as confirmed by the work of Davies et al.[40]. Housing also has an influence on species recognition. We confirmed the assumption that respondents living in single-family houses

are better at identifying birds compared to respondents living in apartment buildings. We demonstrated an influence of the school year in which pupils are on the dimension of knowledge (p = 0.048), while the significance in the other two dimensions was not demonstrated. This finding confirms that pupils who completed the fifth-grade biology have better knowledge about birds and their feeding. An interesting finding was that the gender dimension did not correlate with any other dimension. We did not observe any differences between the genders of the pupils (p = 0.932) in their behavior and the ability to recognize individual bird species, with negligible differences in knowledge between genders.

Zeidan[41] and Jones et al.[42] affirm that girls tend to have higher preferences for the subject of biology compared to boys, which may be related to our measured values. Furthermore, they state that girls are more inclined towards subjects related to biology and humanities, while boys tend to favor subjects with a technical focus. Many authors have demonstrated that girls have better environmental attitudes than boys[43–49]. These findings do not correspond with our own.

Furthermore, we delved into the motivations for feeding birds and demonstrated the positive influence of family on bird feeding. The initial incentive to start feeding birds by pupils primarily came from parents (36%), grandparents (23%), personal initiative and teachers. The influence of teachers and school ranked fourth (13%), lagging behind personal initiative (17%). The cumulative influence of media (newspapers, books, television), neighbors, or friends only reached 11%. Many studies have examined predictors of pro-environmental behavior, including the social environment, time spent in nature, culture, educational attainment, family influence, teacher influence, and others[50–52].

Additionally, we assumed that pupils would only perceive the positive impacts of bird feeding. However, we found that as many as 46.5% of respondents were aware of potential risks. Understanding the attitudes and motivations of people who feed birds is crucial because their behavior and, ultimately, how their feeding practices affect the urban ecosystem depend on them. Their motivation, for example, can influence their choice of bird feed and whether they focus on specific bird species. Many authors have explored the risks associated with bird feeding stemming from public awareness[53–55].

5. Conclusion and recommendations

Of all the classes of wild vertebrates, birds are the most conspicuous in the vicinity of humans. They signal their presence with unmistakable vocal utterances, which, however, change their character during the winter. In times of severe food shortages, it is up to us humans to provide them with survival aid in the form of bird feeding. The work presented focused on the topic of winter bird feeding. It deals with their food, different types of bird feeders, but the main part of the work focuses on the actual act of feeding the birds. The results of our research confirm that winter bird feeding has a positive effect on the knowledge of the respondents. In addition, we have shown a significant effect of the environment in which the pupils are in on their willingness to feed birds. Pupils attending schools in rural areas had a higher tendency to feed birds. This was similar for housing type, as respondents living in houses fed birds more. In our study, we did not find significant differences in bird feeding between genders. Since we found a positive effect of bird feeding on students' knowledge, we recommend including it in biology teaching in primary schools, for example through field or practical exercises. Improving attitudes can reinforce pupils' pro-environmental attitudes as well as the correctness of bird feeding and understanding of potential risks. For a broader interpretation of the results, we would recommend expanding the research sample to include additional respondents. It would also be possible to conduct the research after the implementation of practical bird feeding activities by comparing the results of the groups that implemented such activities with the control group (without participation in the practical activities).

Author contributions

Conceptualization, II and VP; methodology, AT; software, RM; validation, AT, VP and RM; formal analysis, VP; investigation, BP; resources, BP; data curation, II; writing—original draft preparation, II; writing—review and editing, VP; visualization, VP; supervision, AT; project administration, AT; funding acquisition, AT. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare no conflict of interest.

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