LESSON 13: ASTEROIDS AND DINOSAURS

The movie "The Good Dinosaur" posits what would have happened if, instead of hitting the earth and killing all the dinosaurs, the asteroid that hit near Yucatan 65 million years ago had passed near the earth without doing any damage. This micro-lesson explores a few aspects of asteroid impacts and near misses.

GRADES K-2

While a very large asteroid hit the earth and killed the dinosaurs, most asteroids are not that large. In fact, most asteroids are the size of a speck of dust or a grain of sand. They hit the earth every day and cause no more harm than a regular grain of sand would cause if you dropped it on the ground. Larger asteroids, about the size of a baseball or basketball or washing machine, hit the earth every month or so and may break whatever it is that they land on.

(There is a lot of open space on the earth, though, so a meteor hitting something important is an extremely rare event.) Impacts of very large asteroids, such as the one that killed the dinosaurs, are extremely rare, happening less than once every million years. Something that is large enough to cause significant harm is also large enough to see coming; NASA has a program that searches for large near-earth asteroids so that any that might be coming towards us can be moved away before they get here.

GRADES 3-5

Teachers may wish to read aloud *What Happened to the Dinosaurs*? by Franklyn M. Branley (an NSTA Outstanding Trade Book), or *Asteroid Impact* by Douglas Henderson. Discuss with the class what theories the scientists have developed about the extinction of dinosaurs, and what evidence has caused them to come to these theories.

(Excellent Common Core practice of citing specific evidence from the text to support the reader's conclusions.) Students may wish to research specific dinosaurs or other extinction level events.

For more information specifically about asteroids, Seymour Simon's book *Comets Meteors, and Asteroids* carefully explains the distinction between the three objects and their physical composition.

GRADES 3-5 (CONTINUED)

To add geographical practice, students may mark the impact (or explosion) locations of various space objects (links in the text take you to Wikipedia articles and Google Maps locations). The locations are Chicxulub (this is the crater from the meteorite that killed the dinosaurs, at 2 1°24′N 89 °31 ′W), Tunguska (at 60 °55 ′N 10 1 °5 7 ′E), Chelyabinsk (at 55 °0 9 ′N 61°25′E), Vredefort (at 26 °59 .5′S 27 °22.4 ′E), Meteor Crater in Arizona (at 35 °01 .6′N 111°01.4′W), the Manson Crater in Iowa (at 42 °35 ′N 94 °33 ′W), and Lake Manicouagan (at 51°24′N 68°42′W).

A question for further discussion would be – why were so many craters not discovered sooner? Answers might include lack of knowledge by those living near the sites and the development of satellites and other sensing devices used to observe and identify phenomena. (The Manson Crater in Iowa is not visible due to the area being covered over by glacial till, but analysis of the soil and rock structures provided the identification.) Are there impact craters or have there been proven bolides near where the students live?

GRADES 6-8

The students may want to look up the impact (or explosion) locations of the meteors listed for Grades 3-5 above.

To expand on the Chelyabinsk meteor a little, NASA has a web page titled "Aftermath of Chelyabinsk Meteor" about the atmospheric dust that resulted from the Chelyabinsk bolide and how satellites were used to track it. The animation shows how the debris trail from the explosion circumnavigated the globe completely in just days.

The class can discuss how much more widespread the debris would have been from the asteroid 65 million years ago which caused, or helped to cause, the extinction of the dinosaurs. Smithsonian offers a good article at their Department of Paleobiology that discusses some of its effects. A comparison of the estimated composition of the two objects and their relative sizes could help students visualize the destruction caused by the asteroid's impact.

The Earth Impact Effects Program is a very easy-to-use page that calculates the effects of an asteroid hitting the earth. An article on Science.com about the Chicxulub asteroid includes an interactive asteroid quiz, found at The Dino-Killer. Students might also read the books suggested for grades 3-5.

GRADES 9-12

A blogger at the Wired web site has analyzed the trailer to the movie "The Good Dinosaur" and calculated that the asteroid as depicted in the trailer travels at about half the speed of light. Here is a link: Rhett Allain's Analysis.

It would be a fun exercise to calculate the speed of the asteroid by measuring the length of its path in earth diameters, multiplying by the 8,000 mile diameter of the earth (this can be tied in with significant figures—the other measurements are crude enough that the difference between 7,926 and 8,000 miles is immaterial), and dividing by the amount of time it takes the asteroid to travel along its path (somewhere around a third to a half a second).

The greatest speed at which an object which is orbiting the sun can approach the earth is a little less than 45 miles per second. (This is the escape velocity of the sun, starting at the radius of the earth's orbit, plus the speed of the earth in its orbit, assuming a head-on collision.)

At a speed of 45 miles per second, the asteroid in "The Good Dinosaur" would have taken almost three minutes to travel a distance equal to the diameter of the earth. (7,900 miles divided by 45 mi/sec gives 176 seconds.) This would have made for a dreadfully boring scene in the movie and so some artistic license is called for.

The students may also be interested in the Earth Impact Effects Program and other resources mentioned in the Grades 6-8 lesson.