Impact Craters

Lesson 4 – What Really Happened to the Dinosaurs?

USGS
science for a changing world
Astrogeology Research Program

What Really Happened to the Dinosaurs?

Grade level: 7-12

Objectives:

- Use the scientific method to generate proposed explanations for the extinction of the dinosaurs.
- Evaluation of scientific evidence relevant to the dinosaur extinctions.
- Work in cooperative groups to conduct research.
- Oral presentation of group research to peers.

Arizona State Standards:

- **6SC-F5.** Identify major features of natural processes and forces that shape the Earth's surface, including weathering and volcanic activity. **PO 3.** Identify natural processes (e.g., earthquakes, floods, volcanic eruptions) that rapidly shape the Earth's surface.
- **1SC-P1.** Propose solutions to practical and theoretical problems by synthesizing and evaluating information gained from scientific investigations. **PO 1**. Evaluate scientific information for relevance to a given problem. **PO 2**. Propose solutions to a problem based on information gained from scientific investigations.
- **1SC-P4.** Create and defend a written plan of action for a scientific investigation. **PO 1**. Design an appropriate protocol (written plan of action) for the investigation of a scientific problem. **PO 2**. Justify the protocol in terms of the elements of experimental design.

Introduction:

Up until 1980 scientists were divided on what had caused the extinction of the dinosaurs approximately 65 Ma (Ma is million years before present). This point in time is known geologically as the K-T Boundary (K is the geology abbreviation for Cretaceous Period). It marks the end of the Mesozoic Era/Cretaceous Period and the beginning of the Cenozoic Era/Tertiary Period. Then, in 1980, Walter and Louis Alvarez proposed an explanation of the dinosaurs' extinction and evidence to support this theory was introduced. The evidence was the location of a large crater named Chicxulub buried under water off the coast of the Yucatan Peninsula in Central America. Even with this new evidence, some scientists still believe that while there was an impact event at 65 Ma, it was not necessarily the primary reason for the dinosaur extinction. Animal species were already dying out before that time. Also there are other large impact events in Earth's history with no related extinctions. It is still not clear exactly what the connection is between the impact of 65 Ma and extinctions at that time.

Lesson:

This lesson allows students to do critical thinking and develop their inquiry skills.

To begin, have students develop hypotheses to explain K-T boundary extinctions, including the demise of the dinosaurs and write them on the board. This is a brainstorming session, all explanations proposed by students should be written on the board for further scientific investigation.
Hypothesis might include:

- Slow decline in numbers and diversity.
- Rapid change in climate from warm to cold.
- Dinosaurs were an evolutionary dead end and could no longer adapt to their environment.
- The effects of massive volcanic eruptions.
- Asteroid or comet impact .

Have the students break into groups of 3 or 4 and assign one of the hypotheses on the board to each group to investigate further. The students will role-play that they are scientists before 1980 and have proposed one of the suggested theories for the extinction of the dinosaurs. They have been invited to present their theory to an audience of peers in their field. They must include their hypothesis, how they would test the hypothesis, and their predictions.

Students must use the scientific method to construct a research proposal or plan for the hypothesis assigned. An example of a research plan can be given to the students using one of the hypotheses from the board. For example if we chose that the effects of massive volcanism resulted in the extinction of the dinosaurs then a research plan might be outlined as follows:
IF massive volcanic eruptions led to the demise of the dinosaurs
AND we look for evidence of extensive lava flows at the time of the extinctions
THEN we should not find dinosaur fossils after the time of the lava flows
AND/BUT we do/do not find dinosaur fossils after the time of the lava flows
THEREFORE our hypothesis is supported/not supported

Depending on their assigned hypothesis, here are some questions to get the brain warm:

- What kind of evidence would you look for? Lava flows, regional ash deposits, change in fossils, and/or core samples from a particular area, impact craters.
- How would you gather that evidence? Fieldwork, lab work, both.
- What are some ways you could test your hypothesis using that evidence?

The students are not expected to research their hypotheses in this exercise. It is just an exercise to get students familiar with using the scientific method as scientists use it everyday.

Assessment:

- Have the groups present their research plan to the rest of the class. A whiteboard is a good tool to use for this lesson.

- Grades can be based on a rubric with the criteria outlined above. For example - does each group have a hypothesis written, a test designed, and a prediction made.

Homework:
Have each student use the worldwide web or other sources to find out what research and experiments have been conducted testing the hypothesis they chose. Students will write a short overview of their findings to share with other members of their group. While in groups, students will synthesize the new information with the hypothesis, tests, and predictions they created earlier. Does the evidence found support their theory? Have the students revise their initial testing methods and predictions. A representative chosen by each group will explain the group's conclusions to the rest of the class.

Follow Up/Extension:

- **Use USGS overhead** "An Asteroid Wiped Out the Dinosaurs. What's Next?" to initiate a discussion on the probabilities and risks of another asteroid or comet impact on Earth. Tell the students it will happen again but we don't know when. Ask if there might be a way scientists could predict an impact or stop an impact. You could even bring in pop culture by mentioning some of the recent Hollywood movies such as "Armageddon" or "Deep Impact".
- "The chance of being killed by an asteroid is about one in 5,000. Greater risk than being killed in a plane crash", from © MCMXCIX IMP AB Secrets of the Universe™. **This is an excellent statistic to write on the board to start a discussion.**
- Mention the **LONEOS program at Lowell Observatory** in Flagstaff. Astronomers are searching the skies for objects that pass very close to Earth. As of March 2001, 450 objects have been identified. There are roughly 1,000 near-Earth asteroids (NEAs) larger than 1 km. Locating these asteroids can help scientists design innovative techniques and technologies that can be used to prevent a future catastrophic impact on Earth.

Vocabulary:
K-T boundary, asteroid, comet, impact, Near Earth Objects (NEO's), Near Earth Asteroids (NEA's)

References and Resources:

* **Killer Asteroids**, Secrets of the Universe™, International Masters Publishers AB, 1999. (provided)

* USGS Poster (Overhead 1), **"An Asteroid Wiped Out the Dinosaurs. What's Next?"** data from Morrison et al., 1994. (provided)

* **LONEOS Program** at Lowell Observatory: http://asteroid.lowell.edu/asteroid/loneos/loneos1.htm

* **Earth Impact Database**, Geological Survey of Canada:
  http://www.unb.ca/passc/ImpactDatabase/

* **Terrestrial Impact Craters**, Calvin J. Hamilton:
  http://planetscapes.com/solar/eng/tercrate.htm

* **Terrestrial Impact Craters and their Environmental Effects**, Lunar and Planetary Laboratory, University of Arizona:
  http://www.lpl.arizona.edu/SIC/impact_cratering/intro/IntroImpact.html

* **Asteroid and Comet Impact Hazards**, NASA: http://impact.arc.nasa.gov/

Overhead 1.