



From fear to care: The role of entomological dissection in shaping students' attitudes toward insects

 Viera Peterkova¹

 Ivan Il'ko²⁺

 Paulina Halvonikova³

 Alexandra Maruniakova⁴

^{1,2,3,4}Department of Biology, Trnava University in Trnava, Priemyselna 4, 91843 Trnava, Slovakia.

¹Email: viera.peterkova@truni.sk

²Email: ivan.ilko@truni.sk

³Email: halvonikovap@gmail.com

⁴Email: Alexandra.maruniakova@tvu.sk



(+ Corresponding author)

ABSTRACT

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Students often express fear, aversion, and disgust toward insects, which can reduce their engagement in biology education and limit interest in biodiversity conservation. Such negative emotions may also hinder the acceptance of content highlighting the ecological importance of these organisms. This study examined the effects of two instructional approaches, physical dissection and video-based dissection of cockroaches, on students' attitudes, emotions, and behavioral intentions toward insects. A total of 169 primary and secondary school students participated and were divided into three groups: physical dissection (E/P), video dissection (E/V), and a control group (C) receiving traditional instruction without dissection. Pre- and post-tests measured fear, willingness to protect insects, and openness to insect consumption. Both E/P and E/V groups showed a significant reduction in fear and disgust ($p \leq 0.05$), with the strongest effect in the E/P group. Willingness to protect insects increased significantly only among primary school students after the intervention ($p = 0.033$). Regarding insect consumption, a significant positive shift occurred only in the E/P group ($p \leq 0.05$), while no change was observed in the control group ($p \geq 0.05$). These results indicate that even short-term experiential interventions can reduce negative emotions and promote pro-environmental attitudes. However, hands-on activities appear to have a stronger affective impact than video-based methods, especially in shaping conservation intent and openness to entomophagy. The findings underscore the importance of choosing teaching strategies that address both cognitive and emotional aspects of science learning.

Contribution/Originality: The paper's primary contribution is demonstrating that brief, ethically acceptable experiential learning activities, such as insect dissections, significantly reduce fear of insects and promote pro-environmental attitudes. This study enhances the existing literature by emphasizing the emotional and conservation aspects of science education.

1. INTRODUCTION

Insects constitute one of the most diverse animal groups on Earth and fulfill indispensable ecological functions (Jongema, 2017). Nevertheless, public perception of these organisms is often unfavorable. They are commonly linked to emotions such as fear, disgust, or aversion, which contribute to their neglect in education and limited interest in their conservation (Bixler & Floyd, 1999; Borgi, 2015). Feelings of disgust toward insects may be understood as part of an evolved protective mechanism against pathogens, which could explain the persistence of negative reactions to

this group of animals (Curtis, Aunger, & Rabie, 2004; Lorenz, Libarkin, & Ording, 2014). Cultural context also shapes these perceptions: in Western countries, insects are frequently regarded as harmful or repulsive, whereas in many other societies, they form an everyday presence and even a routine food source (Prokop, Usak, & Fančovičová, 2010).

This study builds on previous research and extends it by comparing the impact of two types of interventions, physical cockroach dissection and video dissection, on the attitudes of lower and upper secondary school students toward insects. The aim of the study is to determine to what extent these two distinct teaching methods influence students' emotional and behavioral attitudes, specifically fear, disgust, and willingness to protect insects.

The significance of this topic lies not only in its educational contribution to biology as a school subject but also in its support for environmental literacy and responsible attitudes toward nature (Janoušková, Žák, & Rusek, 2019). In addition, this study addresses the question of whether digital substitutes for traditional hands-on activities are capable of fully replacing direct physical experiences, not only regarding knowledge acquisition but, more importantly, in shaping attitudes and fostering motivation for nature conservation. Within the framework of contemporary education, where schools must cope with limited resources, increasing ethical expectations, and ongoing digitalization, this issue has significant practical relevance for daily teaching practice (Sultana, Jain, Shariff, Quadras, & Ramos, 2022).

2. LITERATURE REVIEW

2.1. Attitudes toward Insects

Negative emotions such as fear, disgust, or aversion are frequently associated with insects, which contributes to their marginalization in both education and conservation efforts (Bixler & Floyd, 1999; Borgi, 2015). Disgust can be interpreted as part of an evolved protective mechanism against pathogens (Curtis et al., 2004; Lorenz et al., 2014). Cultural context further shapes these responses: while insects are often considered repulsive in Western societies, in many other cultures they are a normal part of daily life and even a food source (Prokop, Usak, & Fančovičová, 2010). Gender also plays a role, with girls typically reporting stronger fear and aversion than boys (Fančovičová & Prokop, 2008).

2.2. Entomophagy and Food Acceptance

Entomophagy is increasingly recognized as a nutritional and environmental opportunity; however, its acceptance is often hindered by food neophobia. Tolve et al. (2025) reported that younger, more educated males tend to be more receptive to entomophagy, particularly when insect-based ingredients such as cricket flour are incorporated into familiar foods.

Prior exposure to insect-based products reduces aversion and enhances acceptance. Similarly, populations in regions with diverse diets are generally more open to entomophagy than those in meat-centric, conservative dietary cultures (Ros-Baró, Sánchez-Socarrás, Santos-Pagès, Bach-Faig, & Aguilar-Martínez, 2022). Socioeconomic status also influences acceptance, with individuals from lower socioeconomic groups demonstrating greater openness to entomophagy (Florencia et al., 2022).

2.3. Educational Interventions and Student Attitudes

Educational activities can positively influence students' attitudes toward insects. Direct interaction with living organisms, whether in the field or laboratory settings, is particularly effective (Randler, Hummel, & Wüst-Ackermann, 2013; Schlegel, Breuer, & Rupf, 2015).

Even short-term practical tasks, such as insect rearing or dissections, have been shown to reduce disgust and increase students' willingness to support insect conservation (Sieg & Dreesmann, 2021; Wagler & Wagler, 2011).

2.4. Dissection in Biology Education

Dissection has a long-standing tradition in biological education, dating back to antiquity, when it was used to study organismal structure and function (Brenna, 2021). Today, it remains central in anatomy and biology classes because it enables students to work directly with biological specimens, supports deeper learning, and develops practical skills (Dvojmoč, Perez, & Rutland, 2024). Moreover, dissection offers a strong sensory experience that helps learners appreciate the complexity of living systems (De Villiers & Monk, 2005). Nevertheless, ethical and practical concerns have grown, and teachers increasingly express a demand for alternatives that are easier to implement and more aligned with animal welfare (Zemanova, 2022).

2.5. Digital and Virtual Alternatives

Digital resources, such as 3D models, computer simulations, and dissection videos, are widely promoted as substitutes for traditional dissection. These methods allow learners to explore anatomy without handling actual specimens, while also ensuring consistent instructional conditions (Oliveira, Wainman, Palombella, Rockarts, & Wojkowski, 2023; Ormandy et al., 2022). Research indicates that such approaches can achieve cognitive outcomes comparable to physical dissection, particularly in understanding anatomical structures (Lalley, Piotrowski, Battaglia, Brophy, & Chugh, 2010). However, their impact on affective learning outcomes is limited. Studies show that hands-on manipulation of biological material has a stronger influence on emotions and attitudes than virtual formats (Holstermann, Grube, & Bögeholz, 2009; Randler, 2012).

2.6. Research Gap

When assessing biology education, it is crucial to examine not only the effectiveness of teaching methods but also their emotional and ethical acceptability. The present study contributes by comparing physical and video dissections in terms of their influence on both cognitive and affective domains.

2.7. Research Questions and Research Design

Based on these considerations, the present study seeks to address the following research questions:

1. To what extent do physical and video-based insect dissections reduce students' fear and aversion toward insects?
2. How do these two instructional approaches influence students' willingness to protect insects?
3. Do physical and video-based dissections affect students' openness to entomophagy differently?
4. Are there differences in these effects between primary and secondary school students?

This study was designed as a quantitative experiment aimed at analyzing changes in students' attitudes toward insects following different educational interventions. Three groups were formed: the physical dissection group (E/P), the video dissection group (E/V), and the control group (C). Pre- and post-tests were administered to measure fear, willingness to protect insects, and openness to insect consumption. All interventions were implemented during a single 45-minute biology lesson and were delivered by the same qualified biology teacher to ensure methodological consistency.

3. MATERIALS AND METHODS

3.1. Working Group

The research was conducted in school settings, specifically in five sixth-grade classes at primary schools and four second-grade classes at secondary schools, during the 2024/2025 academic year. When selecting grades, we based our selection on educational standards in the Slovak Republic. Schools were deliberately selected from central and western Slovakia to ensure that the impact of the teaching intervention would not be limited to a specific locality, thus increasing the likelihood that the results would reflect diverse regions of the country.

A total of 169 students participated in the study. The sample size was determined based on the recommendations of Hadjichambis and Paraskeva-Hadjichambi (2020); Dhenge, Ghadge, Ahire, Gorantiwar, and Shinde (2022); Fink (1995) and Salkind (1997), who suggest that a sample of at least 118 participants is sufficient to identify statistically significant differences. The number of respondents in this study therefore substantially exceeds this threshold.

Three groups were formed for the purpose of the study: two experimental groups and one control group. The real dissection group performed a real dissection of a cockroach. The virtual dissection group watched a video of the dissection.

The control group did not experience any form of dissection. Instead, students in the control group attended a lesson in which a traditional lecture combined with image description was used (Table 1).

Participation in the study was voluntary and anonymous. Informed consent was obtained from the students' parents prior to the start of the study. Students also had the option to decline participation in the dissection without facing any negative consequences. The basic demographic variables collected were students' age and grade level.

Table 1. Characteristics of respondents.

Group	Number of pupils in 6th grade of elementary school	Number of students in the 2nd year of secondary school
Real dissection group	33	30
Virtual dissection group	27	26
Control group	27	26
Average age	11	16

3.2. Data Collection Tools

As a research tool, a questionnaire was used and distributed to respondents through the online application Google Forms. The questionnaire was administered twice once as a pre-test and again as a post-test.

Both tests contained 39 identical items focused on insect aversion, attitudes toward insects, and willingness to protect insects.

The questionnaire consisted of closed-ended questions using a 5-point Likert scale, where 1 represented strong disagreement and 5 represented strong agreement. It was divided into three main sections:

- Degree of aversion and fear toward insects (e.g., "I find insects unpleasant," "I am afraid when I see an insect").
- Attitudes toward insect conservation (e.g., "I think insects should be protected," "Insects are important for nature").
- Willingness to eat insects (e.g., "I would be willing to try insect-based food").

The questionnaire was inspired by similar instruments used in studies by Rozin, Haidt, McCauley, Dunlop, and Ashmore (1999). The reliability of the research instrument was determined using Cronbach's alpha, with an average value of 0.88 across all dimensions, indicating very high internal consistency. A similar procedure was employed by Santosa (1999). The questionnaire was also pilot-tested with 12 respondents, leading to minor adjustments in the wording of some items.

3.3. Experimental Process

All interventions were carried out by the same instructor, a qualified biology teacher with several years of teaching experience. She conducted the physical dissections, facilitated the virtual dissection sessions, and led the traditional lectures in the control group. To ensure consistency across all participating schools, she also coordinated the organization, timing, and structure of each lesson. Her involvement helped maintain methodological uniformity and minimized variability related to instructional delivery.

The educational activity took place during a single 45-minute lesson, and its content varied based on group assignment. Before the lesson, students completed the pre-test.

- Real dissection group conducted a real dissection of a Madagascar hissing cockroach (*Gromphadorhina portentosa*), purchased from pet stores. The cockroaches were euthanized shortly before the lesson using carbon dioxide (CO₂) and then preserved in ethanol. This species is not protected by law, and according to §22(5) of Slovak Act No. 39/2007 on veterinary care, invertebrates are not subject to regulations concerning humane euthanasia. Therefore, the dissection complied with all legal requirements.
- The dissection was conducted in pairs or small groups. Students had access to all necessary tools: dissection trays, scalpels, scissors, pins, and magnifying glasses. Before beginning, they received a worksheet with step-by-step instructions. In primary schools, the dissection was guided step-by-step by the instructor, while secondary school students worked more independently. The worksheet was based on the high school biology textbook *Biologie pro střední školy gymnazijního typu* by Jelínek and Zicháček (1996). During the dissection, students identified and labeled anatomical structures of the cockroach.
- Virtual dissection group watched a video of the cockroach dissection. The video, titled *BIO153 Madagascar Hissing Cockroach Dissection*, was in English with Slovak subtitles and is publicly available on YouTube (<https://www.youtube.com/watch?v=ovT-7dfrIc0>). To ensure comprehension, the video was paused and commented on at intervals. The aim was to convey the same content as the physical dissection but in virtual form.
- The control group participated in a traditional lesson covering insect internal and external anatomy, using lecture and image description methods.

At the end of each lesson, a reflection session was conducted during which students summarized what they had learned, discussed key takeaways, and asked clarifying questions. Afterwards, all groups completed the post-test.

Following the post-test, students had the opportunity to taste insects prepared as food. This option was taken up mainly by secondary school students, though in every class, at least one student tried the insects. The ratio of students who tasted the insects versus those who did not was recorded.

Since it was not feasible to offer this option to every student, the tasting was retained as a potential secondary influence on students who only observed others.

3.4. Data Analysis

The collected data were processed in Microsoft Excel and analyzed using the Statistica software (StatSoft, 2011). The Shapiro–Wilk test was used to assess data normality, which indicated that the data were not normally distributed. Consequently, the Kruskal–Wallis test was applied for statistical analysis.

3.5. Teaching Environment

The interventions took place in standard school classrooms during regular biology lessons. All sessions were led by the same experienced biology teacher, ensuring consistent instructional delivery, lesson structure, and timing across all participating schools.

4. RESULTS

The results obtained show a statistically significant difference between the pre- and post-test scores in both the Real dissection group, which conducted the dissection in person, and the Virtual dissection group, which participated via video ($p \leq 0.05$).

This indicates that both forms of dissection led to a statistically significant reduction in aversion and fear of insects compared to the control group. In contrast, the control group did not show a statistically significant difference ($p \geq 0.05$) (Figure 1).

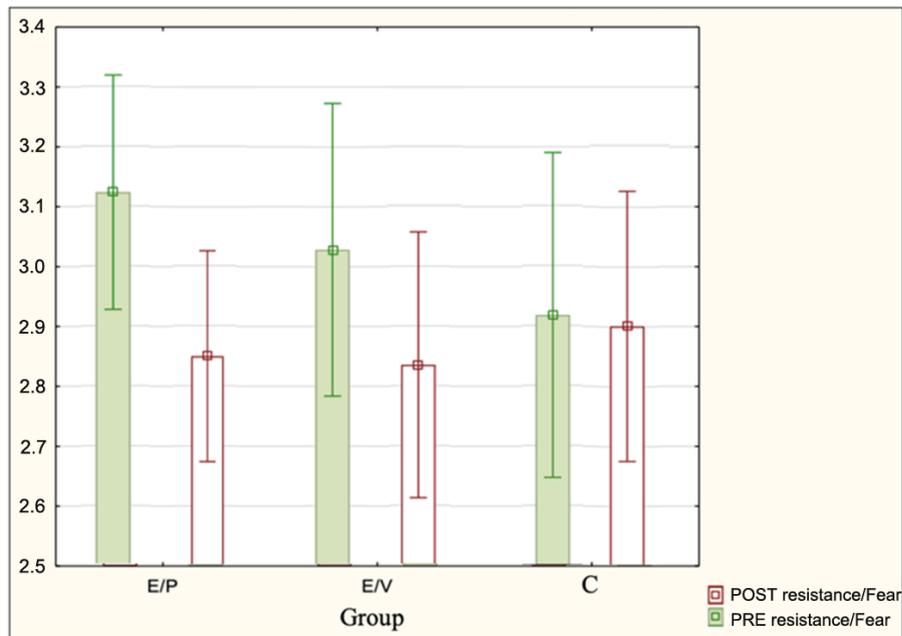


Figure 1. Level of aversion/fear toward insects before and after the intervention (in-person dissection E/P, video dissection E/V, control group- C).

We also examined whether the experimental interventions influenced students' interest in insect conservation. The results confirmed that the differences between groups were statistically significant ($p \leq 0.05$). The experimental group that performed the hands-on dissection (E/P) showed the highest level of interest in insect protection already before the intervention, and this interest slightly increased after the physical dissection. This suggests that direct practical experience with insects can foster a more positive attitude toward the conservation of animals, even those that are generally disliked, such as insects. In contrast, the video dissection group (E/V) and the control group (C) did not show a notable effect, and a slight decline in interest was observed in the post-test (Figure 2).

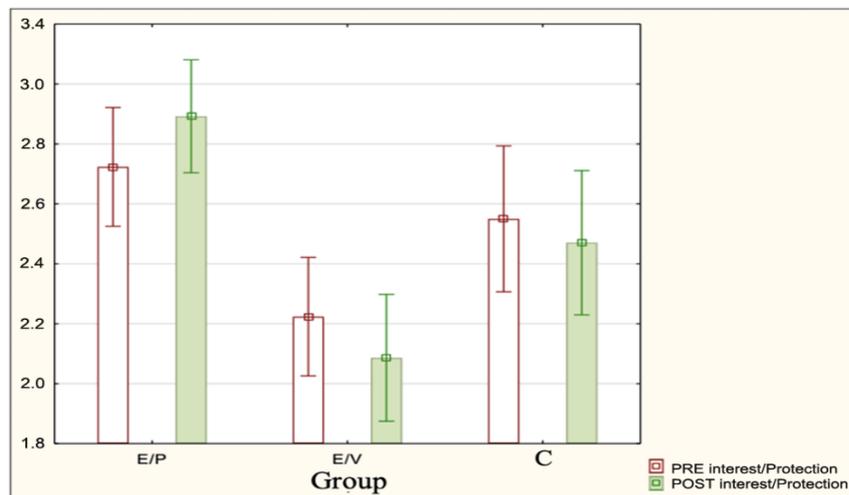


Figure 2. Level of interest in insects and willingness to protect them (in-person dissection E/P, video dissection E/V, control group- C).

We also compared students' attitudes toward insects between primary and secondary school students before and after the intervention. No statistically significant differences were found in the pre-test ($p = 0.2276$) or post-test ($p = 0.2856$). Similarly, differences in levels of aversion and fear toward insects between primary and secondary students were not statistically significant either before ($p = 0.491$) or after ($p = 0.959$) the intervention. However, when comparing the willingness to protect insects, we found that while there was no statistically significant difference before the intervention ($p = 0.163$), a statistically significant difference emerged after the intervention ($p = 0.033$).

Primary school students (PS) showed a higher interest in insect protection compared to secondary school students (SS), especially in the post-test (Figure 3).

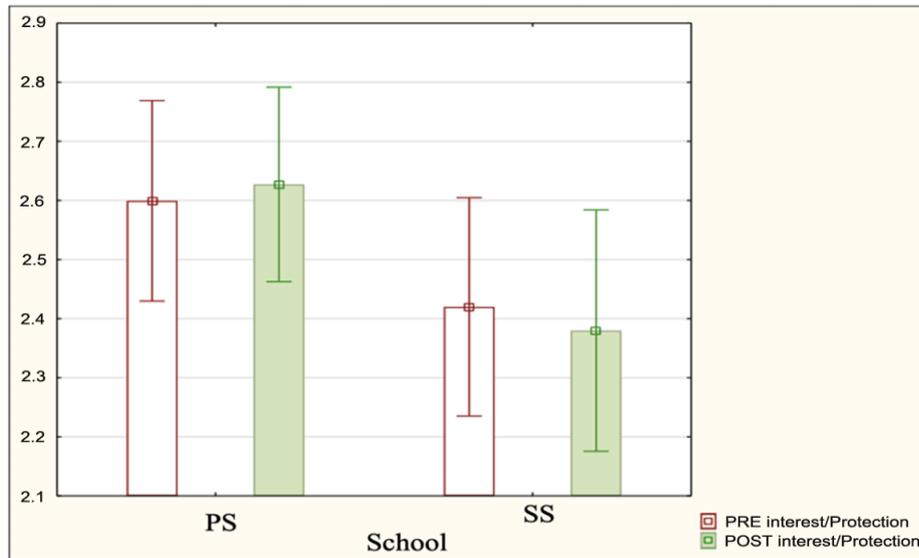


Figure 3. Comparison of interest in insects and willingness to protect them between primary (PS) and secondary (SS) school students before and after the intervention.

We also investigated whether the intervention, specifically physical or video insect dissection, had an effect on students' attitudes toward insect consumption. Before the intervention, no statistically significant differences were found between the groups ($p = 0.816$). However, after the intervention, a statistically significant difference was observed ($p = 0.033$).

Our analysis revealed that the most notable increase in positive attitudes toward insect consumption occurred in the group that conducted the physical (in-person) dissection. In this group, the post-intervention average score for willingness to consume insects was significantly higher ($p \leq 0.05$) compared to the group that watched the video dissection. No statistically significant change was found in the control group ($p \geq 0.05$) (Figure 4).

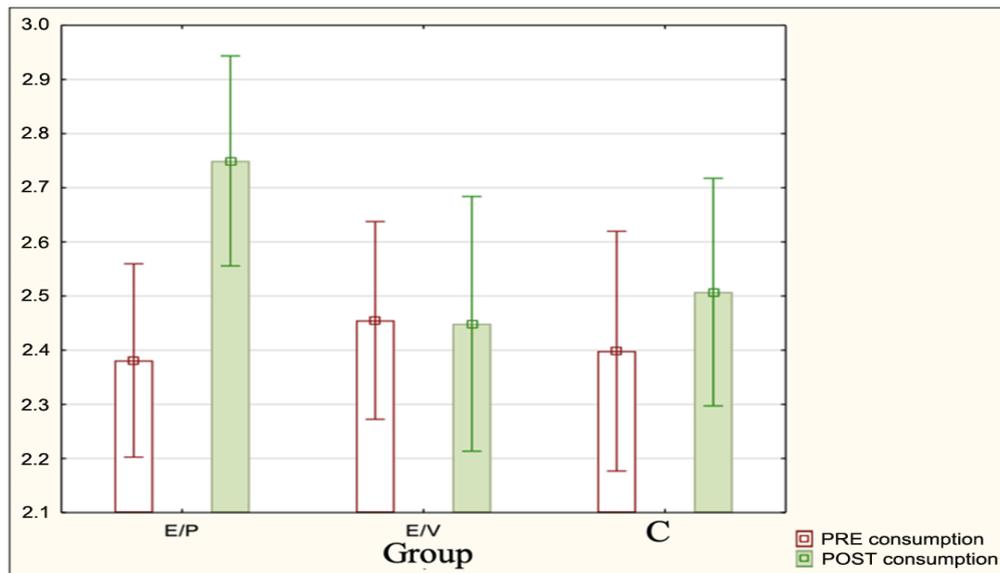


Figure 4. Attitudes toward insect consumption before and after the intervention (in-person dissection E/P, video dissection E/V, control group C).

When comparing attitudes toward insect consumption between primary and secondary school students before and after the intervention, no statistically significant differences were found, neither before the intervention ($p = 0.694$) nor after it ($p = 0.558$). This suggests that student age did not play a key role in shaping their attitudes toward eating insects.

5. DISCUSSION

Practical activities play an important role in shaping students' attitudes toward less popular animal groups such as insects. For example, the study by Miller, Beegle, Blevins Wycoff, and Frank (2025) showed that interactive school programs involving direct contact with live arthropods significantly reduced fear and increased children's interest in insects. Another study by Sammet and Dreesmann (2017) found that students who participated in hands-on activities with ants scored higher on knowledge tests and exhibited more positive attitudes toward these organisms compared to students who only received theoretical instruction.

Fančovičová and Prokop (2008) suggest that dissections in primary schools are rare, and their frequency in secondary schools is also low. They also state that virtual dissections are rarely used by Slovak teachers as an alternative to real dissections. Our research results confirm that entomological dissection, whether physical or through video, can significantly influence students' attitudes toward insects. A positive effect of in-person dissection on reducing aversion was demonstrated. These results suggest that changing emotionally conditioned attitudes toward animals, such as fear or disgust, likely requires positive experiences with insects in the educational process.

These findings align with the work of Kos, Jerman, and Torkar (2023), who also noted that direct contact with animals positively affects children's attitudes and supports recommendations that experiential learning with live animals should be an integral part of school curricula (Kos et al., 2023). Direct contact with living organisms, whether in the field or during lab activities, has proven effective in shaping more positive attitudes (Randler et al., 2013; Schlegel et al., 2015). Another study also showed that experiential education, such as interacting with spiders in class, leads to increased knowledge about these animals and improved attitudes toward them. Practical and extended educational activities are key to promoting nature conservation (Albo, Perfecto-Irigaray, Beobide, & Irabien, 2019).

Our results also showed that direct, hands-on dissection had a clear positive effect on students' willingness to protect insects. By contrast, in the group that only viewed the dissection video, interest slightly declined, though this change was not statistically significant, indicating that the virtual format lacks the same impact as in-person activities. In the control group, no meaningful differences were observed. These outcomes highlight the value of direct interaction with organisms as a way of fostering connections and encouraging supportive attitudes toward nature conservation, even when the organisms involved are generally considered unattractive, such as insects.

Comparable conclusions were reported by Havlíčková, Šorgo, and Bílek (2018), who studied Czech biology teachers' views on traditional versus virtual dissections. Their findings suggested that although digital dissections can be beneficial for cognitive learning outcomes, they fall short in shaping affective aspects, including interest and positive attitudes toward conservation.

When examining the role of school type, our analysis revealed no statistically significant differences between primary and secondary students. This indicates that the intervention was similarly effective across both educational levels, suggesting broad applicability of the approach. No statistically significant differences in fear or disgust toward insects were found between primary and secondary school students. This result suggests that the form of intervention (in-person or video-based) has a similar effect on reducing negative attitudes, regardless of age.

Our findings also support the conclusions of Shahriari-Namadi, Tabatabaei, and Soltani (2018), who investigated entomophobia and arachnophobia among primary and secondary school students in Iran. Their results showed no significant difference in levels of fear and disgust between these student groups. This suggests that age or school type does not play a crucial role in these attitudes.

Interesting differences emerged regarding interest in insect conservation. Although pre-intervention differences between primary and secondary students were not statistically significant, the post-intervention difference became significant. A possible explanation is that younger students may not yet have such deeply rooted negative attitudes as older students, and thus their attitudes are more flexibly shaped by experiential learning. Similar conclusions were also reached in the studies by Miller et al. (2025) and Shahriari-Namadi et al. (2018).

When examining students' attitudes toward insect consumption (entomophagy), no statistically significant differences were observed between the groups before the intervention. However, after the intervention, significant differences emerged. The group that experienced in-person dissection showed the largest increase in positive attitude. The video dissection group showed only a slight increase, and the control group showed no change. Regarding differences between primary and secondary students in their attitude toward insect consumption, there were no statistically significant differences either before or after the intervention. This suggests that age group did not play a key role in shaping attitudes toward entomophagy. This result partially aligns with findings from other studies focusing on the effect of educational interventions on attitudes toward insect-based foods.

For instance, a study conducted in Germany found that a short-term educational intervention significantly influenced adolescents' attitudes toward insects as food. After the intervention, a decrease in food neophobia and disgust toward insects was observed, along with a marked increase in willingness to consume insects (Szczepanski et al., 2022).

In our study, we did not examine the effect of gender, as this had been sufficiently explored in works such as Lock (1995) and Akpan and Andre (1999), which showed that women tend to have less supportive attitudes toward dissections.

6. CONCLUSION

6.1. Implications

The findings of this study confirm the importance of practical, experiential methods in education, particularly in shaping students' attitudes toward insects and strengthening their environmental awareness. Physical dissection was shown to substantially reduce fear and aversion while increasing students' willingness to protect insects, which may positively influence their future pro-environmental behavior. By contrast, the video-based dissection, although effective in transmitting knowledge, did not produce the same level of attitudinal change. This suggests that passive instructional formats such as videos or digital simulations may be less powerful than hands-on experiences in fostering affective engagement with living organisms.

6.2. Limitations

Several limitations should be acknowledged. First, the study sample was not fully representative; participants were drawn from accessible schools rather than selected randomly, which restricts the generalizability of the results. Second, the effects observed were measured only in the short term, immediately following the intervention, without assessing longer-term changes in attitudes. Finally, variation across teaching environments and instructors could have influenced the outcomes, despite efforts to ensure consistency in lesson delivery.

6.3. Future Research

Future studies should address these limitations by employing more representative samples and longitudinal designs to explore how attitudes evolve over time. It would also be valuable to investigate the role of initial levels of insect aversion and fear in shaping intervention outcomes. Moreover, further comparisons between different experiential and digital methods could provide deeper insights into how best to combine these approaches to maximize both cognitive and affective learning gains.

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Institutional Review Board Statement: This research was reviewed and declared exempt by the Ethics and Integrity Committee of the Faculty of Education at Trnava University in Trnava, Slovakia, on September 11, 2025 (Decision No. KEIV 07/2025). The exemption was granted within the category for pedagogical research involving minimal risk and the use of anonymous data.

Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

Competing Interests: The authors declare that they have no competing interests.

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Disclosure of AI Use: The authors used OpenAI's ChatGPT (GPT-5) to assist with text refinement, stylistic editing, and translation into English. All generated content was carefully reviewed, verified, and revised by the authors before inclusion in the manuscript.

REFERENCES

- Akpan, J. P., & Andre, T. (1999). The effect of a prior dissection simulation on middle school students' dissection performance and understanding of the anatomy and morphology of the frog. *Journal of Science Education and Technology*, 8(2), 107-121. <https://doi.org/10.1023/A:1018604932197>
- Albo, J., Perfecto-Irigaray, M., Beobide, G., & Irabien, A. (2019). Cu/Bi metal-organic framework-based systems for an enhanced electrochemical transformation of CO₂ to alcohols. *Journal of CO₂ Utilization*, 33, 157-165. <https://doi.org/10.1016/j.jcou.2019.05.025>
- Bixler, R. D., & Floyd, M. F. (1999). Hands on or hands off? Disgust sensitivity and preference for environmental education activities. *The Journal of Environmental Education*, 30(3), 4-11. <https://doi.org/10.1080/00958969909601871>
- Borgi, M. (2015). Children's perceptions of rainforest biodiversity: Which animals have the lion's share of environmental awareness? *PLoS One*, 10(10), e0130032.
- Brenna, C. T. A. (2021). Post-mortem pedagogy: A brief history of the practice of anatomical dissection. *Rambam Maimonides Medical Journal*, 12(1), e0008. <https://doi.org/10.5041/RMMJ.10423>
- Curtis, V., Aunger, R., & Rabie, T. (2004). Evidence that disgust evolved to protect from risk of disease. *Proceedings of the Royal Society of London. Series B: Biological Sciences*, 271(suppl_4), S131-S133. <https://doi.org/10.1098/rsbl.2003.0144>
- De Villiers, R., & Monk, M. (2005). The first cut is the deepest: Reflections on the state of animal dissection in biology education. *Journal of Curriculum Studies*, 37(5), 583-600. <https://doi.org/10.1080/00220270500041523>
- Dhenge, S. A., Ghadge, S. N., Ahire, M. C., Gorantiwar, S. D., & Shinde, M. G. (2022). Gender attitude towards environmental protection: A comparative survey during COVID-19 lockdown situation. *Environment, Development and Sustainability*, 24(12), 13841-13886. <https://doi.org/10.1007/s10668-021-02015-6>
- Dvojmoč, A., Perez, W., & Rutland, C. S. (2024). Dissecting the need for dissection in veterinary and medical training. *Journal of Veterinary Medical Education*, 61(4), 512-520.
- Fančovičová, J., & Prokop, P. (2008). Students' attitudes toward computer use in Slovakia. *Eurasia Journal of Mathematics, Science and Technology Education*, 4(3), 255-262. <https://doi.org/10.12973/ejmste/75347>
- Fink, A. (1995). The survey handbook. In (pp. 129). Thousand Oaks, CA: Sage Publications
- Florenca, S. G., Guine, R. P. F., Goncalves, F. J. A., Barroca, M. J., Ferreira, M., Costa, C. A., . . . Cunha, L. M. (2022). The motivations for consumption of edible insects: A systematic review. *Foods*, 11(22), 3643. <https://doi.org/10.3390/foods11223643>
- Hadjichambis, C. A., & Paraskeva-Hadjichambi, D. (2020). Environmental citizenship questionnaire (ECQ): The development and validation of an evaluation instrument for secondary school students. *Sustainability*, 12(3), 821. <https://doi.org/10.3390/su12030821>
- Havlíčková, V., Šorgo, A., & Bílek, M. (2018). Can virtual dissection replace traditional hands-on dissection in school biology laboratory work? *Eurasia Journal of Mathematics, Science and Technology Education*, 14(4), 1415-1429. <https://doi.org/10.29333/ejmste/83679>

- Holstermann, N., Grube, D., & Bögeholz, S. (2009). The influence of emotion on students' performance in dissection exercises. *Journal of Biological Education*, 43(4), 164-168. <https://doi.org/10.1080/00219266.2009.9656177>
- Janoušková, S., Žák, V., & Rusek, M. (2019). The concept of scientific literacy in the Czech Republic: Analysis and comparison. *Studia Paedagogica*, 24(3), 93-109. <https://doi.org/10.5817/SP2019-3-4>
- Jelínek, J., & Zicháček, V. (1996). *Biology for grammar school type secondary schools*. Olomouc: Czech Republic: FIN Publishing.
- Jongema, Y. (2017). *World list of edible insects*. Wageningen, The Netherlands: Wageningen University & Research, Laboratory of Entomology.
- Kos, M., Jerman, J., & Torkar, G. (2023). Preschool children's attitude toward some unpopular animals and formation of a positive attitude toward them through hands-on activities. *Journal of Biological Education*, 57(1), 83-100. <https://doi.org/10.1080/00219266.2021.1877779>
- Lalley, J. P., Piotrowski, P. S., Battaglia, B., Brophy, K., & Chugh, K. (2010). A comparison of V-Frog© to physical frog dissection. *International Journal of Environmental and Science Education*, 5(2), 189-200.
- Lock, R. (1995). GCSE students' attitudes to dissection and using animals in research and product testing. *School Science Review*, 77(279), 15-21.
- Lorenz, A. R., Libarkin, J. C., & Ording, G. J. (2014). Disgust in response to some arthropods aligns with disgust provoked by pathogens. *Global Ecology and Conservation*, 2, 248-254. <https://doi.org/10.1016/j.gecco.2014.09.012>
- Miller, K. M., Beegle, D. K., Blevins Wycoff, S., & Frank, D. L. (2025). Transforming children's attitudes toward insects through in-school encounters. *Insects*, 16(1), 93. <https://doi.org/10.3390/insects16010093>
- Oliveira, A., Wainman, B., Palombella, A., Rockarts, J., & Wojkowski, S. (2023). Piloting an interprofessional virtual cadaveric dissection course: Responding to COVID-19. *Anatomical Sciences Education*, 16(3), 465-472. <https://doi.org/10.1002/ase.2275>
- Ormandy, E., Schwab, J. C., Suiter, S., Green, N., Oakley, J., Osenkowski, P., & Sumner, C. (2022). Animal dissection vs. non-animal teaching methods: A systematic review of pedagogical value. *The American Biology Teacher*, 84(7), 399-404. <https://doi.org/10.1525/abt.2022.84.7.399>
- Prokop, P., Usak, M., & Fančovičová, J. (2010). Health and the avoidance of macroparasites: A preliminary cross-cultural study. *Journal of Ethology*, 28(2), 345-351. <https://doi.org/10.1007/s10164-009-0195-3>
- Randler, C. (2012). A possible phylogenetically conserved urgency response of great tits (*Parus major*) towards allopatric mobbing calls. *Behavioral Ecology and Sociobiology*, 66, 675-681. <https://doi.org/10.1007/s00265-011-1315-y>
- Randler, C., Hummel, E., & Wüst-Ackermann, P. (2013). The influence of perceived disgust on students' motivation and achievement. *International Journal of Science Education*, 35(17), 2839-2856. <https://doi.org/10.1080/09500693.2012.654518>
- Ros-Baró, M., Sánchez-Socarrás, V., Santos-Pagès, M., Bach-Faig, A., & Aguilar-Martínez, A. (2022). Consumers' acceptability and perception of edible insects as an emerging protein source. *International Journal of Environmental Research and Public Health*, 19(23), 15756. <https://doi.org/10.3390/ijerph192315756>
- Rozin, P., Haidt, J., McCauley, C., Dunlop, L., & Ashmore, M. (1999). Individual differences in disgust sensitivity: Comparisons and evaluations of paper-and-pencil versus behavioral measures. *Journal of Research in Personality*, 33(3), 330-351. <https://doi.org/10.1006/jrpe.1999.2251>
- Salkind, N. J. (1997). *Exploring research* (3rd ed.). Upper Saddle River, NJ: Prentice Hall.
- Sammet, R., & Dreesmann, D. (2017). What do secondary students really learn during investigations with living animals? Parameters for effective learning with social insects. *Journal of Biological Education*, 51(1), 26-43. <https://doi.org/10.1080/00219266.2016.1150873>
- Santosa, J. R. A. (1999). Cronbach's alpha: A tool for assessing the reliability of scales. *Journal of Extension*, 37(2), 15.
- Schlegel, J., Breuer, G., & Rupf, R. (2015). Local insects as flagship species to promote nature conservation? A survey among primary school children on their attitudes toward invertebrates. *Anthrozoös*, 28(2), 229-245. <https://doi.org/10.1080/08927936.2015.11435399>

- Shahriari-Namadi, M., Tabatabaei, H. R., & Soltani, A. (2018). Entomophobia and arachnophobia among school-age children: A psychological approach. *Shiraz E-Medical Journal*, 19(7), e64824. <https://doi.org/10.5812/semj.64824>
- Sieg, A.-K., & Dreesmann, D. (2021). Promoting pro-environmental behavior in school. Factors leading to eco-friendly student action. *Sustainability*, 13(12), 6598. <https://doi.org/10.3390/su13126598>
- StatSoft, I. (2011). *STATISTICA (data analysis software system), version 10*. Tulsa, OK: StatSoft, Inc.
- Sultana, Q., Jain, R., Shariff, M. H., Quadras, P. R., & Ramos, A. (2022). The impact of simulation-based teaching module involving virtual dissection on anatomy curriculum delivery. *International Journal of Anatomy and Research*, 10(4), 8476-8481. <https://doi.org/10.16965/ijar.2022.219>
- Szczepanski, L., Dupont, J., Schade, F., Hellberg, H., Büscher, M., & Fiebelkorn, F. (2022). Effectiveness of a teaching unit on the willingness to consume insect-based food—An intervention study with adolescents from Germany. *Frontiers in Nutrition*, 9, 889805. <https://doi.org/10.3389/fnut.2022.889805>
- Tolve, R., Zanoni, M., Sportiello, L., Musollini, S., Tchuenbou-Magaia, F. L., & Favati, F. (2025). From fear to fork—exploring food neophobia and the inclination towards entomophagy in Italy. *International Journal of Food Science and Technology*, 60(1), vvae047. <https://doi.org/10.1093/ijfood/vvae047>
- Wagler, R., & Wagler, A. (2011). Arthropods: Attitude and incorporation in preservice elementary teachers. *International Journal of Environmental and Science Education*, 6(3), 229-250.
- Zemanova, M. A. (2022). Attitudes toward animal dissection and animal-free alternatives among high school biology teachers in Switzerland. *Frontiers in Education*, 7, 892713. <https://doi.org/10.3389/feduc.2022.892713>

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