Teaching With Live Insects

Overcome student and teacher discomfort with this series of lessons—touching optional!

By Nicole Fisher and Amanda Lorenz-Reaves

Insects are fascinating creatures. They are the most abundant and diverse group of animals on Earth, with over a million described species and an estimated total of up to 30 million species (Entomological Society of America 2010). They exhibit diverse morphological characteristics and display unique behaviors and life cycles. Insects are extremely important for maintaining the natural environment, performing such essential ecosystem services as decomposition, dung burial, and soil aeration, as well as providing food for other wildlife. Insects are also important for human interests such as crop pollination. Though the advantages of using insects as teaching tools are well-recognized (Matthews, Flage, and Matthews 1997; University of Arizona 1997), insects are under-utilized for instruction in K–12 classrooms.

In this article, we present an example of a *Next Generation Science Standards*–aligned unit that promotes hands-on experience with the insect world. We worked with three 3/4 split Montessori type classrooms. To help minimize student discomfort, none of the lesson plans outlined here requires students to physically touch or handle the insects, though they are certainly encouraged to do so. In addition, all of the insects we suggest here are nonbiting, nonflying, and docile. One of the challenges that persists in insect education is overcoming initial negative attitudes. Negative attitudes toward insects are common and widespread and can contribute to students' general discomfort in nature (Bixler et al. 1994). Providing opportunities for positive experiences may help mediate these negative responses.

An important component of teaching is building a sense of community in the classroom. Toward this end, keeping live pets in the classroom helps encourage positive social interaction, connect lessons to the real world, and facilitate development of important social skills such as empathy and language (Meadan and Jegatheesan 2010; Daly and Suggs 2010). Unlike traditional mammalian classroom pets, insects are relatively inexpensive, low maintenance, and can be used to teach many Standards (NGSS Lead States 2013). Despite these advantages, insects are rarely considered as educational pets, with the exception of butterflies and mealworms. With instruction and positive experiences, children are given the opportunity to overcome pre-existing negative perceptions of insects. Our hope is that use of the following lessons will help lead to wider appreciation and valuation of insects.

Insect Selection

We began by brainstorming insects that are safe, hardy enough to survive repeated handling by children, and easy to obtain and maintain (Wagler 2018). The insects we chose were the mature blue death-feigning beetle (*Asbolus verrucosus*), Madagascar hissing cockroach (*Gromphadorhina portentosa*), and darkling beetle (*Zophobas morio*) in its larval stage. Table 1 provides an overview of these insects and their care requirements.

The insects suggested here all have lifespans lasting more than six months; therefore, they are appropriate as long-term pets in the classroom. If the insects are no longer wanted, they should be donated to a local insectarium, zoo, or other appropriate institution. They may also be sent home with students as pets. Please note that a USDA permit is required for domestic transport of the blue death-feigning beetles. If there is no other alternative, all of these insects may be humanely euthanized in the freezer. Deceased insects may also be preserved by freezing before mounting for display.

While the death-feigning beetles have an intimidating name, they are particularly well-suited for classrooms due to their easy care and their inability to bite or fly. The name references the beetle's defense mechanism of playing dead when threatened, which makes them particularly interesting to children. Blue beetles can be ordered online from multiple sources, such as the Bugs in Cyberspace website (see Internet Resources).

The Madagascar hissing cockroach has an interesting defense behavior of hissing when it perceives a threat—forcibly expelling air through their spiracles (breathing holes). These cockroaches are well-suited for classrooms due to their minimal habitat requirements and docile temperament. They are easily obtained at many pet stores or from online retailers. Since hissing cockroaches are sexually dimorphic (males and females look different from each other), we included two males and two females in each classroom. Note that keeping both sexes in the same enclosure will result in reproduction, necessitating the separation of males and females.

A species of darkling beetle (*Zophobas morio*) in its larval stage, known as the "superworm," was chosen to provide an example of an immature insect life stage. Superworms are inexpensive and easy to obtain at many pet stores or online sources such as Carolina Biological Supply Company (see Internet Resources). They can also be reared to their adult stage in the classroom. We recommend superworms rather than mealworms (*Tenebrio molitor*) because the larger size of the superworm makes observation easy and fun. The superworm does not have wings (as with all immature insects), and its six legs are tiny. Because of this, the superworm looks similar to a caterpillar, which provides for a comparison of insect life cycle characteristics.

Despite the benefits of using live insects, we recognize that some teachers may not be comfortable or permitted to host insects in their classrooms. For this reason, it would also be possible to complete a modified version of this unit using videos of insects instead of live insects (see Internet Resources). Students observing videos of live insects are able to engage in all of the core lesson activities and are still able to meet the learning objectives of each lesson.

Wonder, Explore, Learn

Parts of the Insect Body

To introduce the insect unit, we asked students to share what they knew about insect biology, behavior, and habitat, which we recorded on the board. Most students contributed stories about insects such as butterflies, ants, bees, and so on, as well as insect-like creatures such as spiders and centipedes. In general, students were curious to learn about insects.

Next, we allowed students time to explore and observe the blue beetles in their cages. We provided each classroom (25 children) with a total of four adult beetles. After their initial observations, the children were asked to record the features of the insect and its habitat in their science journals. *As with all living creatures, it is important to remind students to be respectful and gentle when picking up the insects. No special safety equipment is necessary but students should wash their hands afterward.* After five minutes of observation time, we came back together and recorded their observations next to their brainstorm. We asked students to analyze the lists we generated to determine what physical characteristics define an insect. Insects are defined by their three body parts (head, thorax, abdomen) and six legs. To reinforce these characteristics, we gave small groups of students 20 photographs of invertebrates, including insects, and asked them to sort the photos into two piles: insects and noninsects. The activity and photographs were downloaded from a photo template

TABLE 1

Insects used in the activity.

INSECT	CARE INSTRUCTIONS	MATERIALS	COST	SPECIAL NOTES
Blue Death-Feigning Beetles (*Asbolus verrucosus*) 	Should be kept dry on a layer of Zoo Med Eco Earth Loose Coconut Fiber. The habitat should also contain: cork bark for hiding, very shallow water dish filled with pebbles for water, and oatmeal, cheerios, and dry dog/cat food. Give fruit or carrots for added moisture and nutrients.	Beetles from Bugs in Cyberspace Zoo Med Eco Earth Loose Coconut Fiber Cork Bark Water dish Food Container **Total**	$9.00/bug $7.69/8 qt bag $8.41/log $1.00 $5.00/month $1.00 $32.10	Coconut is not a nut, and allergies to it are rare. Make sure that the water dish is very shallow so the beetles do not accidentally drown.
Superworm (*Zophobas morio*) 	They like to dig and be under things. Keep them in dry oatmeal. Dry dog/cat foods are a good source of protein. Give fresh carrot pieces, apple slices, etc. as a source of moisture and nutrients.	Superworm from Carolina Supply Oatmeal Dry dog/cat food Carrots, apples, etc. Container **Total**	$18.50/50 bugs $2.00/month $3.00/year $1.00 $1.00 $25.50	Oatmeal does not contain gluten. If a superworm curls up for a whole day, move them to a separate bin so they can proceed to the pupal stage.
Madagascar Hissing Cockroach (*Gromphadorhina portentosa*) 	Layer of coconut fiber is recommended but not required. The habitat should also contain: a hiding place, a shallow water dish with pebbles, and oatmeal and cat food. They can also eat fresh fruits and vegetables.	Cockroach from Carolina Supply Cork bark Water dish Food **Total**	$9.75/1 bug $8.41/log $1.00 $1.00/month $20.16	Cockroach cages can develop yucky odors; limit the number of roaches kept to 1 per gallon of space to minimize odor, and replace substrate and rinse cork bark.

resource (Orkin Lesson Plans; see Internet Resources). Asking students how they sorted their pictures served as a formative assessment.

Insect Habitat

During the next lesson, we reviewed our observations of the blue beetles' habitat. Based on prior knowledge and the beetles' cage environment, students were asked to share predictions about what resources insects need to survive and why. A typical student might suggest that they need water to drink, oatmeal to eat, and a log to live under. We then played an interactive game based on Habitat Breakdown by Czech et al. (2004) to help cement the components of a habitat. *To ensure student safety during the activity, we told students not to run*. To set up, color-coded construction paper shapes were scattered around the classroom to represent the four components of a habitat: food, water, shelter, and adequate space. Students took on the persona of an insect of their choosing. Students were challenged to collect enough of each element in one minute to survive to the next round. In the first round of the game, resources were abundant so that all students were able to collect enough resources to survive and move on to the next level. In round two, the students were told that there had been a drought that caused a reduction in available food and water. To represent this, there were fewer food and water pieces scattered around the room, making it much more challenging for all of the students to collect what they needed. In this round, students learned that insects must be able to find enough resources to survive in their habitat. After the lesson, a student mentioned to one of the authors that he had enjoyed the game.

In a whole-class discussion following the game, students were asked to predict ways that an insect might respond to the lack of food. Students replied that some insects might eat something different, move to a different location, or starve to death, resulting in a decrease in population. A formative assessment in the form of an exit ticket asked students to write the four components of a habitat and predict what the outcome would be if their classroom pets didn't have enough of each component (Table 2). Several students wrote about insect defenses as well as adaptations, which was a nice segue into the next part of our unit.

Insect Defenses

The third lesson focused on various defense mechanisms of insects and how insects use different parts of their bodies for defense. As a quick hook, we discussed their answers to the exit ticket from the previous lesson. Most students recalled food, shelter, and water as essential components of habitat and could explain at least two outcomes for an insect not having food. In order to broaden the students' experience of

the insect world, four hissing cockroaches were added to the classroom. Throughout the lesson, as part of their observation, students that felt comfortable touched the cockroaches to provoke the hissing sound. Students were asked why the cockroaches made the hissing sound, how it made them feel, and how it might make other animals feel. Students typically respond to these animals and their sounds with fear. The students were encouraged to make the connection that if they were scared, other animals encountering the roaches may become scared, too. After this discussion, students were shown pictures and given specific examples of some active insect defenses such as running away, spraying a chemical, or making a sound, and passive defenses such as camouflage, toxicity, and mimicry. We presented a PowerPoint that began by discussing how a defense is something whose purpose is to protect. We showed images of different insect defenses such as biting (ants), stinging (wasps and bees), spines (Australian walking stick), making sound (hissing cockroach), hiding (grasshopper), startling (snake-mimicking caterpillar - spicebush swallowtail), and spraying chemicals (bombardier beetle). See Dubner (2016) for a summary of insect defenses with images. As a formative assessment, students were instructed to draw an imaginary insect with a defense mechanism of their own choosing. Students could select active or passive defenses and were required to include appropriate insect characteristics (three body parts, six legs, and wings), as well as providing a rationale for their defense choices.

Social Insects

The fourth lesson actively demonstrates advantages and disadvantages of living in groups. The lesson began with an observation of cockroach interaction. For example, students were asked to note if the cockroaches touched each other with their antennae, hissed at each other, or climbed over each other. Though hissing cockroaches are social insects and live together in colonies, their social structure is not as organized as highly social (eusocial) insects such as ants, termites, and honeybees.

We utilized ants and bees as examples in the following activity, as they exhibit more obvious examples of social interaction than the cockroaches and they are very familiar to most students. To illustrate the advantages of living in groups (e.g., building elaborate nests, stockpiling food, coordinated defense), students took on the role of ants and were tasked with "building a nest" by stacking paper cups. Students made predictions about whether the nest would be built faster with one ant or many ants. In the first round, classmates observed as one student (or the teacher) was given one minute to build a complete nest. The individual was unable to complete the entire nest (i.e., stack all the cups) in the time allotted. Students were asked to consider how a large nest might be built in a short period of time. The best way to build the nest would be to have more ants help. In the next round, many students worked together to build the structure and were able to successfully complete the nest in a minute. This activity could be easily modified to also show disadvantages of living in groups (e.g., increased vulnerability to contagious diseases, competition for food and space, presentation of a larger target for predators to exploit).

At the conclusion of the interactive game, students had the opportunity to reflect on their learning by listing the pros and cons of living in a group. Ultimately they had to make an individual choice about whether they would live in a group or individually. There were clear arguments for both sides so the class didn't agree to one or the other. To accommodate ELL and special needs students, students discussed in small groups and chose one person to be the recorder.

TABLE 2

Lesson 2: Insect habitat.

4 COMPONENTS OF HABITAT	WHAT WOULD HAPPEN IF THE BLUE BEETLES DIDN'T HAVE THIS COMPONENT?

Insect Life Cycle

The final lesson focused on the growth and development of insects. The topic was introduced through a brief discussion of human development from babies to adults. Grade level– appropriate literature, such as *Where Butterflies Grow* by Joanne Ryder and Lynne Cherry (1989), helped bridge the gap between the human life cycle and insect life cycles. Following the story, students were given about five minutes to meet the superworms and five minutes to record their observations. In groups, and then a whole-class discussion, students were asked to explain why the superworm is considered an insect based on previous lessons and guess the superworms' current life stage (egg, larva, pupa, adult). Students were encouraged to connect their observations of the superworm to the caterpillar in the story. They observed that the superworms differed in several ways from the blue beetles. Once this discussion was complete, students watched a brief video from YouTube about the mealworm life cycle (see Internet resources; the mealworms shown in this video look identical to the superworms). This allowed students to evaluate their predictions and observe the superworms' different life stages. To conclude this lesson, students worked in small groups to re-create the superworm life cycle. To do this, each group of students was given a worksheet with four blank spaces arranged in a circle with arrows pointing clockwise. Each group was also given a set of four cut-out images—superworm eggs, larva, pupa, and adult. The students were tasked with arranging the different life cycle stages in order on the blank worksheet. Though it is easy to utilize paper images for this activity, it would also be possible to utilize plastic figurines (see Internet Resources) or actual specimens in lucite blocks. The plastic figurines in particular would be well-suited for visually impaired students. In our unit, students did not rear the superworms through the life cycle, thus they were not able to directly observe living examples of the egg, pupal, and adult stages. However, this would be an easy addition to the curriculum, especially in a long-term situation. Superworms that are observed to lie on top of the substrate curled in a C-shape are ready for pupation; they should be isolated in a separate enclosure lest they be cannibalized by their fellows. Subsequent pupation and metamorphosis occurs in a matter of weeks.

Broader Impacts

This insect pet lesson series provides an inexpensive and effective way to build comfort with insects and to address several life science standards. Some of the many positive aspects of this unit are the opportunities for classroom bonding, empathy development, increased exposure to non-harmful insects, increased knowledge about insects, and the financial ease of obtaining the animals and their enclosures. In addition, the presence of live animals in the learning environment stimulated natural buy-in and engagement in the students. We observed that students' general knowledge of insects had increased by the close of the unit, though there were no detectable changes in student attitudes toward insects (Lorenz-Reaves 2017). Although we did not investigate the teachers' attitudes toward the insects, we believe that interacting directly with insects in an educational setting is a rare experience, thus, our hope is that the teachers also benefited from the interaction. ●

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Internet Resources

Bugs in Cyberspace
http://shop.bugsincyberspace.com
Carolina Biological Supply Company
www.carolina.com
National Geographic Kids
https://kids.nationalgeographic.com/explore/youtube-playlist-pages/youtube-playlist-insects
Life Cycle of the Meal Worm Beetle.
www.youtube.com/watch?v=MJAhglXDQb4
Source for plastic mealworm life cycle figures
www.alisonsmontessori.com/Life_Cycle_of_a_Meal_Worm_Models_p/z35.htm

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www.orkin.com/scienceeducation/kids-and-teachers-lessonplans,
https://cdn.orkin.com/downloads/learningcenter/lesson-plans/ORKIN_LP_AreYouOneofUs34.pdf,
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Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013)

Standard

3-LS2 Ecosystems: Interactions, Energy, and Dynamics

www.nextgenscience.org/dci-arrangement/3-ls2-ecosystems-interactions-energy-and-dynamics

- The chart below makes one set of connections between the instruction outlined in this article and the *NGSS*. Other valid connections are likely; however, space restrictions prevent us from listing all possibilities.
- The materials, lessons, and activities outlined in the article are just one step toward reaching the performance expectation listed below.

Performance Expectation

3-LS2-1. Construct an argument that some animals form groups that help members survive.

DIMENSIONS	CLASSROOM CONNECTIONS
Science and Engineering Practice	
Engaging in an Argument From Evidence	Students gather evidence from a model to write an opinion essay about whether or not animals should live in groups.
Disciplinary Core Idea	
LS2.D: Social Interactions and Group Behavior Being part of a group helps animals obtain food, defend themselves, and cope with changes. Groups may serve different functions and vary dramatically in size.	Students participate in model of advantages and disadvantages of living in a group. Students explore how obtaining food can be difficult for an insect living in a group.
Crosscutting Concept	
Cause and Effect	Students use evidence from the model to explain the cause-and-effect relationship of insects living in groups.

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