

EDUCATOR'S GUIDE

Next Generation Science Standards And Classroom Activities

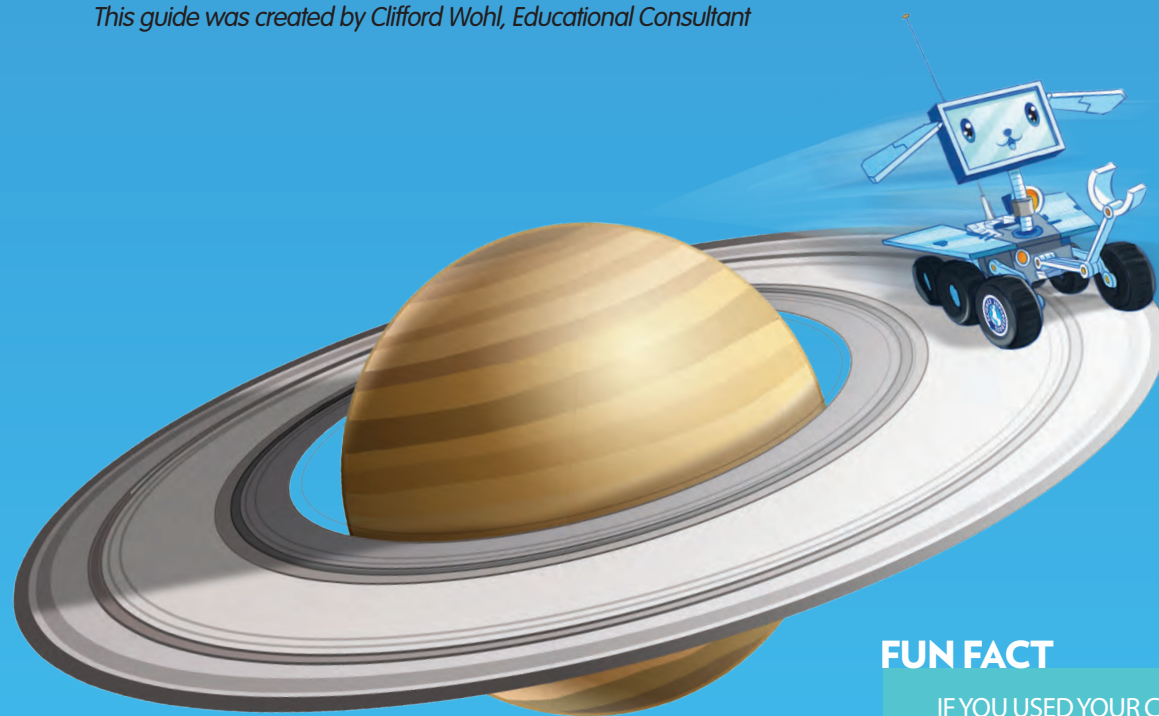
9/ SCIENCE; MATHEMATICS

Craters are the most common landform found in the solar system. Every planet, moon, asteroid, and comet has them. One of the things that scientists study is the amount of energy released by the impact of an asteroid on another surface. Your students should note that a 816-pound meteorite striking the earth can release the equivalent of 4.8 tons of TNT, which is approximately the energy used in an average American home for one month. Using that relationship and the equation on page 84, have your students calculate the energy released when a meteor crashed into the earth 50,000 years ago, creating the Great Meteor crater in Flagstaff, Arizona. Discuss with them what they would have to know in order to solve the problem. To help them along, they should read an article from Space.com on the Great Meteor crater. See the link below.

<https://www.space.com/834-mystery-arizona-meteor-crater-solved.html>

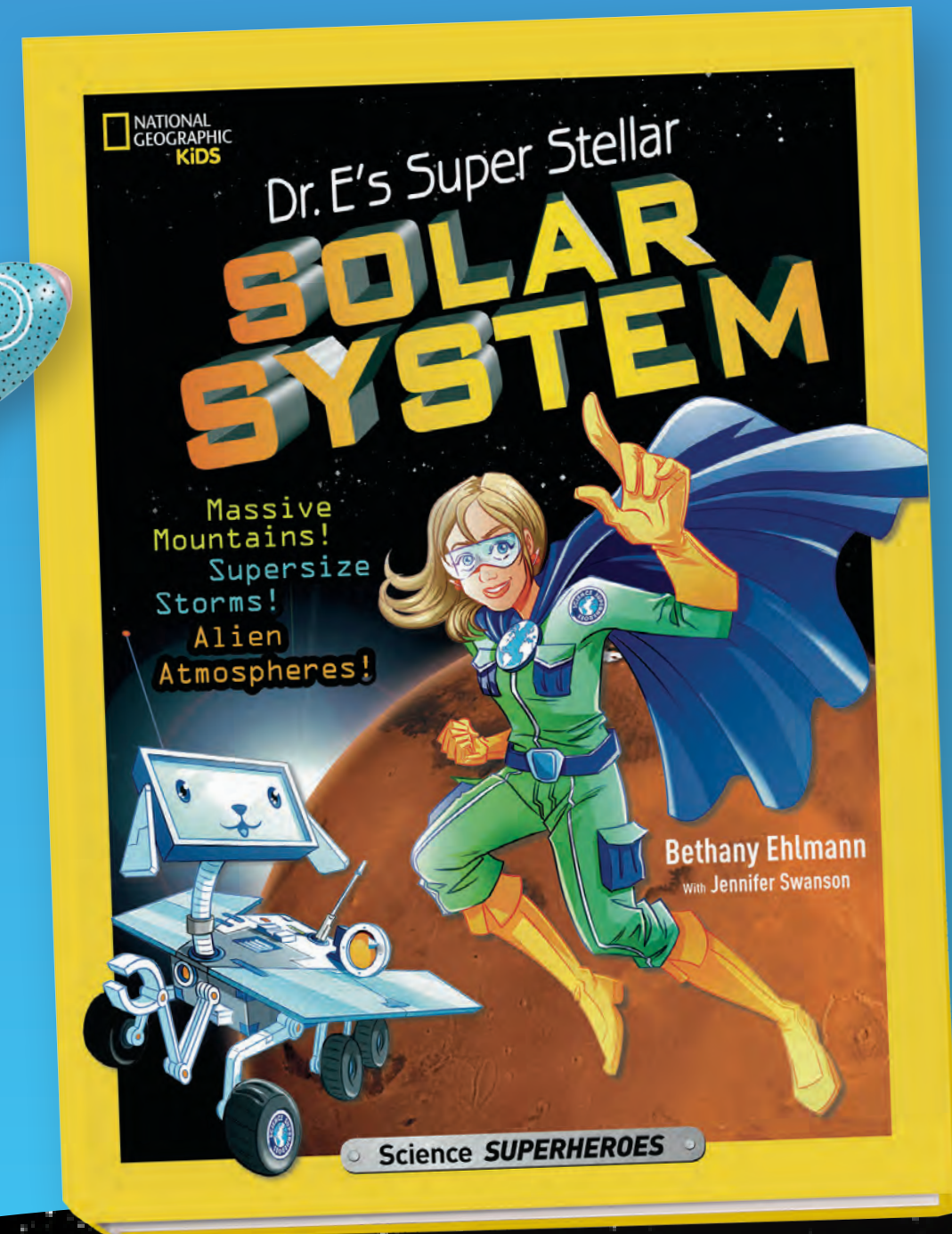
Your students might then want to figure out how many American homes could consume that amount of energy in one month.

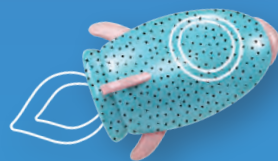
This guide was created by Clifford Wohl, Educational Consultant



FUN FACT

IF YOU USED YOUR CAR, IT WOULD TAKE YOU MORE THAN A WEEK TO DRIVE ACROSS SOME OF SATURN'S RINGS.





INTRODUCTION

Who better to introduce fourth through seventh graders to our solar system than a planetary geologist working at NASA and her alter ego, a superhero space scientist travelling to the outer reaches of space with her robot, Rover? Students will not only learn about our own planet and our neighbors in space from both Dr. Bethany Ehlmann and Dr. E, but they will also get caught up in the excitement of space exploration and scientific investigation. They may even find themselves thinking like scientists, and some might begin to consider careers in the sciences.

The author invites children to explore the mysteries of the cosmos with friendly everyday speech they can relate to and precise language that is used by the scientific community. Illustrations, photographs, artists' renderings, and drawings help make complicated ideas comprehensible. Students will be actively engaged by simple comparisons, easy-to-do demonstrations, and a logical understanding of basic principles along with an extensive glossary of scientific terms.

That approach and the in-depth information provided in Dr. E's Super Stellar Solar System are extended in this educator guide that offers questions and activities that cross the curriculum.

You'll find connections to Science, Language Arts, Reading, Writing, Critical Thinking, Music, Art, Research, and Cooperative Learning as well as to Common Core State Standards such as writing, speaking and listening, and reading for information. There are also activities that align with Next Generation Science Standards (NGSS) that relate to the study of the solar system:

- MS-PS2 – Motion and Stability: Forces and Interactions
- MS-PS3 – Energy
- MS-ESS1 – Earth's Place in the Universe
- MS-ESS2 – Earth's Systems

BEFORE READING

To get your students excited about reading and studying Dr. E's Super Stellar Solar System, we recommend three things:

- Hold up the cover and flip through the book to show them a few of the comic book pages.
- Read aloud the subtitle: "Massive Mountains! Supersize Storms! Alien Atmospheres!" (That ought to get your class's "Star Wars" excitement going.)
- Tell them that Dr. Bethany Ehlmann is a planetary geologist at NASA where she helps to steer the rover Curiosity across the surface of Mars.

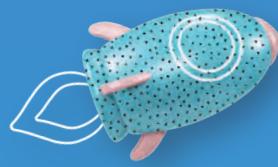
Now they are ready for takeoff!

Ask each student what topics they think will be covered in the book. Then each student should pick one of those topics and write down five questions they have about it. As they read the book, they should look for answers to their questions. When they find them, they should make a list of what they've learned. Later, all the students should share their findings with their classmates.

QUESTIONS OF FACT

SCIENCE; READING COMPREHENSION AND RETENTION; LANGUAGE ARTS: VOCABULARY, SPEAKING AND LISTENING

1. What is one solar system other than our own in the Milky Way galaxy? Tell one thing you know about it.
2. How long does it take Earth to orbit the sun? How long does it take Earth to make a full revolution on its axis?
3. Name the four inner planets and the four outer planets of our solar system. List them in order of their distance from the sun.
4. What are the five known dwarf planets in our solar system? Which is the largest? Which has the longest orbit around the sun? Which is in the asteroid belt? Which has the fastest rotation on its axis?
5. Why does Dr. Bethany Ehlmann say, "Asteroids are the vacuum cleaners of space?"
6. What surprising theory did Stardust scientists develop by examining comet dust and interplanetary dust particles?
7. What is the name for the hot outer layers of gas in a star like our Sun?"
8. Where and what is the Caloris Basin? What caused it?
9. How did Earth begin, and how did it develop into a planet that could support life?
10. What is Enceladus? Why is it considered a likely place for alien life?
11. What is Europa, and how is it like Earth?
12. What is the difference between chemical and physical weathering?
13. Describe the three types of volcanoes.
14. How are volcanoes and craters different from each other?
15. Name and describe at least three different ways that scientists can gather data from objects in space.
16. What is Curiosity? Where is it? What is its job? The author tells us it is part of a "roving mission." What does that mean?
17. An asteroid that created the Chicxulub Crater in Mexico is also thought to have made another very large change on Earth. What is it?
18. What is the difference between a complex crater and a simple crater?
19. Why is it so important for scientists to find the presence of water on other bodies in the solar system?
20. Dr. Ehlmann describes five of NASA's "far out" plans for future space research on pages 106-107. What will scientists learn from each of these? Each student should select which one of these investigations they think NASA should pursue. Why did they make that choice?



QUESTIONS FOR DISCUSSION

READING; LANGUAGE ARTS, SPEAKING AND LISTENING; CRITICAL THINKING; RESEARCH; SOCIAL STUDIES; MATH; COOPERATIVE LEARNING

1. How has reading *Dr. E's Super Stellar Solar System* changed your students' impression of who scientists are and what they do? Did reading this book make any of them think about becoming a scientist in the future? Why or why not?
2. We often think of STEM as four individual and separate fields: Science, Technology, Engineering, and Math. But *Dr. E's Super Stellar Solar System* makes it clear that these disciplines work together in the exploration and investigation of space. How does each discipline—alone and with others—contribute to accomplishing a space mission? Students should be as specific as possible.
3. On October 19, 2017, astronomers detected a mysterious object with a strange shape hurtling toward our solar system from an unusual angle. What kind of object was it? Where did it come from? Where was it going? Is it a natural or artificial object? What would each imply? Why was the object named "Oumuamua?" There has been much speculation about the nature of the object. Both NASA and SETI are studying it. Have your students go to NASA's website and read an article about the object and view a short video.

<https://www.nasa.gov/feature/solar-system-s-first-interstellar-visitor-dazzles-scientists>

Discuss with your students what SETI is and what the scientists involved with it hope to accomplish. They should then read the following article from Scientific American that centers around the work of the SETI project:

<https://www.scientificamerican.com/article/alien-probe-or-galactic-driftwood-seti-tunes-in-to-oumuamua/>

Have your students talk about the different points of view of NASA and SETI and whether they have common goals. Oumuamua is an alien asteroid, but do your students think it could be an alien spacecraft?

FUN FACT

BECAUSE OF TITAN'S DENSE ATMOSPHERE AND LOW GRAVITY, YOU COULD PROBABLY FLY ABOVE ITS SURFACE SIMPLY BY STRAPPING A PAIR OF WINGS TO YOUR ARMS AND FLAPPING THEM.



ACTIVITIES

1/ SCIENCE; LANGUAGE ARTS: SPEAKING AND LISTENING; COOPERATIVE LEARNING

You'll find a number of "TRY THIS" activities in *Dr. E's Super Stellar Solar System*. They are generally easy to do and a long way toward demonstrating some of the ideas presented within the book. Try as many of these with your students as you can. See pages 18, 19, 30, 37, 45, 48, 53, 55, 75, 85, and 99. After each activity, your students should discuss what they learned.

2/ LANGUAGE ARTS: WRITING, SPEAKING AND LISTENING

Have your students imagine that they have discovered a new planet, a comet, asteroid, or some landform not yet known on one of the planets or moons. Tell them that the IAU—the International Astronomical Union—has given them the rare privilege of naming their discovery. Each student should research the rules that the International Astronomical Union has set down on the naming of various astronomical objects, and they must use them when they name their new discovery.

Each student should prepare and deliver a three-minute "science-in-the-news" report to introduce their discovery, its name, and tell why they chose the name and how it meets IAU requirements.

The following websites will be valuable. The process can be complicated, so you might want to review the rules with your students before they try on their own:

PLANETARY NAMES:

<https://www.iau.org/public/themes/naming/>

<https://starchild.gsfc.nasa.gov/docs/StarChild/questions/question48.html>

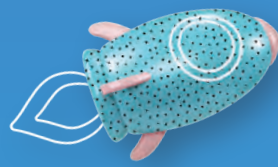
ASTEROID NAMES:

<http://www.planetary.org/get-involved/contests/osirisrex/guidelines.html>

FUN FACT

THE TERM "HELIOCENTRIC" COMES FROM COMBINING THE ANCIENT GREEK WORD HELIOS, MEANING SUN, AND CENTRIC, WHICH IS FROM THE GREEK WORD KENTRIKOS, MEANING CENTER.





3/ SCIENCE; READING; LANGUAGE ARTS: WRITING, SPEAKING AND LISTENING; RESEARCH; COOPERATIVE LEARNING

Divide your class into eight teams. Each should study one of the planets using the information in Dr. E's Super Stellar Solar System and do further research in other books and on the web.

Teams should each present a multi-media report on their planet. They can use PowerPoint, photographs, artists' representations, their own drawings and illustrations, "actual" rocks, dust, or other samples, and a written report.

Teams should be sure to include:

- Topography and physical features
- Chemical composition
- Volcanic activity
- Revolution around the sun
- Rotation on its axis
- Atmosphere
- Temperature
- Weather
- Most recent scientific findings

4/ SCIENCE; LANGUAGE ARTS: WRITING, SPEAKING AND LISTENING; RESEARCH, COOPERATIVE LEARNING

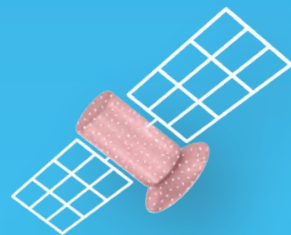
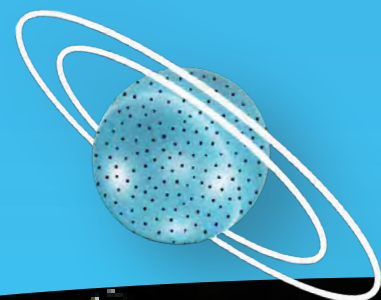
Space continues to fascinate scientists, and research is ongoing. Each week, the New York Times publishes articles about new findings in science specifically relating to the cosmos. You can access these articles at:

<https://www.nytimes.com/topic/subject/space-and-cosmos>

Assign teams of students to read and present articles to the class. After each presentation the class should discuss the importance of the information reported.

5/ LANGUAGE ARTS: WRITING

Announce to the class that NASA is looking for astronauts, astronomers, planetary geologists, mathematicians, engineers, and whiz-kids in technology. Each student should write a letter applying for a job. They should state what they want to study and then convince NASA that they are the one for the job.



6/ SCIENCE; LANGUAGE ARTS: WRITING, SPEAKING AND LISTENING; RESEARCH; COOPERATIVE LEARNING

Divide your class into two teams. Assign each team one of the following projects to research and report on.

- One team will study the ten present-day scientists who are profiled in Dr. E's Super Stellar Solar System. (See pages 13, 26, 29, 41, 58, 66, 73, 86, and 105.) The members of this team should do further research about the scientists and then create a mock roundtable of the scientists. They should develop questions to ask and write a script for the roundtable participants. Members of the team will play the roles of interviewer and scientists. The roundtable should be video-recorded for viewing by other classes.
- The other team will study some of the most influential astronomers from the past. They should include but not limit their study to: Ptolemy, Galileo Galilei, Johannes Kepler, Nicolas Copernicus, Isaac Newton, and Tycho Brahe. The members of this team will research these scientists' contributions to the study of Astronomy. The team should present their findings, emphasizing each man's contribution as a foundation for all future understanding of space. After the reports are presented to their classmates, the students will vote on which of the scientists they think made the most important contribution.

7/ LANGUAGES ARTS: WRITING: ART

Tell the class that Dr. E has been called away on a special assignment and that you have volunteered your class to take over her space adventures. She's left behind Rover her robot companion. Each student should create an eight-panel comic about the space adventure they have. Display the finished comics on boards in the hallways or in your classroom.

8/ MUSIC; ART; LANGUAGE ARTS: WRITING, POETRY

For a musical enrichment experience, have your class listen to a recording of Gustav Holst's orchestral suite "The Planets." The concept of the suite is astrological, not astronomical and is intended to convey to the listener the emotions associated with planets. (If time is limited, you can listen only to Mars and Jupiter, the most popular movements of the suite.) Afterwards, students can respond by drawing pictures or writing poems that express how the music affected them.

FUN FACT

HAUMEA IS THE THIRD-BRIGHTEST OBJECT IN THE KUIPER BELT. ON A NIGHT WITHOUT CLOUDS AND WITH A GOOD TELESCOPE, YOU CAN SEE HAUMEA IN THE NIGHT SKY EVEN THOUGH IT IS HUNDREDS OF MILLIONS OF MILES AWAY.

