Fossil Explorers

Third-grade students examine ancient organisms in modern times.

By Sean Moran, Cheryl McLaughlin, Bruce MacFadden, Elizabeth Jacobbe, and Michael Poole

Many young learners are fascinated with fossils, particularly charismatic forms such as dinosaurs and giant sharks. Fossils provide tangible, objective evidence of life that lived millions of years ago. They also provide a timescale of evolution not typically appreciated by young learners. Fossils and the science of paleontology can, therefore, serve as a gateway for learning and engagement about a diversity of topics and concepts, as well as the processes of science. According to *A Framework for K–12 Science Education* (NRC 2012), students should be provided with opportunities to experience how science is actually done, thereby developing relevant skills for careers in science. Integrating museum collections in the elementary science classroom has the potential to stimulate curiosity in young learners about ancient environments while attracting students to the field of paleontology and associated sciences.

Natural history museum collections present an excellent resource for engaging students in the content and practices of science (Cook et al. 2014). The development of loan materials by museums for use in the science classroom is becoming increasingly mainstream. Many teachers depend on natural history learning kits to provide hands-on, authentic, and artifact-based learning environments for their students. This article describes a third-grade lesson that uses museum collections to help students understand the potential range of diversity represented by the fossil record while facilitating a more relaxed and intimate experience with the artifacts. By manipulating and exploring the variety of fossils, students learned about different types of fossils and used them to make some inferences about ancient environments. It was our hope that exposing elementary school learners early to fossils and paleontology would allow them to gain an appreciation of, and increase interest in, paleontology as well as science in general.

Implementing the Lesson

The lesson took place during one 45-minute session with goals to (1) provide an understanding of what fossils are and why they are important; (2) provide students with an opportunity to examine and identify various fossils based on their prior knowledge and experiences; and (3) encourage students to make inferences regarding ancient environments based on their observations. The materials used in this lesson included:

- Fossil kits on loan from Florida Museum of Natural History containing 10 different fossils – one kit per group of four students (Figure 1). Fossils can be obtained from sources such as local museums of natural history, fossils clubs, or national organizations such as the FOSSIL project (see Internet Resources). If actual fossils are difficult to acquire, a series of flashcards with different fossil images could be created to replicate the activity.
- Magnifying glasses (one per student)
- Student data sheets (one per group; see Figure 2)
- Summative evaluation sheet (one per student; see Figure 3)
- Computer and projector for PowerPoint slides
- Trade books, as outlined in the resource section. We suggest these be used either prior to the lesson to activate prior knowledge or as an extension after the lesson to elaborate on the content learned during the activity.

This lesson was implemented using the 5E instructional model outlined below.

FIGURE 1.

Fossil kit.

Engage (15 minutes)

We began the session by using interactive PowerPoint slides to engage students in a discussion about what fossils are, how they form, the process of finding and identifying them, why they are important, and the difference between a paleontologist and archaeologist (see NSTA Connection). The purpose of this activity was to help us gauge students' prior knowledge of fossils and paleontology. We asked students "What is a fossil?" The responses varied: "Something that's turned into rock." "Dinosaur bones. Like other creatures that died." One student explained that fossils are "remains of prehistoric animals that have died and the soil puts pressure on them and water seeps in and turns it into a mineral and they are hard to find."

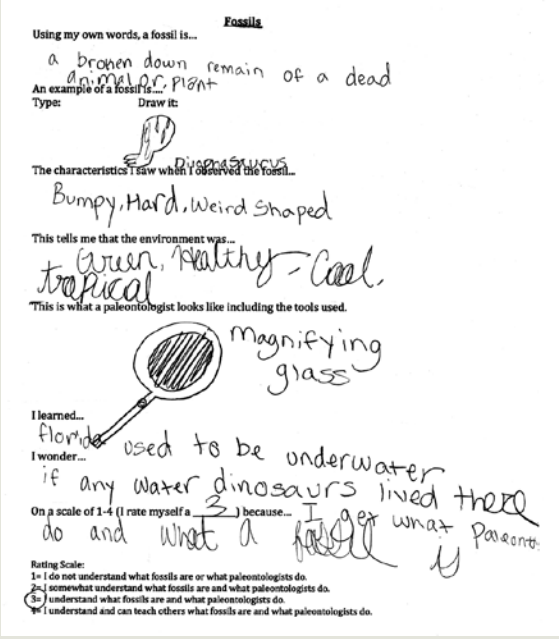
FIGURE 2.

Student data sheet.

Fossil Number:	What is it?
1	dinomis Shark tooth.
2	Sand Dalar
3	Plant fosil
4	Peca of a turtel Shell
5	Shar kvert
6	shark verte
7	clam
8	shark tooth
9	Shell
10	Bone

FIGURE 3.

Summative evaluation sheet.



Fossils

Using my own words, a fossil is...

a broken down remain of a dead animal or plant

An example of a fossil is... Type: Draw it:

The characteristics I saw when I observed the fossil...

Bumpy, Hard, Weird Shaped

This tells me that the environment was...

tropical Green, Healthy - Cool.

This is what a paleontologist looks like including the tools used.

magnifying glass

I learned... Florida used to be underwater

I wonder... if any water dinosaurs lived there

On a scale of 1-4 (I rate myself a 3) because... I do and what a fossil I get what Paleonto

Rating Scale:
1= I do not understand what fossils are or what paleontologists do.
2= I somewhat understand what fossils are and what paleontologists do.
3= I understand what fossils are and what paleontologists do.
4= I understand and can teach others what fossils are and what paleontologists do.

This response provided an opportunity for the lead teacher to talk about fossils as preserved evidence of ancient life, their formation, and also to clarify misconceptions about paleontologists and archaeologists. Some students believed that archaeologists study only artifacts while paleontologists study bones, therefore a scientist who studies human bones would be a paleontologist. We dispelled these myths by explaining that archaeologists study all of human history, including bones and artifacts, while paleontologists study ancient life exclusive of humans. In addition, some students wondered if all fossils are bones or teeth (what paleontologists call *body fossils*) or if a fossil could be a footprint or droppings (also known as *trace fossils*), which led to a short discussion of trace fossils. We talked through the difference with students by noting that trace fossils differ from body fossils in that body fossils are remains of the organism's physical skeleton, while trace fossils simply preserve evidence of the organism's behavior (e.g., footprints, coprolite, burrows).

To further engage students in the lesson, we prompted students to identify their favorite fossil. This proved to be a significant hook as student engagement was particularly high during this portion of the discussion. Some examples included, "shark teeth!" "saber tooth!" and "The bugs that are stuck in amber!" Many students also indicated that dinosaurs were their favorite fossil. We segued this into a discussion of our local geologic history by asking if any dinosaur fossils have been found in Florida. We explained that due to higher sea levels, Florida was submerged through much of its geologic history, particularly in the Mesozoic (when dinosaurs lived) and paleontologists have no record of dinosaurs here. Impressively, several students in our class used prior knowledge to lead the discussion in this direction stating that, "Florida was underwater when dinosaurs lived."

Explore (15 minutes)

Following the discussion, the class was divided into groups of 4–5 students each and a study set of 10 pre-numbered fossils was distributed to each group (Figure 1). The fossils were selected to provide a range of fossil types (i.e., vertebrates, invertebrates, and plants) with an emphasis on fossils found in Florida. Additionally, the fossils were chosen with consideration of the difficulty in identification. We expected fossils such as the cowry shells and shark teeth to be easily identified by the students. To present a greater challenge and promote deeper collaboration and thinking, we included fossils such as the turtle shell fragments and horse teeth. Finally, we added a few fossils that would be very difficult for the students to identify correctly, such as the horse astragalus (ankle bone). All of these fossils were assembled from collections at the Florida Museum of Natural History. While not all of the included fossils could be found locally (e.g., the plant fossil), many of them can be found around the state of Florida.

Each group was required to work together and talk through their ideas about what type they thought each fossil was, while using magnifying glasses to examine the objects. We told the students to be gentle when handling the fossils and to double count them as they were put away in the bag to ensure no fossils were lost. We also taught them how to use a magnifying glass appropriately by giving them two choices. They could either leave the fossil on the desk and move the magnifying glass and eyes down to the object or hold the object in their hands and move the magnifying glass around the fossil. We asked them to try not to touch the part they are looking through, so they can get a clear view of the fossil. These rules helped the lesson implementation to run smoothly and safely. Students washed their hands after handling the fossils.

After observing the fossils, they were expected to choose one answer and record it on their data sheets (Figure 2). The groups were given 15 minutes to complete the worksheet by identifying the fossils to the best of their abilities based mostly on prior knowledge and inference. Over these 15 minutes we circulated among the groups to keep the students on task and to provide assistance while avoiding swaying the students' identifications in any specific direc-

Connecting to the *Next Generation Science Standards* (NGSS Lead States 2013):

3-LS4 Biological Evolution: Unity and Diversity

www.nextgenscience.org/3ls4-biological-evolution-unity-diversity

The materials/lessons/activities outlined in this article are just one step toward reaching the Performance Expectations listed below. Additional supporting materials/lessons/activities will be required.

Performance Expectation	**Connections to Classroom Activity** Students:
3-LS4-1: Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago	• observe actual fossil specimens and draw conclusions about the type of organism and the environment in which they lived.
Science and Engineering Practices	
Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Engaging in Argument From Evidence	• make observations about the shape and structure of the fossil. • discuss the type of organism each fossil represents, the age of the fossils, and the environments in which they may have lived.
Disciplinary Core Idea	
LS4.A: Evidence of Common Ancestry and Diversity • Some kinds of plants and animals that once lived on Earth are no longer found anywhere. • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	• observe fossils that represent a range in the geologic age of the organisms from very recent to long ago, as well as organisms that are extinct and others that still live.
Crosscutting Concept	
Patterns	• investigate and identify similarities and differences in characteristics to sort and identify fossils.

Connecting to the Common Core State Standards (NGAC and CCSSO 2010):

LAFS.2.W.1.2 Write informative/explanatory texts in which they introduce a topic, use facts and definitions to develop points, and provide a concluding statement or section.

LAFS.2.W.3.8 Recall information from experience or gather information from provided sources to answer a question.

LAFS.3.W.3.7 Conduct short research projects that build knowledge about a topic.

LAFS.3.W.3.8 Recall information from experiences or gather information from print and digital sources; take brief notes on sources and sort evidence into provided categories.

MAFS.3.OA.4 Solve problems involving the four operations, and identify and explain patterns in arithmetic.

tion. Every group excitedly manipulated the fossils and provided educated guesses as to what they thought the fossils were. During this period, one student noted to the lead teacher that he had previously heard that the rings on the shark vertebra might indicate something about the age of the animal. Many students asked questions such as, "Is this a shell?" In response, the lead teacher attempted to promote inquiry by further questioning without supporting or rejecting their ideas. Another student was eager to tell the lead teacher that he was able to identify the turtle shell based on a visit with his family to the local natural history museum.

After implementing the activity, we noticed a few changes would perhaps allow for more complex observations and deeper thinking. Instead of simply observing the fossils and writing down identifications, the students could record observations and sketches in a scientific notebook. In this way, the students would replicate the scientific process used by paleontologists in the field as well as better map their thought processes from observation to conclusion.

Several techniques were used to ensure good behavior and participation. Most importantly, we used a lot of partner talk so all of our students were engaged. Partner talk is where we ask a question, give students wait time, and then ask them to turn and talk to their partners. This way everyone is held accountable for sharing.

Explain and Elaborate (10 minutes)

After 15 minutes of exploration, students were asked to turn in their data sheets. Using appropriate vocabulary, the lead teacher facilitated a whole-group discussion about each fossil. We prompted students to respond with their identifications for each of the 10 fossils with a representative photograph of that fossil on a prepared slideshow and explain why they identified the fossil the way they did. During the discussion, we asked students to elaborate on their observations by making inferences about the ancient environment associated with each fossil. After listening to their ideas, we showed them a slide with additional information such as age and habitat as well as a photo of a related modern organism (Figure 4).

FIGURE 4.

Fossil information slide.

Most students were able to correctly identify the shark teeth (specifically the lemon shark tooth with some groups identifying the "Megalodon" tooth as a dinosaur tooth), sea biscuit, sequoia needles, and the cowry shell. The turtle shell and shark vertebra each had a correct response from a single group. As expected, two of the fossils, specifically the horse tooth and horse astragalus, were very difficult for the students and did not yield a single correct response, though the answers for these were especially creative. Finally, all of the groups identified the brachiopod as a "shell" with two further specifying it as a "crab shell" and "clam shell." Because brachiopods (or lamp shells) resemble seashells but are not closely related, this provided an opportunity to make connections to real life and enhance higher-order thinking. We asked the students about other living things that look similar but may not be closely related. The students' responses generated other interesting questions, which led to a rich discussion on species' appearances and relatedness. For example, we talked about how closely related animals such as sea biscuits, sea stars, and sea cucumbers are, even though the appearance of each is vastly different.

Evaluate

Students were asked to complete a summative evaluation sheet (Figure 3) that assessed their understanding of the major themes presented during the lesson. Students were required to document: (1) their developing conceptions of fossils; (2) characteristics that enabled them to correctly identify each fossil; and (3) their understanding of what paleontologists do. Because the fossil objects were so foreign to the students, several responses (such as "weird" to describe the shape in Figure 3) convey the difficulty some students had in describing the fossils in an easily communicable way. To us, this denotes the unfamiliarity students have with paleontology, excluding dinosaurs, despite its advantage of being an engaging and interdisciplinary topic.

Conclusion

Throughout the lesson, the students were actively engaged in the investigation and exploration of fossils by tapping into prior knowledge, inquiry, and small-group discussions. A major reason for the high level of engagement and interest was the manipulation of actual fossils ranging from very familiar to completely unknown. The children loved having ancient artifacts in their hands. The lesson allowed multiple students to handle fossils while acting as detectives and provided an opportunity for the students to attempt to identify fossils and to make inferences about the environments in which the organisms may have lived. Due to the high level of inquiry and interaction, students gained an appreciation of processes associated with paleontology. The use of museum collections as well as actual scientific techniques in the elementary science classroom will likely enhance students' engagement in science (Gano and Kinzler 2011), and could pave the way for a greater interest and literacy in science later in life. ■

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Internet Resources

My FOSSIL project
www.myfossil.org

PaleoTEACH
www.paleoteach.org/fossil-detectives

The Paleontologist's Path
www.nps.gov/flfo/learn/education/paleontologists_path_1_3.htm

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NSTA Connection

Download the data sheets and powerpoint presentation at *www.nsta.org/SC1512*.