



PALEO HUNTER

STEAM Education – Dino Dig Workshop

Introduction

The Paleo Hunter™ Dino Dig Workshop is a hands-on discovery-packed exploration of the prehistoric world of dinosaurs. Through a variety of activities students will learn about:

- Developing goals for scientific inquiry
- Understanding what is a fossil
- Understanding geological time
- Vocabulary/Definitions

Key Concepts & Terms

Paleo Hunter Dino Dig Workshop is designed to help students understand what Scientific Inquiry is and develop the habits of inquiry and skills of expression that they need to be critical thinkers, effective communicators and active citizens in today's world. Digging for Dinosaur bones while researching for information about these prehistoric creatures and the time periods during which these animals existed will provide the context to understanding structure and function

of living systems, changes in environments, population and ecosystems, diversity and adaptation of organisms.

Dig Concepts & Terms

Many Scientific inquiry steps and techniques are employed and followed from finding a fossil to displaying it in a museum for all to see. What is a fossil? How do paleontologists find sites to explore? Do they need permission to dig? How do they prepare a site? What tools do they use? How do they label, document and record their findings?

Learning Objectives

Upon completion of this teachers' guide you will be able to:

- Understand what a fossil is and know the difference between body fossils and trace fossils.
- Explain how scientists establish the age of fossils.
- Identify and discuss what makes a dinosaur a dinosaur
- Understand Cladistics and how dinosaurs are grouped



Scientific Inquiry

Key Concepts & Terms

Propose the following question to the class and capture all the answers from the class:

Do you know what scientists do?

Answer: Scientists study the world around them and explain things based on what they find out.

Scientific Inquiry vs. Scientific Method

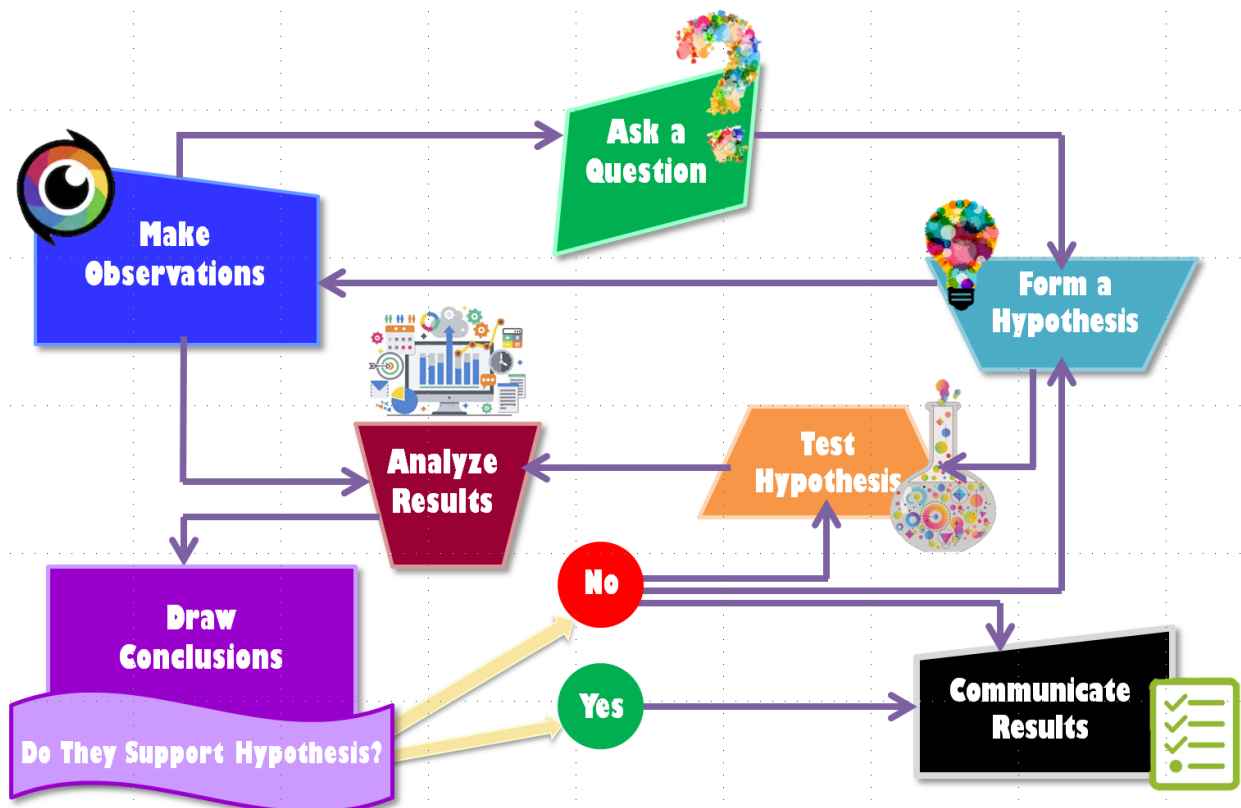
SCIENTIFIC INQUIRY	SCIENTIFIC METHOD
Posed question may generate more questions	Answers a single question
Undefined, non-linear and fluid path	Has a defined and linear path
Communicating and discussions are key throughout investigation	Results are communicated at the end of the experiment

What is Scientific Inquiry?

The National Science Education Standards defines scientific inquiry as "the diverse ways in which scientists study the natural world and propose explanations based on the evidence derived from their work. Scientific inquiry also refers to the activities through which students develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world."

It is also important to note that there are no specific steps that all scientific investigations follow. Different kinds of questions require different kinds of scientific investigations.

Scientific Inquiry is crucial for scientific thinking while the Scientific Method is necessary for lab reports. The table above shows some differences between Scientific Inquiry and the Scientific Method. The flow chart below shows the process a Scientific Inquiry could take.





What Is A Fossil?

Fossils

A fossil is the remains or impression of a prehistoric organism, at least 10,000 years old, preserved in earth, or as a mold or cast in rock - bones, teeth, skin, feathers, footprints. Fossils have been found and excavated from ancient riverbeds and lakes, caves, volcanic ash falls, and tar pits. There are two types of fossils - body fossils or trace fossils:

- Body fossils are parts of the organism - bones or teeth.
- Trace fossils are footprints, dung, burrows, and eggs.

Class Learning Activity:

Learning the difference between body fossils and trace fossils

1. Lead a discussion with the class on fossils and ask students to describe in their own words what they think fossils are. Explain a fossil is any evidence of life that is at least 10,000 years old and that dinosaur fossils are much older - some are 65 million years old, while others are over 225 million years old! Explain that paleontologists use fossils to puzzle together information about life long ago. Ask students to research the web to find 5-10 samples of different kinds of fossils.
2. Create two columns on the white-board: 1) Body Fossils and 2) Trace Fossils and have students classify the fossils they found into one of the two buckets. Lead a discussion on the difference between the two fossils.

How do we know some dinosaurs roamed earth 225 million years ago while others 65 million years ago?

How can we tell how old a fossil is? Scientists use two main methods to determine the age of a fossil:

1. Relative dating - provides an approximate age of fossils by comparing them to similar rocks and fossils of known ages
2. Absolute dating - Determines the exact age of a fossil by using radiometric dating which measures the decay of isotopes, either within the fossil or more specifically the rocks the fossils were found in.

The majority of the time fossils are dated using **relative dating** techniques.

For example if you have a fossil trilobite and it was found in the Wheeler Formation, which has been previously dated to approximately 507 million year old, then we know the trilobite is also about 507 million years old. But, how can we determine how old a rock formation is, if it hasn't previously been dated?

Scientists can use certain types of fossils referred to as index fossils to assist in relative dating via correlation. Index fossils are fossils that are known to only occur within a very specific age range. Typically commonly occurring fossils that had a widespread geographic distribution such as brachiopods, trilobites, and ammonites work best as index fossils. If the fossil you are trying to date occurs alongside one of these index fossils, then the fossil you are dating must fall into the age range of the index fossil.

Absolute Dating uses radioactive minerals that occur in rocks like a geological clock. Volcanic rocks are much easier to date than the fossils themselves, or the sedimentary rocks they are found in. Often layers of volcanic rocks above and below the fossils can be dated to provide a date range.

The atoms in some chemical elements have different forms, called isotopes. These isotopes break down at a constant rate over time through radioactive decay. By measuring the ratio of the amount of the original (parent) isotope to the amount of the (daughter) isotopes that it breaks down into, an age can be determined.

The rate of radioactive decay is called a half-life. If a radioactive isotope has a half-life of 5,000 years, that means after 5,000 years exactly half has decayed from the parent isotope into the daughter isotopes. In another 5,000 years, half of the remaining parent isotope will have decayed.

Carbon dating is rarely applicable to fossils. Carbon-14, the radioactive isotope of carbon used in carbon dating has a half-life of 5,730 years, so it decays too fast. It can only be used to date fossils younger than about 75,000 years. Potassium-40 on the other hand has a half life of 1.25 billion years and is common in rocks and minerals. This makes it ideal for dating much older rocks and fossils.



What Is A Fossil?

How are Fossils Formed?

Animal fossils are formed when an animal dies and slowly becomes covered with soil, mud or silt. Over thousands of years, the animal decomposes and the hard parts of the body become replaced with minerals; this process is called permineralization.

Fossils are often found in sedimentary rock, which is formed by the layering of material over many years. Over time soil and rock layers slowly become pressed together into hard rock, trapping plant or animal remains between the layers, as fossils.

Because sedimentary rocks form in layers, scientists believe that fossils also form in layers from the oldest fossil to the youngest. Fossils at the bottom of a deep layer of rock are likely the oldest; fossils toward the top of a rock are likely the youngest.

But, we know that over time, layers of rock can shift. Sometimes, sedimentary rock layers are not horizontal, but have been moved or shifted due to some change in the Earth.

Some fossils are easy to identify and look like plants and animals alive today.



How do fossils help us learn about the history of Earth?

By studying fossils, scientists can tell how long life has existed on Earth, and how different plants and animals are related to each other. Often, they can work out how and where they lived, and use this information to find out about ancient environments.

Some fossils are easy to identify and look like plants and animals alive today. But many fossils represent animals that no longer exist on earth.

Some animals and plant are only known to us as fossils.



Extinct Animals and Plants

Through unearthing and studying their remains, paleontologists learned what they know today about dinosaurs and saber-toothed tigers. Scientists can put together how the plant or animal looked based on its skeletal structure, discover what the animals ate, and where they lived and how they died. Fossils provide an important record of the species that otherwise may never have been discovered because they died long before people began keeping records.

Evolutionary Evidence

Species evolve over long periods of time, and the change can occur so slowly that it is difficult to know where one species ends and a new species begins. However, fossils help fill in the blanks. By studying fossils, researchers identified the first amphibious creatures that developed legs, a discovery that led to discerning the first species that evolved to live on land. The study of fossils also can identify some factors that influenced evolutionary change. For example, drastic climate changes may kill some species out entirely, or allow only those that adapted to the new environment to survive.

Earth's Geological Time

Scientists who study the past try to put events in their proper order. Long before geologists had the means to recognize and express time in numbers of years before the present, they developed the geologic time scale. Earth's history is subdivided into eons, which are subdivided into eras, which are subdivided into periods, which are subdivided into epochs. See Earth's Geological Time Table on Page 4.

EARTH'S GEOLOGICAL TIME



EON	ERA	PERIOD	EPOCH	MILLIONS OF YEARS AGO	
Phnerozoic	Cenozoic	Quarternary	Holocene	NOW	
			Pleistocene	Late	0.1
				Early	0.8
		Tertiary	Pliocene	Late	1.8
				Early	3.6
			Miocene	Late	5.3
				Middle	11.2
				Early	16.4
			Oligocene	Late	23.7
		Early		28.5	
		Eocene	Late	33.7	
			Middle	41.3	
			Early	49.0	
		Paleocene	Late	54.8	
			Early	61.0	
	Mesozoic	Cretaceous	Late	65.0	
			Early	99.0	
		Jurassic	Late	144.0	
			Middle	159.0	
			Early	180.0	
		Triassic	Late	206.0	
			Middle	227.0	
			Early	242.0	
		Paleozoic	Permian	Late	248.0
				Early	256.0
			Pennsylvanian		290.0
				Mississippian	
			Devonian	Late	354.0
				Middle	370.0
				Early	391.0
Silurian	Late		417.0		
	Early	423.0			
Ordovician	Late	443.0			
	Middle	458.0			
	Early	470.0			
Cambrian	D	490.0			
	C	490.0			
	B	500.0			
		512.0			
	A	520.0			
Precambrian	Proterozoic	Late	543.0		
		Middle	900.0		
		Early	1,600.0		
	Archean		2,500.0		
			3,000.0		
		3,400.0			
		4,000.0			



Vocabulary / Definitions / Assessment

fossil: A remainder of an organism that has been preserved in the Earth's crust.

body fossil: A fossil of an organism's body.

trace fossil: A fossil that shows the activity of an animal or plant but is not formed from the organism itself. A trace fossil shows that an organism was present. Examples: burrows, trails, footprints or droppings.

chemical fossil: Also called biomarkers – a chemical trace of an organism.

extinct: No longer existing.

geologic time scale: A scientific method for classifying historical time periods.

macrofossil: A larger fossil specimen, one large enough to be observed by direct inspection.

microfossil: A fossil that can be studied only microscopically, and that may be either a fragment of a larger organism or an entire tiny organism.

paleontologist: A person who studies fossils.

paleontology: The study of fossils.

permineralization: The process whereby groundwater permeates an organism and minerals from the groundwater precipitate out and fill the empty spaces in the body, thus forming a body fossil.

Class Quiz:

Ask several true/false questions about the lesson material and have students vote by holding thumbs up for true and thumbs down for false. Tally the votes and write the totals on the board. Give the right answer. Example questions:

- True or False: A piece of animal droppings (poop) can be a fossil.
(Answer: True. This type of fossil is called a trace fossil because it shows that an organism was there.)
- True or False: Fossils are formed when people place them into sand for other people to find later.
(Answer: False. Fossils are formed by sedimentary rock being formed on top of and around a dead organism.)
- True or False: Paleontology is the study of Earth.
(False: Fossils)
- True or False: Geological Time Scale shows time in numbers of years before the present.
(Answer: False. Geological Time Scale subdivides Earth's history into eons, which are subdivided into eras, which are subdivided into periods, which are subdivided into epochs.)