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Days of Our Spineless Lives: A Never Ending Saga

Lori Ihrig
Williamsburg Senior High School

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a never ending saga

by **Lori Ihrig**

ABSTRACT: This activity is an interdisciplinary method for engaging students in biological investigations through working with living aquatic invertebrates. The learning cycle begins with students conducting fieldwork to collect aquatic invertebrates. Students then think and propose ideas to create an observation record that they can use to study their organisms in the classroom. Finally, through the use of well-phrased questions along with wait-time, positive non-verbal responses, and non-judgmental responses, the teacher is an ally working with students in inquiry to generate the requirements of a final project. *This article promotes National Science Education Content Standards, A, C, and F, and Iowa Teaching Standards 2,3,4 and 5.*

In Memory of Dr. Charlie Drewes

This activity was co-authored with the late Dr. Charlie Drewes. Dr. Drewes strongly believed that "meaningful interaction of teachers and their students with a wide range of living, behaving organisms not only enhances their biology education in general but it is ultimately crucial for promoting ecological awareness and preserving biodiversity." His unique creative talents, boundless enthusiasm, knowledge, passion, and a focus on minutia - both of detail and in the living world - will continue to have a lasting impact on teachers and their students. His personal website is a wonderful resource to teachers and is being kept active by the department of EEOB at Iowa State University. This activity reflects his impact on my own professional life. I will forever be indebted to Dr. Drewes for teaching me how to walk slowly, look closely, and deeply consider the significance of my interactions with the world. It is my sincere hope that this project can provide a similar experience for you and your students. Visit Charlie's website at:

http://www.eeob.iastate.edu/faculty/DrewesC/htdocs/

Introduction

The activity that follows is an interdisciplinary method for engaging students in biological investigations through working with living aquatic invertebrates. The design is not experimental, but students learn much about the nature of curiosity and observation as foundations to the knowledge base of science.

Exploration Phase

Student Collection in the Field

The exploration phase of this learning cycle begins with one 90-minute class period spent at a local pond collecting invertebrates. "Pond Day" has become an eagerly awaited event that students now ask about on the first day of class. To keep this activity an exploration for students, I do not introduce any content about aquatic invertebrates and their collection prior to visiting the pond. Students are only advised on appropriate dress for the day (After one unfortunate incident following a foot stuck in the mud, it is always recommend bringing a spare pair of clothing, including undergarments!). My school is fortunate to have an easily accessible pond within walking distance where we can conduct fieldwork.

If field collection is not an option for you, many aquatic and terrestrial invertebrates are available through biological collection companies. Biology is the study of life and having students experience working with living organisms in a biology class is important. Living invertebrates, if introduced and studied effectively, generate interest, curiosity, and awe for the biodiversity of life on Earth and the study of biology.

An effective and efficient day at the pond begins with thorough consideration how students will safely travel to the collection site, collect, return to the classroom, and clean up. Are there roads to cross on the way to the site? Having students stop at each crossing is an effective way to keep stragglers from getting too far behind. Is the area students are to visit small enough that all students can be both seen and heard at all times, or do boundaries need to be established to keep students within a safe distance? How deep is the water? Where may students safely venture, and what areas are they to avoid?

If the collection site is not far from the school, it is most efficient to have students put on any boots or waders they may have brought, before they leave the classroom. This keeps their hands free to carry their collection equipment. Students know in advance that they are spending the period doing field collection so the activity itself needs little introduction, but it is important that all students are aware of the necessary safety expectations traveling to and from the collection site.

Once pondside, the equipment in each group's collection kit is sorted through and demonstrations can be conducted as necessary. Resources for creating collection equipment and techniques can be found in Appendix A, but a wonderful place to begin is Charlie Drewe's website.

Thoughtful teacher responses to student questions and remarks are important to maintain the integrity of the exploration activity as students begin finding organisms. After finding their first macroinvertebrates students often exclaim, "Look what I found! What is it?" If you are new to aquatic invertebrates, not directly answering this and other students' questions may be quite easy as you likely will honestly not have answers at hand. This is no problem as an appropriate response to encourage student thinking and investigation is, "*WOW! We are definitely going to have to figure out what that is once we get back to the classroom!*" Followed by, "*See if you can collect a bunch of them to share with your classmates!*" Even if you do know much about the macroinvertebrates collected, hold back and provide some variation of, "*WOW! I am so excited you found one of those because I remember some former students telling me they have amazing feeding behaviors! We will have to remember to watch it eat under a microscope once we get it back to the classroom and identify it!*" Follow this with, "*See if you can collect a bunch of them to share with your classmates!*" The key to this portion of the activity is interacting with students in a manner that encourages their curiosity and questioning about macroinvertebrates and their environment.

Sorting and Identifying Invertebrates

Following collection at the pond, I have my students spend two 90-minute periods sorting, caring for, and identifying organisms that are now being cultured in the classroom. How much time you devote to this is up to you, but ensure you maintain the exploration intent of the learning cycle. However, exploration does not mean simply permitting students to do whatever they want with no structure. In my class, some interactions with students generate individual

and/or group generated inquiries.

Other times, I must interact with students in a way that helps them generate questions. For instance, I might ask, "*What about your organism might be useful in identifying it?*" Using wait-time, positive non-verbal responses, and non-judgmental verbal responses, students can generate a list that the teacher can add to as appropriate (or better yet, ask questions that spark the desired ideas). The key is to use expectant behaviors that encourage students to think and propose ideas. After this short interactive presentation, some form of an observation record results (Figure 1). The key is to not provide the observation record to students, but to generate it through collaborative work so *they are mentally engaged and understand its importance!*

A list of quality book and Internet resources for identification and background knowledge are provided in Appendix A. Students use the generated observation record, as they identify invertebrates and create a listing of them on the board. This observation record functions as a classroom management tool because it holds students accountable for creating a product. This is especially helpful for students who struggle to manage their time and stay on task. It also provides an opportunity for students to sharpen their observation skills.

Explain and Extend Phases

At this point students are prepared to select an organism for further study. The initial directions given to have students explain and extend their initial exploration are as follows:

> You are going to develop and apply your knowledge about ecology and an invertebrate to write a creative essay/story. Write your story in first person [for example: "I am a tiny... and I live in..."]. You can use your own creativity and inventiveness to give your organism some "personality" and "preferences," but specific information about the organism's biology should remain as factual and accurate as possible.

All students, but particularly those new to inquiry, will need some help before beginning. Rather that simply telling students what they ought to do, first ask them questions such as:

"*What information would be important to convey in your story?*"

"*What observations will you need to convey?*"

"*What kind of representations would best convey the information?*"

"*What kind of representations would the reader find most interesting?*"

Taxonomy (Classification):
What is the organism's common name?
Kingdom-
Phylum-
Class-
Order-

Body Form:
Make a detailed sketch. Label the key anatomical features that are evident. Measure size and show scale on the sketch. Note any sensory structures that are evident.

Describe the function of the key anatomical features, if you are unsure of the function you can speculate.

Behavior:
Describe the mechanism of locomotion (What does the organism use to move?).

Note:
State one question you have about this organism, one thing that you are curious about, or one thing that interests you.

Figure 1. *Sample Student Observation Record*

These and other well phrased questions along with wait-time, positive non-verbal responses, and non-judgmental responses will engage students in generating much of what appears in Figure 2. Follow up questions such as, "*What makes this important?*" Or "*How will this help the reader understand your organism?*" helps everyone understand the rationale for needed information. This approach helps students improve their understanding of invertebrates while also teaching them *how* to inquire and *what* to consider when conveying information to

Questions to consider» If information is not available, apply your knowledge of ecology and the invertebrate to create a feasible speculative answer.

1. Who are you? Give your *common name* and *taxonomic name*.
2. What other kinds of organisms are your close or distant *taxonomic relatives*?
3. Describe your *general habitat* (macrohabitat, landform, water form, etc.).
4. Describe details about your specific *microhabitat* (tree, dead log, stone, soil, etc.)
5. Describe your biological *community*. That is, what plants and animals live around you?
6. What is your *niche*? That is, what purpose or function do you serve in your habitat?
7. Provide a detailed description of your appearance, shape, size, color, texture, etc.
8. What *features* are unique about you?
9. Where do you think you will go today?
10. Why will you go there?
11. How will you get there? Provide a detailed description of your pattern or means of *locomotion*.
12. What will you *eat*? Describe your food preferences.
13. How will you *obtain food*?
14. Describe your dining habits and eating "utensils."
15. How do you breathe, or *obtain oxygen*?
16. What is your circulatory system like? Do you have a heart and blood?
17. Describe your *life stages* and *life cycle*.
18. How big will you *grow*?
19. How do you *reproduce*?
20. Do you have a nervous system? Describe its organization.
21. What special structures do you have that are used to sense things around you?
22. What other organisms might want to eat you?
23. How will you *protect* or *defend* yourself from predators?
24. What will you do if part of you gets eaten?
25. What other *environmental extremes* might you experience and how will you deal with them?
26. How long do you think you will live?
27. What could humans do to destroy you or make you ill?
28. How can humans avoid doing this to you?

Important Observations» Examples include carefully drawn details regarding the organism's appearance (size, color, shape, appendages, number of segments, etc.) as well as its movements and other behavior. (e.g. reactions to light, touch, food, etc.).

Use of Resources» In addition to biology facts, the information gathered and presented may include copies of photographs, diagrams, etc. Accuracy and details in pictures/drawings is important. Legends that provide information about a picture/drawing (e.g. "Here I am attached to a...") are quite useful to readers. Consider the credibility of resources you use! Keep in mind the fundamental difference between books and the Internet, the authors of most invertebrate reference books have spent a considerable amount of time creating books that are thorough and filled with accurate information and drawings, unfortunately, the same cannot always be said for information that is on the web.

Summarize» Summaries highlight the most important points you wish to make about your organism. This may vary depending on the organism selected, but might include your most unique adaptations and special characteristics that make you well suited for survival and that allow you to successfully perform in your niche (reproduction, predatory abilities, locomotion capabilities)? Why do you deserve to receive an "Invertebrate Emmy Award" or be selected for the "Invertebrate Hall of Fame" or be voted the "Survivor"?

Postscript» In a separate section, entitled "POSTSCRIPT" at the end of your essay, indicate which aspects of the organism's biology you were (a) interested in, (b) unsure of, (c) could find the most information about, (d) could find no information about, or (e) would like to know more about. Your postscript should be written in first person from your point of view.

Figure 2. Generated information commonly appearing in students' stories.

a reader. The teacher can occasionally make suggestions, particularly ideas students often miss. In this way, the teacher is an ally working with students in inquiry. To reach the important ends set out in the *National Science Education Standards*, we must engage students in investigating the natural world *and* teach them how to inquire. Simply telling students *what* to do does not engage students

mentally in *learning how* to inquire.

This activity need not be limited to invertebrates; any living organism that the instructor has available or familiarity with will work. However, questions may need to be modified to suit other groups of organisms.

If this is the first time your students have done this sort of activity, they will likely need further guidance before beginning to write. Below are two short examples I provide to my students to help them better understand what information is expected in their creative, but biologically accurate, story. One is an example of a successful way to write a creative story while highlighting accurate biological information. The other example is a story in which the creative storyline is used at the expense of accurate biological information.

Poor description for essay:

Today, as my first project, I think I'll go up to the water surface where it is bright and sunny. I like to float on the water. I think that's why I'm nice and tan. While I'm on the surface, I'll grab some food... maybe a bug-burger. They are my personal favorite. Recently, I noticed that the algae seem to hang out near the water surface during the daytime. I wish they didn't do that--all that green stuff really annoys me. If I feel like it, I may make a marathon swim to the other side of the lake where the water is calmer and the bottom is sandier and there's a beach! Plus, there may be some really big bugs over there. Some of my aquatic friends think I'm pretty obsessed because I eat the same food all the time, but I don't care what they think because I'm healthy and my stomach is bulging with bugs. Of course, no matter where I go, I'll use my long legs for galloping in the water. I know my legs are pretty short, but I try hard and I usually get where I want to go. That's more than my friend, the sponge, can say even though I think he's smarter than me!

Critique:

Essay above incorrectly implies the following: daphnia's preferences for flotation on water surface, tanning, insectivorous feeding, and swimming with legs. Use of the last word “me” is grammatically incorrect even though it is probably true!!!!!

Good Description for essay:

Today, as my first project, I think I'll swim upward a few feet toward the surface where it is bright and sunny. I don't know if anybody ever notices, but I often like to move toward the light. While I'm up near the surface, I'll try to snack on some delicious, nutritious algae. Algae are my personal favorite. Recently, I noticed that the algae seem to hang out near the water surface during the daytime. I wonder why? If there are no algae right above me, then I may make a marathon swim to the other side of the lake where the water is calmer and the bottom is sandier and there's a beach! Plus, there may be more algae over there. Some of my aquatic friends think I'm pretty obsessed because I eat the same food all the time, but I don't care what they think because I'm healthy and my stomach is green! Of course, no matter where I go, I'll use the long and bristled antennae on my head to swim. I know my movements are jerky but, hey, my antennae are powerful and I get where I want to go! That's more than my friend, the sponge, can say!

Critique:

Essay above correctly incorporates the following biological features: daphnia's positive phototaxis, preference for algae as main food source, and accurate description of locomotor appendages and movement.

Pulling it all Together

As students work through this project they are often challenged with new terminology or concepts that they may not have previously studied. The motivation needed to successfully deal with these challenges arises as students sense their evolving "ownership" of their selected organism and their

creative writing project. Combining this sense of ownership and a need to know, students are now ready to move into the explanation phase of the learning cycle as they develop an understanding of new concepts through additional classroom activities and reading materials.

As this project comes to a close, the final stage of the learning cycle, extension (or "Application" as it is often called), is complete. This project had students gain an in-depth appreciation of an organism that lives in a pond they may have passed many times in their life. And now that all students have shared a very concrete experience of what biodiversity means for our small pond, we move on to consider the vast biodiversity of larger ecosystems, biomes, and our planet. This project provides a scaffold for appreciating that biodiversity and the complexity of life on a more grand scale. Students have built the conceptual framework necessary to truly understand a concept fundamental to evolution and ecology. As a final note, at the conclusion of this project, as with any project that collects living specimens, make sure to return the invertebrates to their homes.

Appendix A: Book and Web Resources

Book Resources

Kneidel, S. (1999). *A Kid's Guide to Catching and Keeping Insects and Other Small Creatures*. New Jersey. John Wiley and Sons.

Pennak, R.W. (1989*). Freshwater Invertebrates of the United States*. 3rd ed. New Jersey. John Wiley and Sons.

McCafferty, W.P. (1983). *Aquatic Entomology: The Fisherman's and Ecologist's Guide to Insects and Their Relatives*. Boston, MA. Jones and Bartlett.

McGavin, G.C. (2000). *Insects, Spiders and Other Terrestrial Arthropods*. New York, NY. Dorling Kindersley.

Rainis, K.G. and B.J. Russell. (1996). *Guide to Microlife*. London, England. Franklin Watts.

Ruppert, E.E. & Barnes, R.D. (1994). *Invertebrate Zoology*. Saunders College Publishing.

Thorp, J.H. & A.P. Covich. (1991). *Ecology and Classification of North America Freshwater Invertebrates*. Washington, D.C. Academic Press.

Web Resources

Earth-Life Web Productions. (February 27, 2004). *The Wonderful World of Insects*. Retrieved July 14, 2005, from http://www.earthlife.net/insects

Fidget, A. (2002) *Biomedia Museum Biological Sciences at the University of Paisley*. Retrieved July 14, 2005, from http://orion1.paisley.ac.uk/courses/Tatner/biomedia/home/museum.htm

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University of Michigan Museum of Zoology. (2005). *Animal Diversity Web*. Retrieved July 14, 2005, from http://animaldiversity.ummz.umich.edu/site/index.html

BioMEDIA Associates. (2004). *The Classic Organisms of Biology Gallery*. Retrieved July 14, 2005, from http://ebiomedia.com/gall/classics/classics.html

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Lori Ihrig has taught at the Williamsburg Junior and Senior High Schools since 1999. Lori currently teaches General Biology and AP Biology, and is involved with the Iowa Excellence Program, an extracurricular program in math and science for the district's 6th, 7th, and 8th-graders.