Lesson Eight

The Meeting of the Dinosaurs

Evidence Given by Dinosaur Footprints

Summary
During the first set of activities, students focused on the basics, learning about rocks, minerals, time, and fossils. This activity is set up to give students the opportunity to use that knowledge to interpret a fossil site. It shows how paleontologists take fossils and bring an animal to life. In this case, the fossil data illustrates the interaction between two different species, telling a story of how they met and how only one remained alive after the encounter.

In the activity, the teacher shows a series of three slides, each of which reveals a bit more information about the animals. It can be done as either a class activity, in small groups, or individually. In all situations, the teacher projects the maps on to a board and asks students questions. Students could either write down their answers and turn them in or discuss them in groups with each group then presenting their information to the class.

A goal of this activity is for students to work at developing hypotheses, that is to make testable predictions based on evidence.

(*This lesson plan is adapted from one created by the "Earth learning idea" team. www.earthlearningidea.com*)

Objectives
Students will be able to:

1. Have students imagine that footprints were made by dinosaurs that lived near their school 66 million years ago and that the footprints were preserved as fossils in the sedimentary rocks.
2. Use evidence to reconstruct an ancient environment and the activities of some of the animals.
3. Hypothesize what types of dinosaurs might have made the footprints - herbivores or carnivores.
4. Describe how paleontologists use fossils to bring animals to life.
5. State how scientists develop and test an hypothesis.

Estimated teaching time
30 to 45 minutes depending on the age of the students.

Groups
This activity can be done either with the entire class or in smaller groups.

Materials

- Three maps and questions worksheet

Teacher background
While fossilization has the potential to leave behind only one set of bones per animal, it could result in hundreds to thousands of preserved tracks per animal. Paleontologists refer to such imprints as trace fossils, as opposed to body fossils such as bones or teeth. Not only do they have the potential to be more numerous, trace fossils can also reveal aspects of animal's life not directly shown by body fossils. They can provide us a snapshot of an animal's life. For example, tracks can show how fast an individual animal moved when it made the tracks, how it moved, if it traveled with another of its kind, how it hunted, and how it rested. This information can be used to inform our understanding of the paleobiology of that species.

As you have probably observed, tracks are generally ephemeral and only form in certain environments, thus finding them in the fossil record is rare. Wet sand and mud are good mediums for recording animal movement. Preservation requires new sediments of a different texture or color to fill in, bury, and protect the tracks. Then the tracks have to be buried and changed into rock and finally, that rock has to be exposed at the surface and be discovered.

Student background
It helps if students have done Lesson Plan Four on fossilization.

Set up
- Copy worksheets for students.
- Prepare maps to show to students. If you do the lesson plan with the entire class, you will need to have a way to project the images, either on an overhead or as a PowerPoint. If students work in groups, you can photocopy images for each group.

Introducing the activity
Go directly to Facilitating the Activity

Facilitating the activity
1. Explain to the students that 66 million years ago the area where their school sits was a floodplain of a large meandering river. Ask them:
   - What sort of evidence might you look for to better understand who lived in the area? (Body fossils such as teeth, bones, casts of bones, and molds of bones. Trace fossils, such as tracks, eggs, burrows, borings, and coprolites [fossil poop].)
   - How would the information from trace fossils differ from body fossils? (Trace fossils generally preserve direct evidence of biology or an activity. Body fossils also provide evidence but in a more indirect manner. Paleontologists have begun to use more advanced analyses, such as x-rays, computer CT-Scans, and computers, to tease out biology based on bones but trace fossils generally still provide more direct evidence. Also, note that it is often very challenging to know exactly who made a trace fossil. Paleontologists can make an informed analysis but without specific evidence of bones generally cannot say exactly who made the trace fossil. For example, when we see deer tracks, we know it was a deer because we have seen deer make those tracks and we know that deer live in that area. In contrast, when paleontologists discover fossil tracks they can infer who made them based on an animal's anatomy but they cannot be 100% sure because they haven't seen a particular animal leaving a particular track.)

- What sort of information can be learned from this evidence? (Who lived and died here, how they interacted, and how fast they grew [if there are enough bones, one can measure growth rates, how they walked, etc.])
- What cannot be learned from this sort of evidence? (Generally one cannot learn why something happened and often cannot learn how something happened, such as how did one animal kill another. We can make inferences that are plausible explanations of the data.)

2. Now tell them a bit more about what happened. Several varieties of dinosaurs often came down to the water and left their footprints in the mud. The mud dried out and became hard. This mud was then buried by more mud. Finally the mud became a hard rock - mudstone. The footprints were fossilized and are preserved as fossil tracks. In 1945, a school was built atop the mudstone covering most of the tracks but it is now being taken down, slowly revealing more fossil footprints in the mudstone.

3. Ask the students the following questions:
   - Have they ever seen tracks in a field, forest, beach, or some other natural setting?
   - What sort of information could they tell from seeing the tracks?
   - What sort of information could they not tell from seeing the tracks?

4. Show the students Map 1. (*Keep Maps 2 and 3 hidden.*) Ask them to imagine that the ground near their school is being dug up to build a new soccer field. As the old buildings are removed, the footprints shown on the map are discovered in the rocks below. Ask the students to look at the evidence and to develop an hypothesis about what happened 66 million years ago. <u>Encourage the students to look closely at the shape, style, spacing, etc. of the tracks. The goal here is to get the students to start considering what sort of prediction they can make. What can they predict? What can't they predict? Answers could include the following:</u>
   - One dinosaur was bigger than the other.
   - There could have been two types of dinosaurs or one could have been a juvenile. We can't tell whether both were herbivores (plant-eaters) or both were carnivores (meat-eaters) or if there was one of each.
   - The dinosaurs walked by on the same day and when one saw the other it started to run after it.
   - The dinosaurs walked by at different times, anywhere from hours to days to weeks apart.

   <u>A. Now they need to make an hypothesis, to make a testable prediction. Remember that as more evidence is revealed they may have to revise their hypothesis. Also, remember that whatever they predict, it has to be testable. Hypotheses could include the following:</u>
   - The large dinosaur caught the smaller one and ate it.
   - The small dinosaur was joined by others in the pack and they all attacked the large dinosaur.
   - Both dinosaurs were moving towards the same spot – maybe towards prey that they both wanted.
   - They are near a lake and they were going to drink.
   - The baby dinosaur joined its mother.

- The large footprints cross over the smaller ones (or vice versa) so the dinosaurs did not walk here at the same time.
- Both dinosaurs were walking on the mudflats and were not interested in each other.

B. What evidence in support of your ideas would you expect to see when more of the footprints have been uncovered? Answers could include the following:

- Signs of a struggle in the mud with footprints overlapping and the mud disturbed.
- The same as the above but with extra small footprints coming in.
- If the prey were alive, then there would be signs of a struggle. If it were dead, then there would be fewer or no signs of a struggle. In both events there could be some remains of the prey – maybe fossil bones.
- Both sets of footprints stop as the dinosaurs reach the water. There are more footprints as they walk away.
- Both sets of footprints join and continue walking together.
- The larger footprints would cover the smaller footprints (or vice versa), and would have smudged them.
- The footprints continue towards the east and show no relationship to each other.

5. Show the students Map 2 where the buildings have been cleared further away.
Ask the students to consider the following:

A. Was their hypothesis correct? Do they need more evidence? Do they need to revise their hypothesis? What hypothesis would they now make? Hypotheses could include the following:

- The large dinosaur walked away having eaten the smaller one.
- More small dinosaurs joined the struggle and killed the large dinosaur.
- Both dinosaurs walked away.
- The fight continued to the east and both dinosaurs died in the fight leaving their remains.
- The fight attracted lots more dinosaurs.

B. What evidence to support your ideas would you expect to see when more of the footprints have been uncovered? Answers could include the following:

- Only the large footprints would be seen and would be more closely spaced showing the dinosaur to be more sluggish than it was before.
- More small footprints would be seen coming to the site and only these would be seen leaving.
- The same two sets of footprints would be seen leaving. If they had fought, the animals may have been injured and there may be evidence for this in the footprints.
- There would be more signs of the struggle but fossil bones of the two animals would also be found (unless they were scavenged).
- There would be lots of different footprints.

C. Why do you think the dinosaurs came to this mudflat in the first place? (This is not part of a hypothesis as there is no way to test why an extinct animal did what it did.)

- The carnivores came to drink at the river and to search for prey.

- The herbivores came to drink and eat.

D. Does the fossil evidence provide the answer to this question?

- Although you cannot definitively answer "why questions" from fossils, you may be able to come up with plausible scenarios to explain the data or exclude certain scenarios.

6. Show the students Map 3, when the buildings have been cleared 10 m further back. Ask the students:

   A. Which of your ideas best fits the new evidence?

   B. Does this evidence change your ideas about why the dinosaurs came to the mudflat? If so, why?

Assessment

Ask students:

- Fossils are the physical evidence of an organism or an individual. What is the difference between a body fossil and a trace fossil? Trace fossils are the evidence of behavior and activity from one particular moment. They often provide biological information that is otherwise more indirectly inferred from body fossils.
- What is the advantage of one over the other? It depends on what one is looking for. Scientists usually cannot tell what animal made a specific trace. One skeleton equals one individual. Many tracks could come from one individual. Trace is a moment in time. Bone is a lifetime.

Now focus in specifically.

- What sort of evidence would the students use to reconstruct the life of dinosaurs? Answers include teeth marks in bones, tracks, coprolites, bones, teeth, eggs, and tail drag marks.
- Do they think that paleontologists can tell who made the trace fossils, such as tracks, coprolites, or eggs? Get them to think about when they have seen tracks. Can they tell for sure? They can make inferences and possibly narrow the possibilities but unless they see the animal walking they cannot tell for sure. Today, we have the advantage that we can see who makes the tracks, which paleontologists cannot.
- What other pieces of evidence might paleontologists look for? In the case of the situation above, finding the bones would at least provide some corroborating evidence. If they found bones with teeth marks in them, that could help but would not be conclusive. They might also find coprolites with the bones of an animal in them. Again, this would provide corroborating evidence but ultimately no one saw who pooped.
- What sort of evidence would they use to reconstruct a friend's life?
- What can't be learned from any of that evidence?

Going further

- If you live near sand or dirt, have students go out into and create a series of tracks and have other students try to intrepret what the fellow students did. For example, one student could walk and one could run and the others would have to figure who did what.

- Have students find their own evidence of animal traces, take photos of the traces, and get other students to figure out who or what produced that evidence.

References
NA

Teaching standards
Science Content Standard 4. Students, through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

Benchmark Grade 4, Number 3 -Use fossils to describe the geological timeline Investigate fossils and make inferences about life, the plants, animals, and the environment at that time E. Compare a fossil to a plant/animal living today F. Infer what fossils tell us about past life and the environment.

Glossary
- Trace fossils – Evidence of an animal's activity, such as tracks, burrows, eggs, teeth marks, coprolites, and borings.

The Meeting of Dinosaurs Questions

Map 1

A. What do you think the footprints shown in Map 1 tell you about the two dinosaurs?

B. Make an hypothesis about the two dinosaurs and what you think happened on the ground hidden by the buildings to the east. Your hypothesis must be a prediction that is testable.

C. What evidence in support of your ideas would you expect to see when more of the footprints have been uncovered?

Map 2

A. Make an hypothesis about the two dinosaurs and what you think happened on the ground hidden by the buildings to the east. Your hypothesis must be a prediction that is testable.

B. What evidence to support your ideas would you expect to see when more of the footprints have been uncovered?

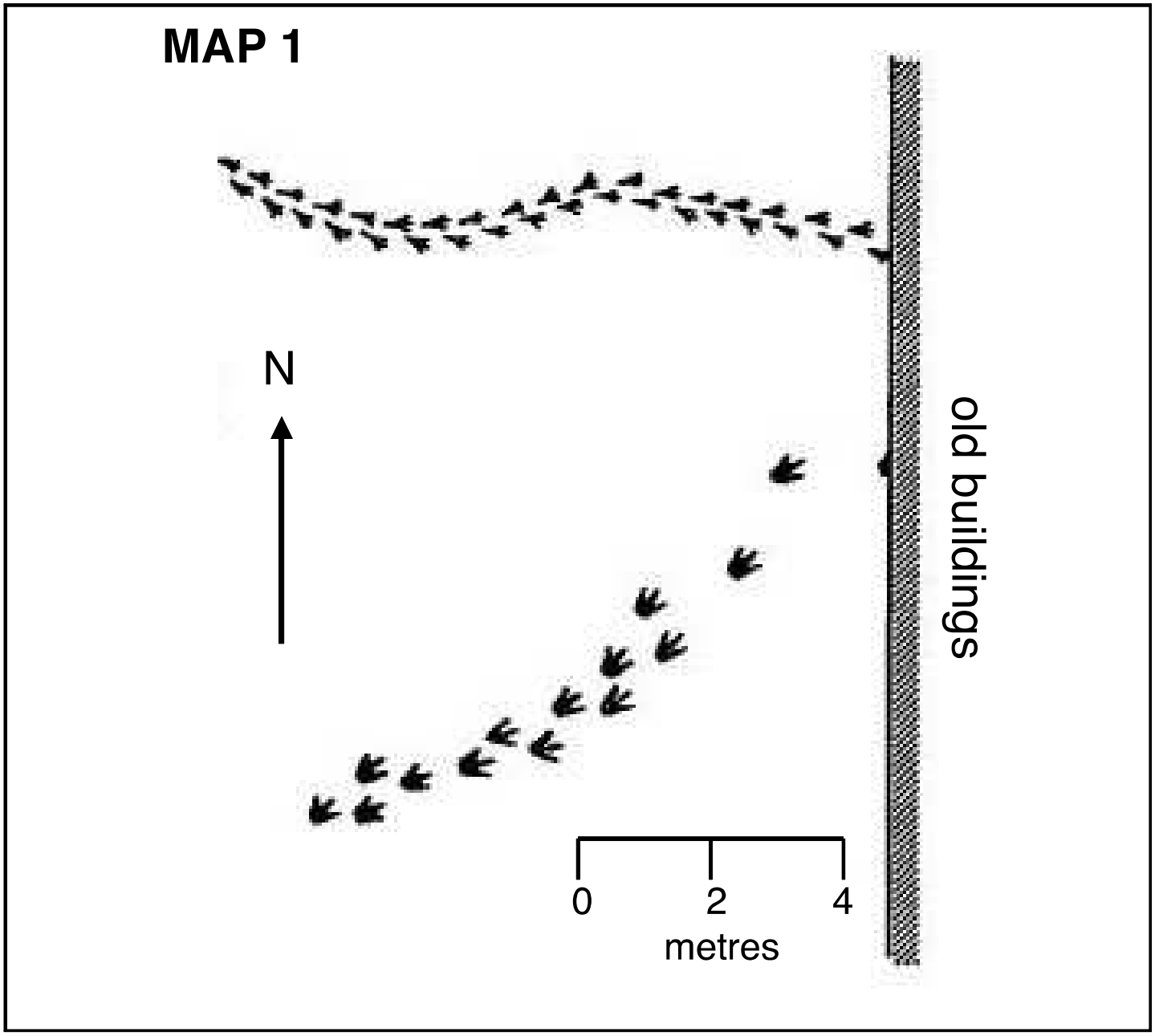
C. Why do you think the dinosaurs came to this mudflat in the first place? Is this a testable question?

D. Does the fossil evidence provide the answer to this question?

Map 3

A. Which of your ideas best fits the new evidence?

B. Does this evidence change your ideas about why the dinosaurs came to the mudflat? If so, why?


MAP 1
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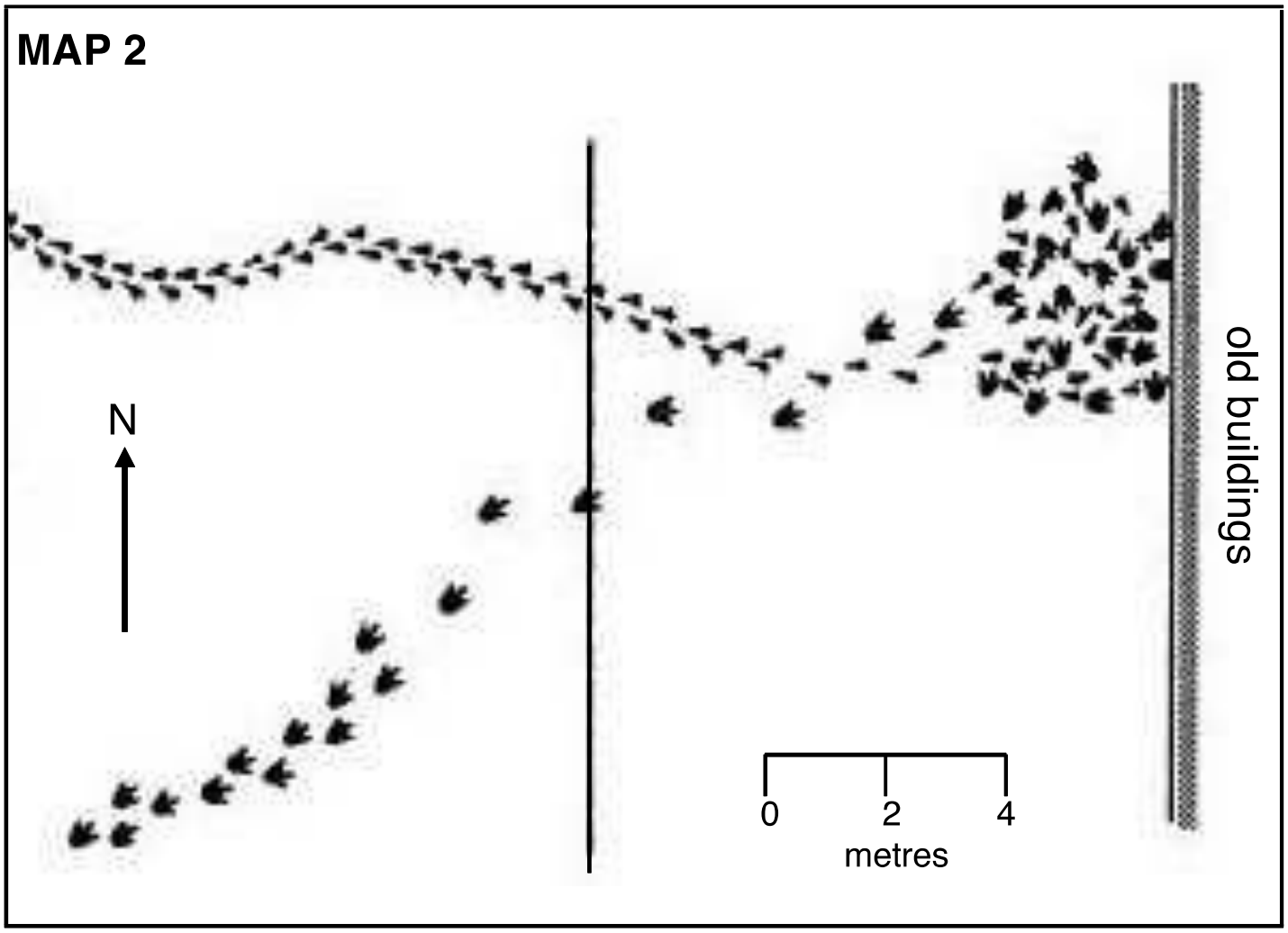
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MAP 3