

SYNOPSIS

Footprint diagrams were made from the trackway of *Australopithecus afarensis* (“Lucy’s” species) at the Laetoli site in East Africa. They are topographic in nature, showing details of depth and superposition. Students are asked a series of probing questions, some requiring direct observation, others expecting inferences and analysis. This is an excellent example of an historical problem-solving exercise, using clues to derive a likely picture of a past event, very much like crime scene scientists must do. It’s also open-ended, where students try to reach a “best explanation” based on the data and reasonable interpretations, with no “correct answer” available.

CONCEPTS

1. Evidence in the present can reveal events of the past.
2. Scientific knowledge is uncertain, tentative and subject to revision.
3. Scientific explanations and interpretations can neither be proven nor disproven with certainty.
4. Scientists use a variety of criteria to compare explanations and select the better ones.
5. Human values deeply influence science (its terminology, the questions asked, and the criteria used for choosing among theories).

TEACHER MATERIALS

Overhead transparencies (or slides) of trackway and enlarged footprints (for class discussion)
Key to Worksheet (reasonable responses)

STUDENT HANDOUTS

Laetoli Puzzle Worksheet

Sheet with Sample **Laetoli Topographic Tracks** with 3 pairs of footprints

Sheet with two **Enlarged Footprints A** (G.1-33 and G.2/3-24)

Sheet with two **Enlarged Footprints B** (G.1-35 and G.2/3-26)

TEACHING CONTEXT

This lesson could be used during your introductory unit on the nature of science as an example of a non-experimental problem-solving process, the type of science (“historical science”) done to help us understand past events that are not repeatable. The thinking processes are much like those used in the **Checks Lab** and **The Great Fossil Find** lesson. It could also be easily inserted in the human evolution portion of your evolution unit, perhaps in conjunction with the lessons on **Hominid Cranial Comparisons** and the **Chronology Lab**.

PROCEDURE

1. Hand out (or show on your screen) the **Sample Laetoli Topographic Tracks**. Ask your students to describe what they see, giving several students an opportunity to respond without much (if any) comment. You may want to jot down short versions of each "observation" on the board or screen for later reference. Do this until at least 2-3 statements are made that are actually assumptions, not direct observations.
2. When they seem to run out of observations, ask them to look at the list, and say “are you sure you can actually see each of these things?” Out of this should come at least a few examples of inferences based on the observations, rather than directly observable items in the diagram. The idea here is that they become sensitized to what they actually see vs what they automatically infer or assume from their observations.

3. Turning to the inferences, ask “Why do you say that?” - getting them to point out specific features shown that might suggest what they inferred. Then ask another student “Could this suggest any other inference?” until you can get at least 2-3 other inferences. While doing this, look for examples of inference that could be attributed to prior experiences or biases on the part of each responding student. Experiences could include walking in sand; biases could include gender bias. All of this is to reinforce that, often, what we think we see we are actually assuming. This dialog should also reinforce the importance of distinguishing observations from inferences, and recognizing how inferences are influenced by personal experiences, opinions, and various biases. Finally, it’s important that they recognize the importance of restricting inferences as close to the observed clues as they can.

4. This should set the stage for handing out the **Laetoli Puzzle Worksheets**. This could be one worksheet for each group of 3-4, or each pair, or even one per student. Groups of 2-4 would probably be best, encouraging them to discuss elements of the introduction as they work with each prompt. The questions become increasingly challenging, but let them grapple with them, doing the best they can, but always tying inferences to the observed clues. As teams work on this, hand out to each team the two additional sheets: **Enlarged Footprints 33 & 24**, and **Enlarged Footprints 35 & 26**. These could be printed back to back on a single sheet, and/or placed in a protective plastic sleeve.

5. When all/most teams are done, or nearly done, open the class to a class-wide discussion - with different people in each team sharing out their responses, to see how much agreement or variety of responses they get, and the reasons why they answered as they did.

6. It would be interesting to see if there is any class consensus on their answers to some of the questions. It would also be instructive to point out that universal consensus on observations could be considered “evidence of reality” (recognizing that this is only diagrammatic representation - or picture - of the original tracks in Africa). In science, we would call such consensus a “scientific fact.”

7. Other degrees of consensus, essentially on inferred assumptions, characterize the mental constructs that we call “ideas” or, more formally, if explanatory, testable and based on observations, “hypotheses.” In a few cases, you should be sure to ask dissenters, “What would you need to know or see in order to go along with the majority?” And, to a majority person or two, “Could your interpretation be changed with new evidence? If so, what kind of evidence? What kinds of clues would you look for? Where?”

8. When completed, be sure to point out these footprints were found in hardened volcanic ash (called “tuff”) in East Africa, and dated at about 3.6 million years in age, about the time that the prehistoric human called “Lucy” (*Australopithecus afarensis*) lived in the region, based on many fossils found for that time frame. When you do this, ask what the trackway suggests about how those early hominids walked (listen for “on two feet” or “bipedally”). You might also want to ask “How tall do you think they were? How could you find out? What other information would help?”

ASSESSMENT

Be sure to do a closing commentary, with students filling in key terms and ideas, or have them respond to “Tell me something new that you learned today.” They should realize that good science can be done on past events by careful observation and analysis of surviving clues (“Evidence in the present can reveal events of the past.”) They should see the distinction between observations and inferences, the role of experiences and biases in creating our inferences, the tentative nature of inferences and explanations, that a scientific fact is a critical observation confirmed by many critical viewers (and can even change with better viewing equipment), that a hypothesis is a tentative, testable explanation for something in nature.

EXTENSIONS & VARIATIONS

1. You may want to engage the class (or interested students) in figuring out how tall the Laetoli walkers were. That's what the "**Footsteps in Time**" lesson is all about, but it could be simplified here by getting them to hypothesize that tallness is directly proportional to foot length, measuring the feet and corresponding heights of classmates to get an approximate correlation (great graphing exercise, plotting a straight line through the cluster of plotted points of height vs foot length), calculating the actual foot lengths by applying the scale on the two trackways sheet - or doing a scaling calculation (comparing the 1:5 scale on the sheet with dimensions on a metric ruler, and this proportion to the approximate lengths of each foot).
2. The **Checks Lab**, **The Great Fossil Find**, **Crime Scene Scenario**, and **Crime Against Plants** provide similar experiences with "historical science," and could be used for reinforcement, or inserted later in the course in appropriate contexts.

RESOURCE

The photogrammetric ("topographic") illustrations used here were adapted from a small portion of Fig. D.3 Site G 1/5th scale of the footprints in the southern part of the hominid trails, as a pocket insert published in
Leakey, Mary D. & J.M. Harris (Ed). 1987. *Laetoli: a Pliocene Site in Northern Tanzania*. Clarendon Press, Oxford.

ATTRIBUTION

Created 2004 by Larry Flammer