

Shaping Future Educators: The Role of Invertebrate Dissections, Handling, and Consumption in Influencing Biology Teachers' Attitudes

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ABSTRACT

This study examines the pedagogical impact of dissection, handling, and consumption of invertebrates on the attitudes of prospective biology teachers toward these organisms. The research aimed to evaluate how experiential teaching methods influence emotional responses, willingness to protect, and openness to consuming invertebrates. The research sample consisted of 40 third-year female students enrolled in a biology teacher education program at a Slovak pedagogical university. Over one semester, participants completed six dissections and participated in four tastings of edible invertebrates. Data were collected using a standardized 52-item questionnaire administered before and after the intervention. The Wilcoxon matched-pairs test was employed for statistical analysis. The results revealed that dissection alone did not significantly influence students' attitudes toward invertebrate conservation; however, a statistically significant decrease in aversion was observed, particularly among participants who had initially expressed low willingness to consume these organisms. Overall openness to consumption increased markedly, and a relationship was identified between prior openness and a subsequently stronger conservation attitude. These findings suggest that practical engagement with biological material, particularly when combined with unconventional approaches such as consumption, may reduce affective barriers and foster a more positive perception of invertebrates. From an educational perspective, such experiential approaches may enhance the professional confidence of future biology teachers when working with these organisms and simultaneously contribute to the development of ethically grounded and sensitive biodiversity education. Further research is recommended on a more diverse sample, incorporating qualitative methods to gain deeper insight into students' subjective experiences.

Keywords: Invertebrate Dissection, Biology Education, Student Attitudes, Experiential Learning

INTRODUCTION

The study of invertebrates within biological education plays a pivotal role in shaping students' perceptions of biodiversity, ethical considerations in animal sciences, and their overall attitude towards biology. Dissection, handling, and consumption of invertebrates may represent primary modes of student interaction with these organisms in educational settings. According to Tolve et al. (2025), food neophobia negatively affects the willingness to consume insects. Younger, more educated men were more open to entomophagy, particularly in the form of cricket flour added to traditional foods. Previous experience with insect-based products reduced aversion and increased acceptance. Studies also show that even short-term practical activities, such as insect rearing or dissection, can reduce resistance and increase students' willingness to engage in insect conservation (Sieg & Dreesmann, 2021). Miller et al. (2025) demonstrated 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 achieved higher scores in knowledge tests and expressed a more positive attitude toward these organisms compared to students who only received theoretical instruction.

While dissection has traditionally been employed as an essential didactic tool for enhancing anatomical knowledge, its ethical implications and impact on students' emotional responses have sparked increasing debate (Ammanna, 2018). Teachers are increasingly expressing the need for alternatives that respect animal rights and are easier to implement (Zemanová, 2022). One promising alternative is the use of digital tools such as 3D models, computer simulations, or dissection videos. These methods allow students to explore anatomy without handling real organisms while also providing standardized learning conditions (Ormandy et al., 2022; Oliveira et al., 2023). Research suggests that virtual methods can be as effective as traditional dissections in terms of cognitive outcomes, such as understanding anatomical structures (Lalley et al., 2009; DeHoff et al., 2011). Havlíčková et al. (2018) analyzed the attitudes of Czech biology teachers toward traditional and virtual dissections. They found that although virtual dissections may be effective for cognitive outcomes, they do not achieve the same impact on the affective dimensions of learning, such as interest and a positive attitude toward nature conservation. Other authors have also pointed to the more positive influence of real dissections compared to virtual ones (Randler, 2012; Holstermann et al., 2009).

Despite substantial scientific evidence affirming that dissections provide invaluable educational experiences, it is crucial to approach this practice with utmost sensitivity. Many students may hold fundamental ethical objections or experience physical discomfort related to dissections and should not be compelled to participate against their will. Recognizing individual preferences and offering alternative educational methodologies for those who refuse to engage in dissections is essential (Armocida, 1991). Similarly, the handling of live invertebrates, such as insects and mollusks, can elicit a broad spectrum of reactions, ranging from curiosity to aversion (Randler et al., 2012). Research has consistently shown that women exhibit significantly higher levels of aversion and fear toward invertebrates compared to men, which may be attributed to evolutionary, social, or individual factors (Azil et al., 2021; Staňková et al., 2021). In our study, female pre-service biology teachers also exhibited initially high levels of aversion toward invertebrates; however, participation in the intervention led to a statistically significant decrease in aversion, particularly among those who had expressed low initial willingness to consume these organisms.

Given these differences in the perception of invertebrates, their consumption, which is increasingly discussed in the context of sustainability, may serve as an effective tool in overcoming such aversions. Educational approaches aimed at integrating edible insects into the curriculum can not only influence young people's attitudes toward alternative food sources but also encourage their acceptance as part of a broader sustainability strategy (Jones & Beynon, 2020). Previous studies have reported mixed outcomes of practical engagement with invertebrates: while some have highlighted cognitive and affective benefits, such as increased appreciation for biological sciences through dissection and handling (Prokop & Fančovičová, 2017), others have pointed to emotional discomfort and ethical concerns that may discourage

further participation in biological disciplines (Balcombe, 2000). Our results reflect this duality: dissections alone did not significantly alter conservation attitudes, yet they reduced aversion, particularly among participants with initially low willingness to consume invertebrates, and increased openness to consumption, which in turn was associated with stronger conservation attitudes. These findings underscore the persistent challenge of balancing educational benefits with affective and ethical considerations, and suggest that combining dissection with other experiential methods, such as handling and consumption, may offer a more effective strategy for overcoming negative perceptions of invertebrates. Education plays a crucial role in this context (Meehan, 1995), as an advanced understanding of invertebrate biology and behavior can contribute to their greater societal acceptance and foster a more responsible approach to their conservation, regardless of students' individual philosophical or ethical beliefs. Additionally, cultural and psychological factors influencing students' willingness to consume invertebrates remain underexplored in pedagogical research (Mather, 2011). By synthesizing perspectives from education, psychology, and environmental sciences, this study provides evidence-based recommendations for optimizing educational strategies that foster positive learning experiences, ethical awareness, and long-term engagement with biodiversity conservation.

METHODS OF RESEARCH

The research sample consisted of 40 female undergraduate students in their third year of a biology teacher education program in Slovakia. Demographically, all participants identified as female, with an average age of 23 years. The sample was selected intentionally, as previous studies have consistently shown a significantly higher prevalence of negative emotional responses to invertebrates among women (Azil et al., 2021; Staňková et al., 2021). The aim was to examine the attitudes of future female biology teachers toward invertebrates and identify potential barriers related to their integration into biology education.

To assess levels of fear and disgust toward invertebrates, a 52-item questionnaire was administered. The instrument included closed-ended questions using a Likert scale, allowing for precise measurement of individual attitudes. The questionnaire was adapted from existing validated tools to reflect the specific domains under investigation, namely, conservation attitudes, aversion, and willingness to consume invertebrates (Herzog et al., 1991; Prokop et al., 2008). Participants completed the questionnaire twice, once at the beginning and once at the end of the semester. During the semester, they engaged in six dissection sessions and four tastings of edible invertebrates. This design enabled the monitoring of attitudinal changes over time and allowed for the evaluation of the impact of practical experiences on participants' perceptions of invertebrates.

Following data collection, statistical analysis was conducted using Statistica software. The normality of data distribution was assessed using the Shapiro–Wilk test, which confirmed that the dataset did not follow a normal distribution. Prior to analysis, responses to negatively worded items were reverse-coded. For statistical evaluation of differences, the Wilcoxon Matched Pairs Test was employed. Subsequently, a comprehensive statistical analysis was performed, including the calculation of mean scores for each of the targeted dimensions and the assessment of interrelationships among them.

RESULTS AND DISCUSSION

Statistical analysis of the pre-test and post-test data indicated that the implementation of invertebrate dissections did not significantly affect participants' attitudes toward the conservation of invertebrates ($p \geq 0.05$). Furthermore, no relationship was found between conservation attitudes and changes in aversion toward invertebrates ($p \geq 0.05$). Some studies show that even short-term hands-on activities, such as insect breeding or dissection, can reduce resistance and increase students' willingness to engage in insect conservation (Sieg & Dreesmann, 2021; Wagler & Wagler, 2011). Our data, therefore, did not support earlier claims that such short-term activities directly increase willingness to protect invertebrates. However, we identified an indirect relationship: participants who reported higher willingness to consume invertebrates prior to the intervention subsequently demonstrated stronger conservation attitudes after the course ($p \leq 0.01$). This suggests that openness to unconventional forms of interaction with invertebrates may be linked to a greater readiness to support their protection. In the domain of aversion, no association was observed between the level of disgust and the subsequent willingness to protect invertebrates ($p \geq 0.05$). Nonetheless, following participation in the course involving practical dissections, a reduction in aversion toward invertebrates was detected among students, reaching the threshold of statistical significance ($p \leq 0.05$). No correlation was found between the initial level of disgust and the subsequent willingness to consume invertebrates ($p \geq 0.05$). Conversely, in the domain of willingness to consume invertebrates, a statistically significant positive association was confirmed with conservation attitudes after dissection ($p \leq 0.01$). Specifically, students who reported a higher willingness to consume invertebrates prior to the intervention subsequently exhibited stronger conservation attitudes. Moreover, a statistically significant reduction in aversion was observed, particularly among participants who had initially demonstrated low willingness to consume invertebrates ($p \leq 0.01$). Similar results were also found by Szczepanski et al. (2022), who observed that after eating insects, there was a decrease in food neophobia and aversion to insects, along with a significant increase in willingness to eat insects. Similar conclusions were also reached by studies by Miller et al. (2025) and Shahriari-Namadi et al. (2018), where, when examining students' attitudes towards eating insects (entomophagy) before the intervention, no statistically significant differences were noted between groups. However, significant differences emerged after the intervention. The group that underwent a personal autopsy showed the greatest increase in positive attitudes.

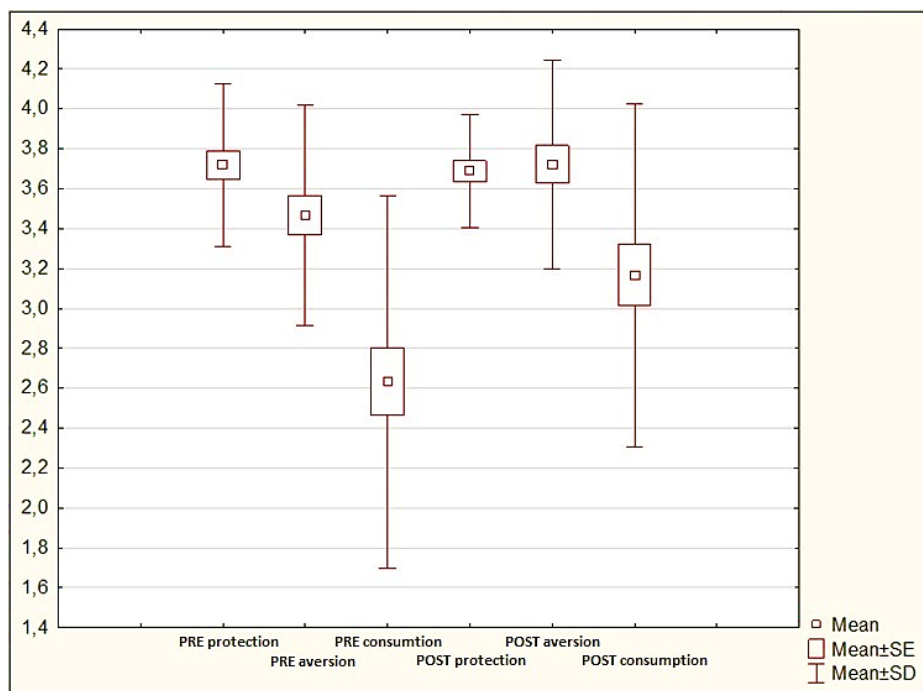


Figure 1 Pre-Test and Post-Test Analysis

Our findings further confirm that the dissection of invertebrates had a positive effect on participants' openness to consuming these organisms ($p \leq 0.05$) (Figure 1). Our findings revealed a moderate yet statistically significant decrease in aversion toward invertebrates following the dissection sessions. This effect was more pronounced among participants who initially exhibited lower willingness to consume invertebrates. A similar trend was observed in the study by Wüst-Ackermann et al. (2018), who demonstrated that repeated exposure to live or dead invertebrates in educational settings can lead to reduced disgust and enhanced intrinsic motivation. This effect may be understood as a process of adaptation to direct contact with invertebrates and as a form of experiential learning that helps to overcome affective barriers. Comparable findings were reported by Kaiser et al. (2023), who emphasized that direct interaction with real animals, even when initially accompanied by feelings of disgust, can in some cases transform emotional responses and lead to increased intrinsic motivation to learn, ultimately fostering a more positive relationship with the subject matter. Their research further supports the claim that experiential learning holds significant potential for reducing aversion, lowering emotional resistance, and increasing interest in science education.

An additional noteworthy finding is the positive association between willingness to consume invertebrates and attitudes toward their protection. Respondents who expressed a higher level of acceptance toward invertebrate consumption before the dissection also demonstrated stronger conservation attitudes following the intervention. This outcome may be interpreted as evidence that practical experiences and openness to unconventional forms of biological interaction foster a deeper appreciation of these organisms' ecological roles. Similar conclusions were drawn by Knutsson (2015), who advocated for the inclusion of invertebrates in the ethical discourse of biology education. Similarly, a study by Bukchin-Peles

et al. (2024) showed that individuals with higher levels of cognitive, goal-oriented hope experienced more positive changes in attitudes toward entomophagy after receiving information about it. This effect suggests that psychological factors, such as motivation to achieve sustainable goals, may enhance the impact of educational interventions on the acceptance of insects in the diet. The authors recommend that these interventions aim to strengthen environmental motivation and awareness of the benefits of entomophagy. Furthermore, according to Tolve et al. (2025), previous experience with insect-based products reduced aversion and increased their acceptance. In line with our findings, the study by Stone et al. (2023) also highlights the effectiveness of targeted educational interventions in increasing the acceptance of entomophagy. In two preregistered experiments, the authors asked participants to briefly explore and write an essay on the value of insect-based foods in terms of health and sustainability. This “utility-value” intervention significantly increased the willingness to try insect-based foods and improved their evaluation in terms of curiosity, perceived taste, healthiness, and sustainability compared to the control group, with the effect persisting even after one month. The authors recommend similar educational approaches as a practical way to reduce aversion and promote positive attitudes toward entomophagy. This positive link between openness to consumption and strengthened conservation attitudes is further supported by Looy & Wood (2006), who showed that educational experiences involving insect consumption not only reduce aversion but also enhance understanding of their ecological value and the need for their protection. In such contexts, consumption becomes an experiential tool that can promote positive attitudes toward organisms often marginalized in biological and ethical discussions.

The composition of the research sample, female pre-service biology teachers, also allows the findings to be interpreted in terms of professional attitudes toward the use of living organisms in teaching. Tomažic et al. (2017) noted that future educators often report higher aversion to working with animals, especially invertebrates, which subsequently influences their willingness to incorporate them into classroom practice. Our results suggest that well-designed practical experiences, such as dissection combined with handling live invertebrates and their consumption, can help reevaluate such attitudes and may have a positive impact on the future quality of science education. It is equally important to cultivate responsible and respectful approaches when working with live organisms and biological material, with emphasis placed on using ethically sourced specimens, such as by-products from the food industry or animals that died of natural causes. As Pedersen (2002) argues, sensitive guidance and the use of humane approaches and alternatives are key to fostering positive attitudes toward living organisms. Therefore, future research should address not only cognitive but also ethical and emotional aspects of educational interventions.

Based on the outcomes of this study, we recommend that future research include male participants to enable gender-based comparisons of attitudes toward invertebrates. Moreover, it would be beneficial to broaden the sample to include students from different universities and study years to improve the generalizability of the findings. Complementing the research with qualitative methods, such as interviews, would also allow for a deeper understanding of students' experiences and emotional engagement. Finally, future studies should consider monitoring the long-term effects of such educational interventions, for instance, several

months after the course has concluded. It would also be valuable to examine the impact of different forms of exposure to invertebrates, whether live organisms, dead specimens, visual, or tactile contact, on students' attitudinal change.

CONCLUSION

This study examined the impact of invertebrate dissections, handling, and consumption on the attitudes of pre-service biology teachers. The findings show that while dissections alone did not significantly change conservation attitudes, they reduced aversion, particularly among participants with initially low willingness to consume invertebrates, and increased openness to consumption, which was positively associated with stronger conservation attitudes. These results suggest that combining dissections with additional experiential approaches, such as live handling and consumption, can address both cognitive and affective learning goals, helping to overcome emotional and ethical barriers that often limit the inclusion of invertebrates in biology education. From a pedagogical perspective, such strategies may strengthen future teachers' confidence and willingness to work with these organisms, ultimately contributing to biodiversity conservation education. The implications of this study are twofold: first, experiential multi-method interventions can be a practical solution for reducing aversion toward invertebrates; second, integrating ethically sourced specimens and diverse teaching methods can balance learning effectiveness with ethical sensitivity. Nevertheless, the study's limitations, its all-female, single-program sample, and short-term scope, should be addressed in future research. Broader and more diverse samples, longitudinal designs, and qualitative methods are recommended to capture the long-term and nuanced effects of such interventions. These steps will help refine evidence-based strategies for fostering positive, informed, and ethically grounded attitudes toward invertebrates in future educators.

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