Tricky tracks

Fossil Finders Curriculum, University of Georgia- Spring 2013

Lesson Description

This lesson engages students in the nature of science and introduces them to the work of paleontologists through interpreting the geologic past. Students will learn about making observations and inferences based on evidence.

* Tricky Tracks was adapted from the National Academy of Sciences (1998). Teaching about Evolution and the Nature of Science. Washington, D.C.: National Academy Press. (ISBN: 0309063647) pp. 87-89.

Time Estimate: 50 Minutes

Essential Questions

What is the difference between and observation and an inference? What is the difference between a quantitative and qualitative observation? How does this lesson relate to what scientists do?

Learning Outcomes: The students will…

- Distinguish between observations and inferences
- Distinguish between quantitative and qualitative observations
- Propose explanations and make predictions based on evidence
- Recognize and analyze alternative explanations and predictions
- Recognize that scientific explanations are subject to change
- Recognize that scientific explanations must meet criteria such as: being consistent with experimental and observational evidence about nature, yield accurate predictions, be logical, respect the rules of evidence, be open to criticism, report methods and procedures, and make knowledge public

Next Generation Science Standards

Scientific and Engineering Practices

4. Analyzing and interpreting data
6. Constructing explanations
8. Obtaining, evaluating and communicating information

Crosscutting Concepts

1. Patterns

NGSS Nature of Science

Scientific Knowledge is Based on Empirical Evidence
Scientific Knowledge is Open to Revision in Light of New Evidence
Science is a Human Endeavor

Vocabulary

Observing- the process of using one or more of your senses to gather information

Inferring- The process of making an inference, an interpretation based on observations and prior knowledge

Quantitative- observations that use numbers which can be measured such as: height, length, width, area, volume, temperature, speed, humidity and cost.

Qualitative- type of observation describing things that are difficult to measure. These observations use qualities or characteristics such as smell, taste, texture, color.

Materials

- Box of cereal that has pieces of different colors (Trix, Fruity Cheerios etc).
- Paper towel or napkins
- Ruler
- Blank sheet of paper
- Crayons or colored pencils
- Overhead projector (If none is available you may also make student copies of the Tricky Tracks Overhead Slide for student use)
- Tricky Tracks Overhead Slide or PowerPoint
- Tricky Tracks Field Notes Handout and Make Your Own Footprint Puzzle Handout

Safety

- Make sure students do not throw cereal pieces
- Check to make sure students do not have any food allergies before allowing them to work with cereal pieces
- Demonstrate appropriate ruler use

Preparation

Make an overhead transparency of the footprint puzzle from the master provided on the website or use the PowerPoint from the Fossil Finders website. If using a transparency, have a blank piece of paper on hand to mask the puzzle when it is put on the projector. If you do not have a projector you may print out the overhead on paper and distribute them to students, but you must cut it into three pieces and hand out each piece individually. Copy handouts for students or provide scratch paper. Please note, the suggestions given in the lesson are ideas to help address nature of science concepts, there are many other concepts and ideas one can do and discuss with this activity. Do not feel constrained by what is suggested in the lesson.

Engage (5-10 minutes)

In small groups or individually pass out a small amount of cereal to students. Cereal pieces should be put on a piece of paper towel or napkin. Pass out a ruler to each student. Tell students to spend some time "checking out" the cereal and writing down anything they notice about the cereal on a piece of paper. At this point, do not tell students they must use the ruler and do not use the word observation yet.

After about 5 minutes call on students and make a class list of things that they noticed about the cereal (such as color, size, shape, number, smell, taste). Please

note, that students may have different numbers or colors based on randomness. If students only used their sense of sight encourage them to use their other senses to describe the cereal. If students did not think to use the ruler encourage them to measure their cereal pieces using the millimeter side of the ruler.

Explain to the students that what they just did was to make observations and that scientists often make observations. Explain the difference between a quantitative and qualitative observation. You may want to split a blackboard into two columns and then divide student cereal observations into the appropriate category.

Tricky Tracks (20-25 minutes, try to spend about 5 minutes on each position)
Tell students to imagine they are part of a group of scientists working in the field in Texas that just found a set of fossilized tracks and that they will be the first to investigate the tracks. Explain how each set of tracks can tell a story about what happened in the past and by observing these tracks they can infer what happened in the past.

Tell students that they will be taking field notes like a scientist and recording their observations and inferences about the tracks. Have students fill in the top of the Tricky Tracks Field Notes Sheet. You may choose to use the internet to look up the weather conditions for Glen Rose, Texas to make it more authentic for students. Start with position 1 of the footprints from the overhead while covering the other two positions with a blank piece of paper. You may also use the Tricky Tracks PowerPoint presentation. Using the Tricky Track Field Notes Handout, ask students to write down as many observations as they can about position 1 in the blank provided.

Next, have students partner with another student or several other students to discuss their observations. Allow a few minutes for students to confer with their partner(s). Bring the class together and ask groups to share their observations.

Discuss what an inference is and have students make their own inferences. Explain how scientists must use their observations to make inferences. You could also compare this action to being like a detective.

Give students a chance to compare their interpretation with other students; you may do this in small groups or as part of a class discussion. Have students answer the questions “how does your interpretation differ from your neighbors?...” etc.

E.g. of observations: one is red or one is green, students may count the number of prints or compare sizes.

E.g. These are animal tracks or they are heading towards the same point. Inferences here include calling the marks “animal tracks” or stating they are moving towards the “same point.” One can only be sure that these as animal tracks if they observed the tracks being formed.

Tell students that a funding agency has given them money to excavate more of the track site. Uncover the second position, position 2, of the puzzle and allow time for the students to consider the new information. Use a think, pair, share strategy or

continued group work. Students will see that the first explanation may need to be modified and new explanations may need to be added. Additionally, they might notice that not all of their interpretations are the same. Ask them to explain why there is more than one interpretation for what is happening if everyone is seeing the same picture. Have students share their observations and inferences again with the class and engage them in a similar discussion asking if their hypotheses have stayed the same or changed. Another option is to allow the student groups to critique one another's hypotheses based on the evidence they see in the picture.

For the final position, position 3, tell students more funding has come through to unearth the rest of the track site. Reveal the complete puzzle and ask students to interpret what happened. It is important for students to understand that any reasonable explanation must be based only on those proposed explanations that still apply when the entire puzzle is projected. For an interpretation to be acceptable it must be consistent with all the evidence.

Should it become necessary to challenge the students' thinking and stimulate the discussion, the following questions may help. "In what directions did the animals move? Did they change their speed and direction? What might have changed the footprint pattern? Was the land level or irregular? Was the soil moist or dry on the day these tracks were made? In what kind of rock were the prints made? Were the sediments coarse or fine where the tracks were made? What environment could you find tracks like these today?" (National Academy of Science, 1998).

Take some time to discuss the environment in which the tracks were created. For dinosaur tracks, the climate was most likely warm and humid. Students may suggest that the dinosaurs did not see each other and may propose the idea that there was vegetation. Widened pace might suggest a slope or change in speed. Have students give ideas on what the surface was like at the time the tracks were laid down. What conditions were necessary for their preservation?

Make Your Own Footprints Puzzle (10 minutes, you may choose to let students take home to finish)

Pass out the Make Your Own Footprints Puzzle and crayons or colored pencils to students. On the front side students will make their own puzzle and on the back side they will fill in a table which shows observations and inferences for each position.

Concluding Discussion (5-10 minutes)

Bring in the nature of science and discuss with students a real-world example of science being tentative. Tell students that within the last ten years there has been a controversy in paleontology with the "dinosaur dancefloor" on the Utah-Arizona border. This site is unique because the impressions in the rock were hard for scientists to figure out what they were and were originally thought to just be "potholes" formed by erosion. After further investigation some scientists now think that the impressions are dinosaur footprints and tailmarks, but not everyone is convinced. Use the internet to show students pictures from the article and ask their thoughts on the issue. Ask students to think about how this story relates to what they did today during tricky tracks.

http://unews.utah.edu/old/p/042508-1.html
http://www.eurekalert.org/pub_releases/2008-10/uou-dd101708.php

Assessment

Collect the Make Your Own Trackway assignment to see students' understanding of observation and inference. Optional: Give students a journal prompt and ask them to answer how two scientists could have different explanations for the same problem.

Teachers Tips

- We extended this lesson by students coming up with their own tracks and stories. Some students also researched different animals and their tracks independently.
- I gave very little explanation and minimal prompts as we went through this investigation. It was interesting to see how student hypotheses changed with the increasing information and by sharing with one another. At the end of the period, I introduced some potential bits of information such as the type of animal (dinosaur), the existence of vegetation/obstructed views, climate, slope, etc.
- An extension I included to this lesson was having my students create narrative "Tricky Track" stories incorporating their inferences and vocabulary learned.
- I enlarged the copy and went to Staples and had them make a color overhead of the Tricky Tracks. I then cut it into the 3 sections. I was then able to manipulate the track sections so the students could try to get them in order first. This got them thinking about the order and possible reasons for it (observations/inferences). These were difficult concepts for some and I spent a bit more time with this concept. I did a Mystery Box activity where students had to infer about objects that might be in the closed boxes and write a short note explaining. Also, I assigned a similar activity to Tricky Tracks where students had to take it home and do the activity with someone. Students were very engaged and loved the activity. The next day for a launch I used a recent picture of an object spotted on Mars that appears to be human and the students had to make observations and inferences.
- As the students shared their answers I put them into two lists- the observations on one side and the inferences on the other. After they all shared we discussed the differences between the two lists. We studied observations and inferences in the beginning of the year, so this was a nice review.
- I found other inference and observation worksheets to send as homework for more practice.
- At the conclusion of the track bed discussion I included photographs of real track beds and photos of a scientist/artist interpretation of a track bed at the Children's Museum in Baltimore. This shows a saurapod being attacked by a therapod.
- I had students write stories in their notebooks about what they thought happened. I had to remind them that a scientific inference is a REASONABLE explanation.

- I had my 6th graders share the lesson with 1st graders. The first graders told the 6th graders the story based on the "Tricky Tracks" slide and then the partners shared with the whole class. The 6th graders were the experts here and the 1st graders got to learn about fossils in the process.
- There is a kit available from AMEP called Fossils Videolab that I use. The kit has life sized posters of 2 different types of dinosaur footprints (front and back feet). Students are asked questions such as, "Do you think either of these may have been a predator and why do you say this? Why do you think this animal's front feet looked so different from its back feet?" It also asks questions about their environment. Great for inferring!

ELL Adaptations

1) Include a variety of cultural experiences and materials in instruction.
   - How do other cultures understand the geologic past? Ask students.
   - What are some examples of observations/inferences made by people from other cultures? (i.e. is the world round?)
2) Share scientific authority
   - Respond to student questions with further probing questions.
   - Employ the use of a student journal to record their observations and explanations
   - Invite students to try Tricky Tracks at home with family (provide hand-out on paper). What do family members think?
3) Encourage the use of students' home language to enhance understanding in classroom instruction.
   - Supplement KWL charts and graphic organizers with use of native language and student sketches
   - Invite the use of native language for classroom discussion, reading, note-taking
   - Group students to communicate in native language when using reciprocal teaching and other instructional strategies
4) Tailor verbal communication (in English) to enhance students' understanding
   - Provide visual aides when introducing students to new vocabulary and concepts.
   - Use hand and facial gestures.

ELL References

Barton, M. L., & Jordan, D. L. (2001). Teaching Reading in Science: A Supplement to the Second Edition of Teaching Reading in the Content Areas Teacher's Manual. Aurora, CO: Mid-continent Research for Education and Learning.

Luykx, A., & Lee, O. (2007). Measuring instructional congruence in elementary science classrooms: Pedagogical and methodological components of a theoretical framework. Journal of Research in Science Teaching, 44(3), 424-447.