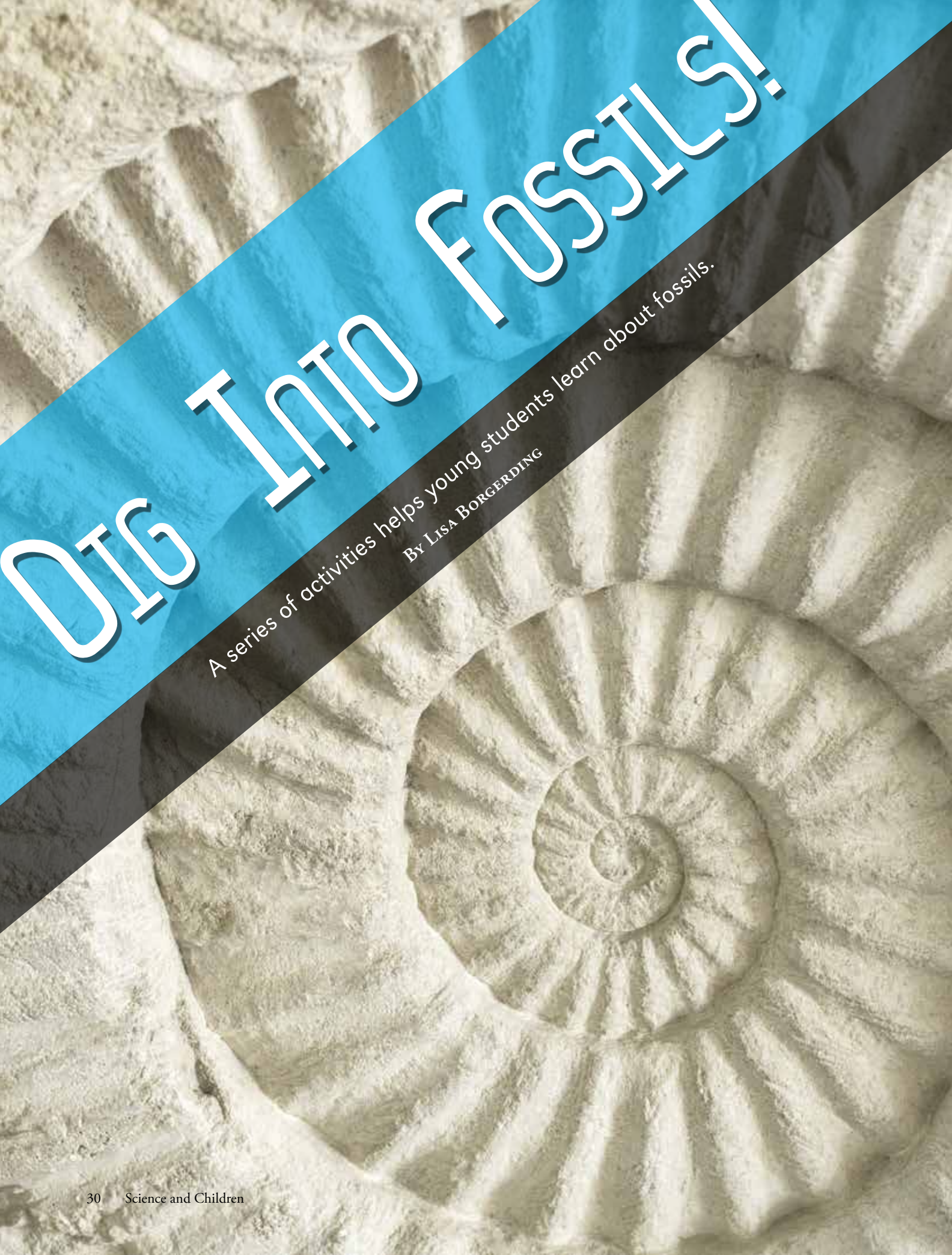


Dig Into Fossils!

A series of activities helps young students learn about fossils.

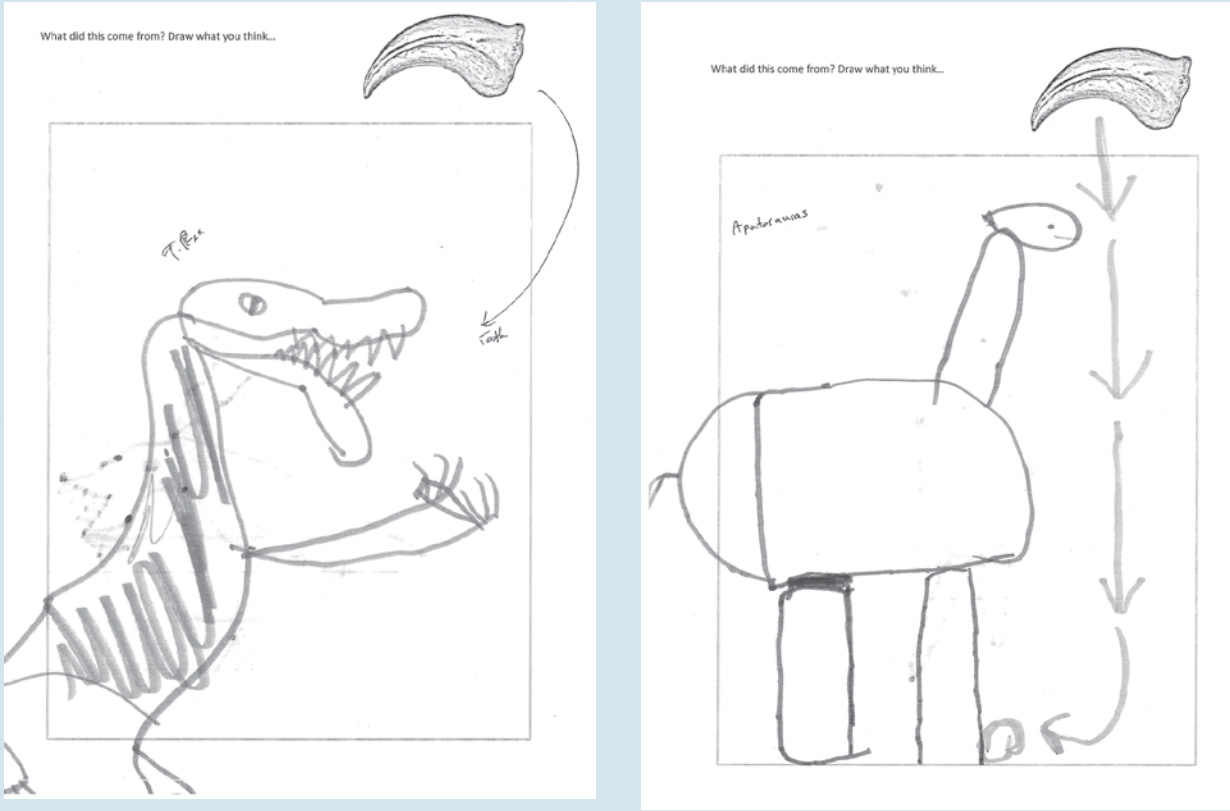
By Lisa Borgerding

Fossils are interesting and mysterious to young learners. They are amazed that these things that look like rocks actually used to be alive a long, long time ago! Although fossils fascinate students, there are usually many things they don't understand about them. When can children begin to make sense of fossils? Fossils are not addressed in the *Next Generation Science Standards* until the third grade. This *NGSS* standard focuses on how children can use observations of fossils to make inferences about organisms (structure and function) and their environments (habitats). However, in a learning progression on evolution (Catley, Lehrer, and Reiser 2004) fossils are introduced in the K–2 grade band. These authors suggest that young children can describe fossils; investigate how fossils are made; have tactile experiences with stand-alone fossils and fossils embedded within other rock; represent fossils using drawings, photos, and impressions; and compare fossils to living organisms. Furthermore, research from *Taking Science to School* (NRC 2007) also indicates that young children are able to comprehend more science than had been previously considered. I had previously successfully used a crinoid fossil activity with a Saturday science class of K–2 students, leading me to believe that young children (K–2) can learn both nature of science and science content from fossils (Akerson and Donnelly 2010). These sources suggest that K–3 children can learn about fossils; what about preschool students?

Preschool- and kindergarten-age children are curious about dinosaurs and paleontology. They frequently engage with relevant children's programming like *Dinosaur Train*. In a recent *Science and Children* article (2014), Peggy Ashbrook says, "beginning efforts in [the tasks of investigating questions, gathering evidence through observations, and holding class discussions to share evidence and ideas] can start in preschool with developmentally appropriate expectations" (p. 24). This lesson provides developmentally appropriate opportunities for preschool and kindergarten children enrolled in a science-focused camp to engage with fossils and the nature of paleontology. As such, Connecting to the *Next Generation Science Standards* (p. 36) connects the preK activities to the *NGSS* grade 3 standards, illustrating how young children can begin to meet

FIGURE 1.

Sample claw drawings.



these standards. Based on these standards and literature, I designed lessons to address three big ideas about fossils:

- Fossils are the remains of organisms that used to be alive a long time ago.
- We make inferences about fossil organisms' form, function, and habitats based on observations.
- Fossils can be similar to organisms alive today.

Lessons

Activity 1: Digging for Whole Fossils

The introductory lesson began with a 20-minute whole-group discussion about fossils. First, students were given the opportunity to examine some real fossil ammonites. When asked, "What do you think these are?" students replied, "seashell," "snail," and "a fossil with a worm in it." Half of the students indicated when asked that they had heard of fossils and a quarter of the students had heard of paleontologists. Some students explained that paleontologists "dig for bones and fossils" and "bring them back to a lab for them to study." I added to this, explaining that fossils are the remains of organisms that used to be alive a long time ago and a paleontologist is a special kind of scientist who studies fossils.

Students then explored fossils at greater depth at three different whole-fossil discovery centers. The first center was an outdoor dig where children used small shovels to find baked play dough ammonite and seashell fossils in an outdoor sandbox. The second center was an indoor dig where children used paint brushes to dust sand off of plaster of paris ammonites and shells. The third center contained a bin of real fossil ammonites that children explored using hand magnifiers. Students then rotated freely between the three centers, usually spending 10 to 15 minutes at each center. Each center accommodated about six children at a time, and children could also choose to revisit centers if there was an opening.

At all centers, children were reminded to make careful observations using their vision and touch senses. Also, we reviewed safety rules such as not putting things in their mouth and washing hands after they have completed the activity.

We opened a 15-minute whole-group discussion by reviewing what we dug up. Students eagerly said, "Seashell fossils like the one we were talking about." We learned that these animals are called ammonites. When asked about their age, students made guesses including 10, 900, and 1600 years old. Students were surprised to learn that these ammonite fossils are animals that lived 200 million years ago. When challenged to imagine *where* these ammonites once lived, students offered "outside," "under the ground," and "at the beach." We learned that paleontologists used observations of these fossils and what they know about snails and squids living today to infer that ammonites lived in the sea. I explained that paleontologists think ammonites swam to move and most likely ate tiny sea plants and animals.

Activity 2: Digging for Partial Fossils

The second lesson required students to make inferences from two partial fossils (dinosaur claw and crinoid) and some whole fossils (ammonite, fish, fern, and trilobite). Students rotated among the three centers that contained new fossils, visiting each center for about 10 minutes (see Fossils on a Budget, p. 35). In the outdoor dig, children used small shovels to unearth baked play dough trilobite, fish, and claw fossils. Children used paint brushes to dust off plaster of paris fish, fern, trilobites, stand-alone (not embedded in rock) crinoids, and crinoids embedded in rocks in the indoor sandbox. Children also used hand magnifiers to explore real trilobites, stand-alone crinoids, and crinoids embedded in rocks at a third center.

As a way to help students make inferences from their partial fossil evidence, children were given a picture of the claw fossil they found earlier. They were asked, "What did this come from? Draw what you think" as teachers circulated and used children's words to label their images for about 15 minutes. The children most often indicated that the claw fossil was a dinosaur claw or tooth. Other responses included possible organisms such as bats, whales, octopi, and dragons while some responses indicated that students did not understand what fossils were: a train, balloon, and water. We followed up with questions like, "Do you think there were trains and balloons that long ago?" Sample drawings are included in Figure 1, p. 31. Appro-

FIGURE 2.

Felt dinosaur bones.

PHOTOS COURTESY OF THE AUTHOR

priate performance on this claw task was evidenced by students drawing and describing animals which would have a tooth or claw. We had a discussion about whether everybody had "the same idea" for this fossil, and the children agreed that they did not. I explained how paleontologists sometimes have different ideas about fossils, too.

In our next 15-minute whole-group debriefing, students observed a whole-organism trilobite held up at the front of the classroom and were prompted to make guesses about what it was. Unlike the ammonites from the first activity, trilobites do not obviously resemble living things found today. Students indicated that they were unsure of whether these were plants or animals. We learned that trilobites were *animals* that lived in the *sea* and ate little animals and plants in the water. When asked how they thought trilobites moved, students answered, "They swam!" We discovered that some trilobites had eyes but some did not, and students engaged in a rich conversation about how trilobites would move without eyes. We also learned that trilobites were extinct, although relatives of the trilobites still live today.

We next discussed the crinoid fossils. Students had only found partial crinoids and so this discussion centered on how paleontologists make inferences about partial fossils by comparing them to today's living organisms. Students debated whether or not crinoids were plants or animals. Students offered explanations such as "They have stems like plants" or "That's not a stem, that's a snake." When asked, "Do you think this is a part of the fossil or the whole thing?" most students replied, "part." We looked at a more complete crinoid and learned that crinoids were animals that live in the sea stuck to rocks. Students then learned that crinoids are alive today and were shown a picture of an extant feather star.

As an assessment, children were given a page containing two environment pictures—an aquatic beach habitat and a terrestrial forest habitat. Students were given various familiar fossil stickers (ammonites, ferns, trilobite, dinosaur, and fish skeleton) and asked to place them in the environment where they would expect to find these fossils. Over the next 10 minutes, most children appropriately demonstrated their understanding by placing the ammonites (aquatic), fish (aquatic), and dinosaurs (terrestrial) but were less able to appropriately place the trilobites (aquatic) and ferns (terrestrial). When the children incorrectly placed an organism, we directed their attention to our previous discussion of the organisms ("Do you remember when we talked about trilobites?") and prompted them to think about specific adaptations ("What do you think these little things on the side were used for?")

Activity 3: Digging for Fossils With Many Parts

We started the next lesson with a 20-minute discussion about what students already knew about dinosaurs. When asked if students thought there were any dinosaurs still left today, most said "no" while one student offered that birds are actually dinosaurs. We reviewed the idea of extinction explored earlier.

We discussed how paleontologists dig and assemble fossil dinosaur bones. With some model felt dinosaur bones (Figure 2), students were ask to assemble the bones on a felt board. Teachers asked probing questions such as, "How do you think these fit together?" and "Is there only one way they could fit together?" (to the latter, students replied "no"). We discovered that paleontologists use what they know about dinosaurs and their imaginations

TABLE 1.

Fossil organisms in lesson.

Organism	Picture	Description	Age of Fossil
Trilobite		Extinct marine arthropods (animals) whose bodies were segmented into a head, thorax, and tail.	225–570 million years ago
Ammonite		Extinct marine mollusks (animals) with coiled shells.	65–190 million years ago
Crinoid		Extinct marine echinoderms (animals) that had stem attached to a surface and a crown of arms. Living relatives are feather stars.	225–570 million years ago
Fish		Bony fishes with bony skeletons and scaly skin.	395 million years ago – present
Crab		Horseshoe crabs that lived in freshwater environments. Related to present-day horseshoe crabs.	500 million years ago – present
Fern		True ferns (plants) that commonly grew as large trees in the Paleozoic. Living relatives are small ferns.	395 million years ago – present
Claw and Skeleton, Dinosaur		Reptiles (animals) that included plant- and meat-eaters and lived in a variety of aquatic and terrestrial habitats.	65–225 million years ago

Note: Information obtained from Thompson (1995)

to put dinosaur skeletons together. Students observed a model felt skeleton and were asked, "Which of these pictures might show how the dinosaur looked when it was alive?" Students realized that not all pictures were possible as some were not consistent with the skeletal structure. Therefore, we could make inferences about the type of dinosaur based on the skeleton.

Students engaged in two centers this day. For the outdoor dig, children worked in research teams of six and used small shovels to find baked play dough dinosaur

FIGURE 3.

Fossil arrangement and a drawing of an inferred dinosaur.

fossils. As teams, they collected 10 fossils at a time, assembled the bones, and drew their inferred dinosaurs. The children moved the fossils around on a table to infer the most likely whole skeleton. Figure 3 shows how one group arranged their fossils along with a drawing of an inferred dinosaur. Students spent about 10 minutes digging and 10 minutes analyzing their results. Appropriate performance on this dinosaur drawing task was exemplified by a drawing and description that included at least two found bones. The last center gave students an opportunity to practice making inferences from evidence and included paper dinosaur bones that children assembled to infer a whole animal.

We concluded this lesson with a 10-minute whole-group discussion about assembling dinosaur bones. When prompted, students answered the questions of whether everyone assembled the bones the same way ("no") and if we are sure about how to put these dinosaurs together ("no"). Students were reminded that paleontologists have to have a lot of background knowledge and good imaginations to figure out how to put dinosaur bones together. When asked how scientists know what color to make their pictures of dinosaurs, students recognized that "bones don't have any colors on them." We learned that paleontologists infer that dinosaurs were probably similar in color as to today's plants and animals.

As brief 10-minute assessment, children were given a page containing an environment with air, sky, and land depicted. They were asked to place three dinosaur stick-

Fossils on a Budget

Because the camp had a limited budget for supplies, I used art supplies to make "fake fossils" and only purchased a few items:

- Three fossil molds:
  - dinosaur-bone sandbox molds
  - a set of five plastic molds (ammonite, claw, trilobite, fossil fish skeleton, and crab)
  - a set of fossil molds through a science supply catalog (see image below)
- A bag of 100 unsorted fossils that contained a fossil key

To make fake fossils, I used plaster of paris for the indoor digs and bake-able play dough for the outdoor digs (see Internet Resource for recipes). A picture and description of these fossils are in Table 1. For safety purposes, the outdoor digs also required that children wear safety goggles. I made felt dinosaur skeletons and fossils for whole-group instruction. Finally, various assessments required stickers of fossils and dinosaurs, so I purchased stickers and made my own using clipart images printed on mailing label sheets.

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

Performance Expectation *The materials/lessons/activities outlined in this article are just one step toward reaching the performance expectation listed below. Additional supporting materials/lessons/activities will be required.*	**Connections to Classroom Activity**
3-LS4-1 Analyze and interpret data from fossils to provide evidence of the organisms and the environments in which they lived long ago.	Students collected fake fossils and examined real fossils to infer what the organisms might have looked like and the types of environments in which they might have lived.
Science and Engineering Practice	
Analyzing and Interpreting Data	Students used observational data about fossils to infer the structures and habitats of these once living organisms.
Disciplinary Core Idea	
LS4.A Evidence of Common Ancestry and Diversity • Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	Children examined ammonite fossils and imagined where they lived (Activity 1), drew their proposed organism from which their fossil class originated (Activity 2), debated whether crinoid fossils were partial or complete (Activity 2), asked to place fossil stickers in the environments where they thought they lived (Activity 2), and assembled dinosaur bones to draw what the whole dinosaur might have looked like (Activity 3).
Crosscutting Concept	
Systems and System Models	Students: • examined the partial fossils and the fossils with multiple parts to make inferences about how they fit together. • examined the fossils and made inferences about how the animal may have interacted with its environment.

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

English Language Arts

Kindergarten: Speaking and Listening Standards; Presentation of Knowledge and Ideas

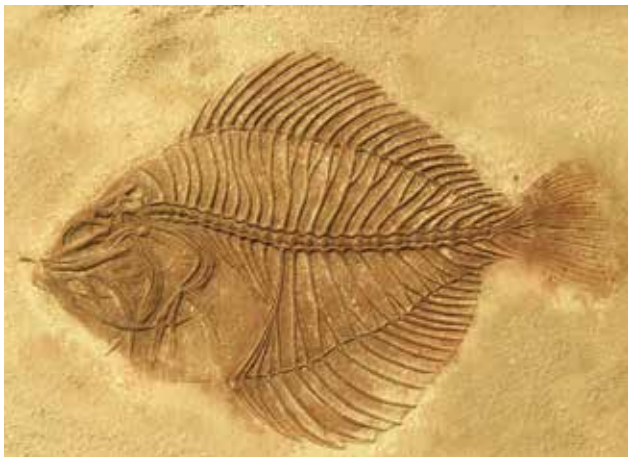
5. Add drawings or other visual displays to descriptions as desired to provide additional detail.

Mathematics

Kindergarten: Measurement and Data

1–2. Describe and compare measurable attributes

3. Classify objects and count the number of objects in each category.



ers (aquatic, terrestrial, and avian) where they thought they belonged. Almost all students correctly placed the aquatic and avian dinosaurs, with slightly fewer correctly placing the terrestrial dinosaurs. When students incorrectly placed a dinosaur, we circulated and asked questions about particular adaptations like "Does this one have wings?" and "Where do you think we would find a dinosaur with wings?"

At the end of the week, students were given a summative assessment in the form of individual interviews during which they were asked to identify fossils—pictured and real, familiar (used in previous activities) and unfamiliar.

Several modifications could be made to suit children in different contexts. First, in a larger class, consider adding additional centers. For example, one day, we included a coloring center where children colored paleontology coloring pages. Another day, we added a center where children could explore dinosaur picture books. Second, in a group that included mostly three- and four-year-olds, expect less understanding of time (as we experienced with the three-year-olds in this class) and focus more on making observations of similarities and differences between fossils. Finally, in a group that included mostly five- and six-year-olds, use more measurements and measurement tools while comparing the fossils they found. Our one concern about this lesson was that students might think that the plaster of paris and play-dough fossils were real. We tried to point out the differences between the authentic fossils and our homemade fossils often, and we recommend doing the same.

Conclusion

The children showed gains in their understandings of fossils, why fossils are found in particular places, and how paleontologists construct explanations from fossil evidence. Moreover, the students and I had so much fun exploring this topic. Parents came in each day saying that their children wanted to dig in their own backyards to find fossils! Based on this experience, I contend that preschool students can engage with and learn about fossils even at this early age. ■

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Internet Resource

Bake-able play dough for the outdoor digs
www.cooks.com/recipe/is6nn849/make-bake-playdough.html