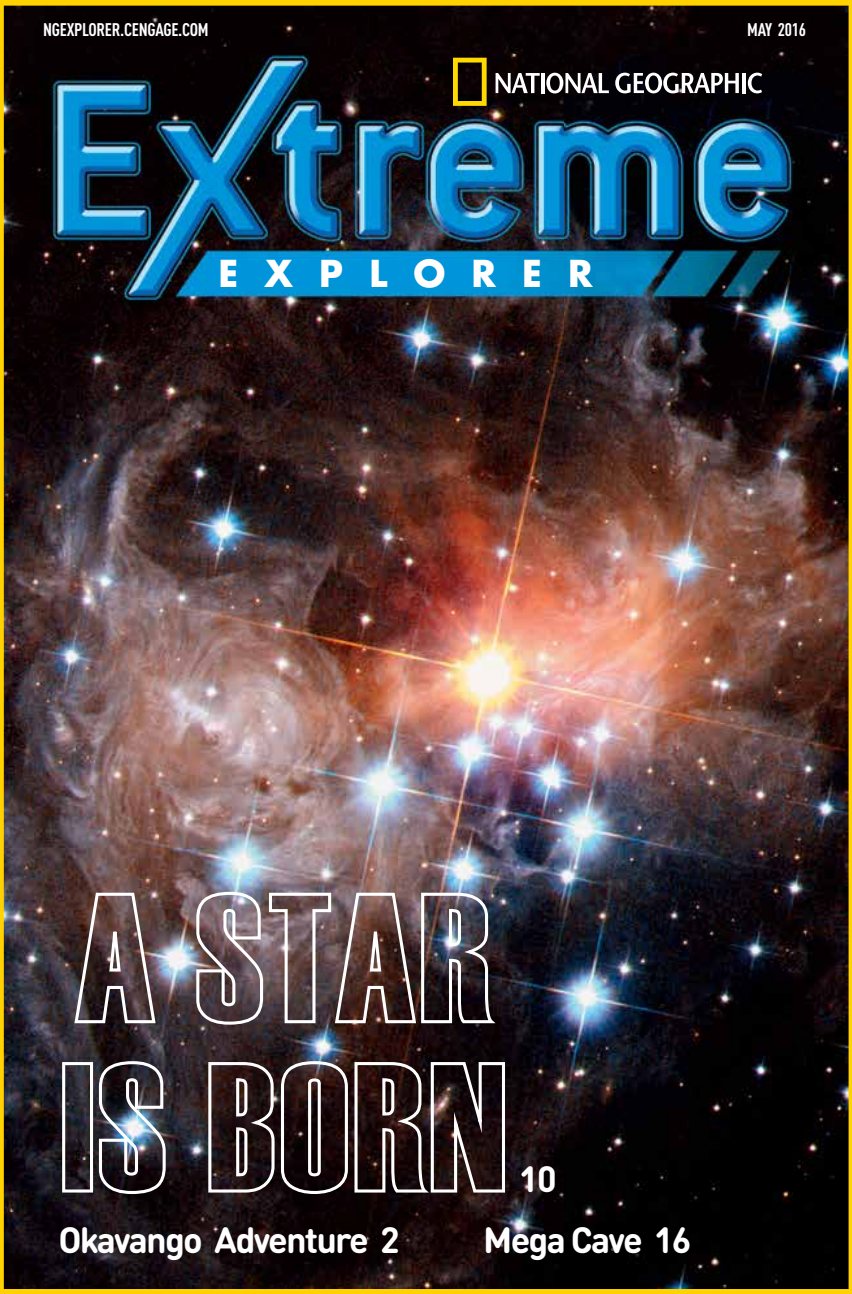
TEACHER'S GUIDE



Extreme
May 2016

In This Guide

In this guide, you will find science and language arts lessons for the articles in the May issue of Extreme Explorer.

Explorer Magazine

Extreme Explorer magazine is a classroom magazine specifically written for middle school students. The magazine contains grade-appropriate reading experiences, develops literacy skills, and supports standards-based science content. Great storytelling and stunning photographs inform your students about our planet and the people, plants, and animals that live on it. Use Extreme Explorer in your classroom to encourage students to explore our world and make it a better place.

Extreme Explorer is part of National Geographic Explorer's Education program. Visit the "For Teachers" tab on Explorer's website, *ngexplorer.cengage.com,* to find additional resources for extending your students' learning.

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Okavango Adventure

LANGUAGE ARTS

Objectives

- Students will determine an author's point of view or purpose in a text and explain how it is conveyed.
- Students will determine the meaning of words and phrases as they are used in a text, including vocabulary specific to the topic.
- Students will summarize the text.

Resources

- Bonus Article: The Cuito River—An Okavango Delta Tributary (page 6)
- Bonus Article: Pioneering Live-Data Expeditions (page 7)
- Vocabulary Activity Master (page 8)
- Language Arts Activity Master (page 9)

Summary

The article "Okavango Adventure" follows National Geographic Explorer Steve Boyes as his team travels through the Okavango Delta and shares their research with the world.

BUILD VOCABULARY AND CONCEPTS

- **delta**
- **expedition**
- **sediments**
- **trek**
- **wetland**

As a class, discuss the difference between familiarity and knowledge. Have students discuss the strategies they frequently use to gather vocabulary knowledge as they encounter terms with which they are not familiar that may be critical to the comprehension of a passage they are reading. Challenge students to acquire new vocabulary strategies as they work through this activity.

Display the vocabulary words. Then give each student a copy of the **Vocabulary Activity Master.** Instruct students to write each word in the first cell of the table. Have students rank their familiarity with each word by writing the number 1–5 after the word, with the number 5 meaning that they are very familiar with each word and could teach it to a student that had written a 1 beside it.

Divide the class into groups and have them each use the **Vocabulary Activity Master** to create a game that the other groups will use to explore the vocabulary words. Allow class time for groups to play the games and evaluate their game's success.

Display the Wordwise feature on page 9 of the **Projectable Magazine.** Have students write those definitions on the back of their worksheets and then compare them with the definitions they wrote. Encourage students to scan the article to review the words in context. Guide the class to recognize that words can take on very specific meanings in different contexts. Discuss how that concept applies to the vocabulary words in this article.

READ

Elicit from students how "Okavango Adventure" explores changes in wetlands seasonally and how the changes impact the things that live there. Throughout the article, the explorer gives anecdotes from several expeditions into the tributaries and the delta itself and describes how conditions change. Remind students that knowing the author's point of view will help them to better understand the text.

Display pages 4–5 of the **Projectable Magazine**. If needed, model how to find the author's point of view. **Say:** *When I read the first two paragraphs I am struck by how clearly the author shares his thoughts with us. We see his observation out of the corner of his eye. I can imagine he and his canoe being thrown into the air. Thinking about an animal the size of a car is a bit staggering. Swimming like crazy is understandable. The sentence in italics says it all—"Just another exciting day . . . " in a place where the author loves to spend as many days as he can.*

Remind students to use headlines, text, photos, and captions as clues to help them identify the author's point of view. Explain to students that identifying the author's point of view can help them understand where the points made in the rest of the article are taking the reader.

Give each student a copy of the **Language Arts Activity Master.** Have students read pages 6–7 of the article. As they do, instruct them to identify clues to the author's point of view that they find in the article.

Okavango Adventure

LANGUAGE ARTS

TURN AND TALK

Have students turn and talk to compare their **Language Arts Activity Master** with a partner. Did students interpret the author's point of view in the same way? Did they adequately support their interpretation? Have students explain their reasoning to their partners. If partners used the same information to come to different conclusions, encourage them to reread the text and review the information together.

Point of View

Students should keep in mind that the author can have more than one point of view. Have partners examine each other's clues and decide which clues are the most valuable in identifying point of view. Each team can then rank order how valuable the clues are in identifying point of view by numbering them from 1–5.

Close Reading for Point of View

Share with students the two bonus articles written by Steve Boyes that give more background about his work and why he thinks the work is so important. Students might use close reading techniques such as annotating the margins, highlighting important points, and writing questions they have in the margin. Also, students might text code the passage with a *P* to indicate anywhere the author gives a clue about his point of view. After coding the article, students should review all of the *P*'s and make a claim supported by evidence about the author's point of view.

Summarize

Say: *One way to determine if you understand information is to try to summarize the main idea of what you have read. If you can't create a summary that states the author's point of view and the major concepts presented in the article, you might need to read the article again.* Have students turn and talk to summarize the reasons why the Okavango wilderness should continue to be protected. Promote discussion with questions such as:

- What might happen if the Okavango wilderness is not protected?
- What has to be done to assure the Okavango wilderness continues to be protected?
- What does Steve Boyes think will save the Okavango wilderness in the end?

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

- How can the work that Steve Boyes does make all of the risks that he takes worthwhile?
- What do you think Steve Boyes's most compelling argument is for saving the Okavango wilderness?
- What interested you most about what you read?

Okavango Adventure

SCIENCE

Objectives

- Students will identify the ways organisms are dependent on the other living things and nonliving factors.
- Students will identify resources needed to maintain biodiversity in an ecosystem.
- Students will consider how disruptions can affect an ecosystem.

Resources

- Science Activity Master (page 10)
- Science Quiz Master (page 11)

Science Background

The Okavango Delta, in northern Botswana, is Africa's last remaining wetland wilderness and was listed as the planet's 1,000th UNESCO World Heritage Site in June 2015. The delta is home to the world's largest remaining elephant population and the second largest lion population. It is a living sanctuary, a self-sustaining wilderness, which is keystone to biodiversity conservation in the region. The delta at the end of a 1,500 mile-long, winding river is about the size of Massachusetts, and a unique oasis that Steve Boyes implores us to protect for future generations.

The Okavango Delta depends on 24–27 inches of local rainfall between November and March, followed by the annual flood between April and September. Without the floodwaters from the Angolan highlands, the Okavango Delta will dry up and die. If there are any significant changes in water flow or nutrient level, the delta will clog up and choke. This wilderness can support 100,000 elephants and the abundance of life because the Okavango River Basin is the largest undeveloped river basin on the planet. Steve Boyes thinks the flow of the main tributaries in Angola is one of the great conservation opportunities of our time.

Find out more about Steve Boyes and his team's exploration of the Okavango wilderness at *http://adventure.nationalgeographic.com/adventure/adventurers-of-the-year/2016/steve-boyes/*.

ENGAGE

Tap Prior Knowledge

Engage students in wetlands with a gallery walk. Print four images of Okavango wetland animals and habitats found in an Internet search with keywords such as *Okavango, wetlands,* and *wetland animals*. Post the images, one to each wall of your classroom. Divide the class into four groups and have them take turns exploring each image with clipboards and the following prompts:

- What type of habitat?
- What does the species shown need to survive?
- What is special about this habitat that this organism thrives here?
- What might threaten this ecosystem?
- What unseen benefits might this ecosystem offer?

One person in each group can be responsible for one prompt at each station. Each group shares together at the conclusion of their gallery walk. Another option would be to regroup the teams by the individual prompt examined. Each new team could then present their finding to the class.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photo on pages 2–3 and the heads, photos, and graphics on the remaining pages. Ensure students have a general understanding of the words *delta, expedition, sediments, trek,* and *wetland.*

Challenge students to predict what the article is about specifically. Discuss with students why calm waters might fool them. Encourage students to elaborate on their answers with some explanation. Prompt students to think about whether their explanation is based on fact or opinion.

Set a Purpose and Read

Have students read the article in order to learn how wetlands change over time and how these changes might impact the living things found there.

Okavango Adventure

SCIENCE

EXPLAIN

Interdependence of Organisms in an Ecosystem
Give each student a copy of the **Science Activity Master.** Allow students to work in pairs or small groups to identify wetland plants and animals and how their interaction in the ecosystem helps in their survival. Elicit claims from students about how wetland organisms are dependent on the other living things and nonliving factors found in the Okavango. Have student cite specific information from the article as evidence for each claim. Encourage students to use the photos in the article as a basis for identifying adaptations of plants and animals that promote their survival in this ecosystem. Students might conduct additional research to find out how a wetland's success is dependent on other surrounding ecosystems. Then, facilitate a discussion about how environmental factors affect the organisms found there.

Biodiversity in a Wetland
Display pages 8–9 of the **Projectable Magazine.** Have students use sticky notes to text code passages that provide information about biodiversity in the Okavango. Help students connect the idea of the rich wetland ecosystem to the larger context of biodiversity.

Disruptions to an Ecosystem
Okavango changes seasonally. Allow students to work in pairs or small groups to identify the cause-and-effect relationships that result. Students might also suggest concerns associated with increasing human populations in the area, political conflict, or changes that benefit humans that result in negative impact on the biodiversity.

ELABORATE

Find Out More
Have students discuss the information found below the BA'YEI GUIDES head. As you review the information, have students speculate how the Ba'Yei are able to survive in the Okavango. Challenge them to research these people to understand how their lifestyle aids survival in an isolated wetland.

Extend Your Thinking About Wetlands
Have students extend their thinking about wetlands and the seasonal changes they experience. Students might research wetlands in other areas of the world, such as the Everglades in the United States, the Mekong Delta in Vietnam, the Kakadu Wetlands in Australia, or the Pantanal in Brazil. Students can compare and contrast these wetlands with the Okavango Delta in terms of biodiversity, seasonal changes, and human population.

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **Why do Okavango explorers not carry freshwater with them?** (The water in the channels is clean and safe to drink. There's no industrial activity or large agricultural fields upstream to taint the river as it enters the delta.)
- **How does being named a World Heritage Site benefit the Okavango Delta?** (It prevents people from developing the delta in any way that would affect the environment.)
- **How would you describe the typical way of getting around in the Okavango?** (They use a flat-bottomed dugout canoe, called a *mokoro*. The mokoro is moved by using a long, trimmed branch as a pole to push off the bottom of the river.)

The Cuito River—An Okavango Delta Tributary

By Steve Boyes

On May 21, 2015, eight armor-plated trucks carrying 32 people and seven mokoros arrived at the little-known source of the Cuito River. This source lake represents the headwater of the Cuito River, one of the two major tributaries of the Okavango River and arguably the most important. Due to land mines and over 40 years of armed conflict, it was considered impossible to explore this part of Angola. When we put our mokoros into the source lake, we launched the 2015 Okavango River Expedition as part of the Okavango Wilderness Project.

The largest-ever tank battles in Africa since World War II were fought in the heart of the Angolan catchment of the Okavango River where the Cuito and Cuanavale Rivers meet. The forests near the source were very inhospitable. Honeybees that sting, and sweat bees that lick and tickle—all day long. Spiders, scorpions, leeches, and mosquitos are with you all the time. Hot and humid by day, and freezing cold at night, it was hard. The river was too narrow to use our mokoros for the first seven miles, so we put on harnesses and dragged the fully laden mokoros on the bank for 10 days. There were no people there to help us. When the river was wide enough, it was filled with trees that we had to cut up and remove to pass by.

We struggled and we struggled until we reached the big river and met our first local people. They ran away at the sight of us. These first people were women with their children cutting holes in the forest to slash-and-burn for cassava—or manioc—growing. They would typically be cleaning the cassava roots by the river when we arrive.

We discovered that these people had not seen anyone from the outside world since moving there in the early 1970s. They knew very little about the government and lived entirely off the land and the river. Beautiful people that never asked us for any help or anything, they were always content to just meet us and answer questions. These people helped us learn what animals were living in that area, which animals were hunted, and why they were burning so much of the forest and riverfront.

The people living in this remote part of Angola use fire to flush animals out of hiding when hunting, to slash-and-burn forest, and to open up access to the river for fisherman. During the expedition there were wildfires nearby at all times, burning up the river or in the adjacent forest. These fires are causing damage to the river by laying the riverbanks bare and allowing rain and wind to flush sand into the river. The river near the source lake is shallow and has trees growing in it due to the fires. We must help these local people find a different, more sustainable, way of utilizing this very sensitive landscape. The Okavango Wilderness Project aims to establish new forest reserves and globally protected wetlands in the upper reaches of the river basin to secure the future of this forgotten, wild river.

Pioneering Live-Data Expeditions

By Steve Boyes

The 2015 Okavango River Expedition was a "megatransect" across the Okavango River Basin almost 1,500 miles down six rivers across three countries over 121 days. Nothing like this had ever been attempted before. Our expedition team has crossed the Okavango Delta six times and joined by 13 of the top biodiversity experts for southern and central Africa. Now we see ourselves as being part of a "new age of exploration" where anyone can participate and everyone should have access to the research data. Our team, including National Geographic Emerging Explorers Shah Selbe and Jer Thorp, believe that we can go beyond open source and share as many aspects of this groundbreaking expedition as possible in real time. From research data and GPS tracks to heartbeats, sound recordings, and photographs of the surroundings, all visualized on a satellite image at *intotheokavango.org*.

During the 2015 expedition from "source to sand," from the headwaters to the Kalahari Desert where it ends, we discovered five new fish species and three new plant species. We recorded over 350 bird species with over 25 being new to Angola. Amazingly, 20 of the 25 reptile species documented during the expedition were new to Angola. This expedition was in winter when insect and animal activity is much lower and research is harder. The 2016 expedition team is undertaking summer surveys, and we expect to discover many new species for Angola and the world.

We are joined by ba'Yei River Bushmen on all of our expeditions and have been accepted into their way of life and culture as "mo'Yei." These are the people of the Okavango Delta, the people of this wilderness whose fates will forever be connected to this place. The ba'Yei have taught us how to pole our mokoros and survive safely in the wild. They have shared the quiet, alert mind that keeps you safe and the simple life that keeps you happy. They rejoice in the wilderness and were the most excited to meet the people we encountered near the Cuito source. Like the ba'Yei, as bushmen we enter the wilderness barefoot, unarmed, with minimal food rations, and no personal possessions. As "digital bushmen" we enter the wilderness with hundreds of pounds of batteries, solar panels, cameras, tablets, and gadgets, to better share the experience with the world and get decades of biodiversity and environmental assessments done in just a few years.

This is what makes this new age of exploration so exciting. Like the ecosystems we study, we are all connected by social media and are starting to carry global opinions and take responsibility for biodiversity and the environment as a global community. Our daily lives on expedition are dangerous with hippopotamus and crocodile in the river with us, and lion, elephant, and buffalo on the land. Millions of biting flies, mosquitos, and leeches try and eat us alive, while the abundant insect life moves through your tent and possessions. We have been charged by lion and crocodile, had dangerous snakes and scorpions crawl over us, in addition to the hippo that capsized a mokoro. Rapids and trees have capsized us, and drowned tanks from earlier wars have sunk us. To share these experiences is to inspire the next generation of explorers who will have the same experience in this remote landscape as long as it stays free of impacts. That is the magic of the wilderness. No matter what, you will always discover something new in the wilderness. Learning and discovery are guaranteed in our last truly wild landscapes that connect us to our distant past and the balance that supports diversity.

Name _____ Date _____

VOCABULARY ACTIVITY: Okavango Adventure

In 10 minutes, design a game using the vocabulary. Take turns playing it.

<table>
<tr><td rowspan="2">Words and Definitions:</td><td>Identify how you will evaluate the success of your game:</td></tr>
<tr><td>Briefly explain the strategy you will use to teach the vocabulary words:</td></tr>
<tr><td rowspan="2">Discuss the game you created and identify the required rules:</td><td>Select a title for your game:</td></tr>
<tr><td>Evaluate your game:
Little success Very successful
1 2 3 4 5</td></tr>
</table>

Name _____ Date _____

LANGUAGE ARTS ACTIVITY: Okavango Adventure

Closely reread pages 6–7. As you read, fill in the table below to help determine Steve Boyes's point of view.

Point of View Clues	
Clues in "Okavango Adventure"	**How the Clue Conveys the Author's Point of View**
Facts or numbers that relate to the author's point of view	
In a debate about the Okavango Delta, which side would the author be on? Why?	
Information the author failed to include	
Words that the author uses to convey his point of view	
How what I know about the topic compares with the author's presentation	
Summary	
How the author's point of view affects the text presentation	

Name _____ Date _____

SCIENCE ACTIVITY: Okavango Adventure

Identify inhabitants of the Okavango wilderness and the resources found in their ecosystems that support them.

Okavango Wilderness Inhabitants	Where They Live	Factors in the Okavango Wilderness That Aid Survival

Name _____ Date _____

SCIENCE QUIZ: Okavango Adventure

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

1. What is atypical about the river delta that forms the Okavango wilderness?

A. It is formed by a river that does not flow under the force of gravity.

B. It is a delta found at the headwaters of the river that forms it.

C. It is a delta located in the middle of a desert.

D. It is formed by a river with a riverbed that does not split up into channels.

2. Why is it that the Okavango explorers do not haul fresh food with them?

A. It would contribute trash to the delta.

B. Planned campsites are stocked before their arrival.

C. The trips are so long that the food would spoil.

D. Both A and C

3. What is the best way to travel in the Okavango delta?

A. small motorboat

B. air boat

C. glass-bottomed boat

D. mokoro

4. Which is NOT a reason why floodwaters are important to the Okavango Delta?

A. Floodwaters allow plants to thrive.

B. Floodwaters spread out animals so they are easier to catch.

C. Floodwaters revitalize dried out areas.

D. Floodwaters cause the delta to double in size.

5. Which is NOT a requirement for the continued healthy future of the Okavango Delta?

A. The Botswana government must maintain the policy of low-volume tourism.

B. Upriver dams must continue to release adequate amounts of water.

C. Upstream water pollution has to be stopped at the source.

D. Hunting of native species must be kept to a sustainable level.

Your Ideas: Do you think it is important for the Okavango wilderness to continue to thrive? Explain why or why not.

A Star Is Born

LANGUAGE ARTS

Objectives

- Students will determine the meaning of words and phrases as they are used in a text, including vocabulary specific to the text's topic.
- Students will trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.
- Describe how a text presents information (e.g., sequentially, comparatively, causally).

Resources

- Vocabulary Activity Master (page 16)
- Language Arts Activity Master (page 17)

Summary

The article "A Star Is Born" identifies how stars form in molecular dust clouds in space. It examines the amount of dust required and where it is found in space and gives gravity its rightful nod as the main character.

BUILD VOCABULARY AND CONCEPTS

- **atom**
- **constellation**
- **dense**
- **molecule**
- **gravity**

Display the vocabulary words. Remind students that increasing the frequency of use is a good way to become familiar with new vocabulary.

Increase the frequency with which the vocabulary words are used with the **Vocabulary Activity Master.** Instruct students to review it and answer any questions they may have. Advise them of the time period during which the activity will take place and tally points at the end.

Then, have students increase their depth of knowledge by joining in think-pair-shares of the instances shown on their tracking sheets, how they used the vocabulary at school, and how they used the vocabulary at home.

READ

Remind students that they become better readers when they can cite strong textual evidence to support a claim that has been made in the text. Throughout the article, the author examines how gravity pulls matter together to form stars. Point out that identifying the supporting evidence in the passage aids in understanding the text.

Display pages 14–15 of the **Projectable Magazine.** If needed, model how to find support for a claim using the "A Star Is Born" passage. **Say:** *In the first paragraph, the claim is made that nearly all stars form in what we call molecular clouds. Looking back, I find clear support for this claim. Starlight destroys molecules. The only places where molecules can survive are where material is fairly dense. Dust in space clouds shield molecules from the starlight that would tear them apart.*

Remind students that headlines, text, photos, and captions can provide support for claims. Let students know that evaluating how well claims are supported will help them to become better readers.

Give each student a copy of the **Language Arts Activity Master.** Have students read pages 14–15 on their own to practice identifying how the author supports a claim made in the text. As they do, instruct them to use text coding to identify passages in which the author makes a claim with a *C* and information that supports a claim with an *S*.

A Star Is Born

LANGUAGE ARTS

TURN AND TALK

Have students turn and talk to compare their **Language Arts Activity Master** with a partner. Remind students that to find an author's position, they can ask themselves questions such as:

- What main idea is the author trying to convince me about?
- Does the author provide support and examples to back his claim?
- Do the stated reasons and support justify the claim?
- What additional support might the author have included that would have more fully supported the claim?

Making Claims

Remind students that individual reading passages should support the claims made in the article. Have students review their **Language Arts Activity Master** together. Did students find the same examples of claims that were strongly supported? Did they disagree on the level of support that a claim was given? Have students explain their reasoning to their partners. They should also discuss and work with a partner to suggest the main idea of the article and identify details that support it. Most students will develop a variation and come to a consensus on how well the author did on supporting the claims that were made in the article. Have students turn and talk to discuss the impact that making claims has on the overall article.

Text Organization

Say: *Understanding how information in an article is organized is key to understanding the article itself.* Have pairs of students reread the "A Star Is Born" article, focusing on how each section is organized. Have them make annotations in the margins to identify sections that are organized sequentially, comparatively, and causally. Students can discuss what they have identified and what strategies they use to better comprehend text passages based on how they are organized.

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

- How can math concepts help you to understand the formation of stars?
- What surprised you about what you read?

A Star Is Born

SCIENCE

Objectives

- Students will understand the series of events needed for a star to form.
- Students will understand why some space clouds can produce stars when others cannot.
- Students will connect processes in star formation to atoms and molecules.

Resources

- Science Activity Master (page 18)
- Science Quiz Master (page 19)
- "The Heavens" poster (Teacher's Guide)

Science Background

Stars are cosmic energy engines that produce heat, light, ultraviolet rays, x-rays, and other forms of radiation. They are composed largely of gas and plasma, a superheated state of matter composed of subatomic particles.

No one knows how many stars exist, but the number would be staggering. Our universe likely contains more than 100 billion galaxies, and each of those galaxies may have more than 100 billion stars. Standing on Earth beneath a clear, dark sky, only about 3,000 stars can be seen.

Hydrogen is the primary building block of stars. Hydrogen circles through space in cosmic dust clouds called nebulae. In time, gravity causes these clouds to condense and collapse in on themselves. As they get smaller, the clouds spin faster because of the conservation of angular momentum.

Building pressure causes rising temperatures inside young stars, and nuclear fusion begins when the core temperature climbs to about 15 million degrees Celsius.

Stars are nuclear reactors. They take a fuel and convert it to something else. Hydrogen fuses to form helium, and the fusion reactions continue to form carbon, nitrogen, oxygen, iron, and sulfur. The material that composes everything on Earth, including our bodies, comes from stars that died in huge explosions.

ENGAGE

Tap Prior Knowledge

Project the images shown on pages 12–13. Have volunteers read each of the captions in turn. Then have students discuss the appropriateness of the names.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photo on pages 10–11 and the purple heads and photos on the remaining pages. Ensure students have a general understanding of the words *atom, constellation, dense, molecule,* and *gravity.*

Challenge students to predict what the article is about specifically. Discuss with students whether or not they find the fact that stars form in dust clouds in space reasonable. Encourage students to elaborate on their answers with scientific support. Prompt students to think about whether their explanation is based on fact or opinion.

Set a Purpose and Read

Have students read "A Star Is Born" in order to explore the role that gravity plays in the formation of stars.

A Star Is Born

SCIENCE

EXPLAIN

Star Formation

Lots of atoms are required to make a star. When there are enough atoms, they join together to form molecules. When there are enough molecules, space clouds become dense. Only dense space clouds have enough matter to make a star. Give each student a copy of the **Science Activity Master.** Instruct students to explain the sequence of star formation.

Dark Areas

Use the **Projectable Magazine** to display the image on page 15. Explain that the dust blocking light from the stars behind the cloud has twice the mass of our sun and it measures about one-half light-year across. Have students share their speculations as to why Bernard 68 has yet to produce a star.

Fusion and Star Formation

Have students use reference materials such as the April "The Elements" poster to connect the atoms and molecules found in molecular clouds and young stars to the characteristics of atoms, such as atomic mass and potential for reactivity. Students can research the basic process of nuclear fusion, emphasizing the impact of gravity on density, and how the elements in stars change as the star ages.

ELABORATE

Find Out More

Display the "The Heavens" poster and have students compare and contrast what they know about how stars are born and the information included on the poster. Point out the key to star magnitude shown below the stars found in the Northern and Southern Hemispheres. Challenge students to use the key to make observations about the location of stars of given magnitudes.

Extend Your Thinking About Star Formation

Have students extend their thinking about how stars are born. Students might research why the Orion Nebula is known as a stellar nursery. NASA also has a wealth of information and images on areas that are generating new protostars and embryonic stars. Students could explore the answers to questions such as: What time scales are required for stars to form? What conclusions can they draw about whether on not stars are born in clusters? What claim does the data support about where stars are born?

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **Why are stars only born in dense space clouds?** (Starlight destroys molecules. The dust in a dense space cloud hides molecules so they can survive.)
- **What role does gravity play in the formation of a star?** (Gravity pulls the matter in a space cloud towards its center causing the cloud to collapse.)
- **Why are molecules important in the formation of stars?** (Molecular clouds might have thousands or even millions of molecules per cubic centimeter, making them dense enough for gravity to collapse the cloud to form a star.)

Name _____ Date _____

VOCABULARY ACTIVITY: A Star Is Born

Vocabulary Tracking Sheet

Total Points _____

Tracking Vocabulary Words I found in speech, print or media – 5 points		
When	Instance	Points

Tracking Vocabulary Words I used in class – 10 points		
When	Instance	Points

Tracking Vocabulary Words I used in writing assignments – 15 points		
When	Instance	Points

Documenting Vocabulary Words I used at home – 20 points			
When	Instance	Initials	Points

Name _____ Date _____

LANGUAGE ARTS ACTIVITY: A Star Is Born

Use your observations from pages 14–15 to complete the chart.

1. Briefly summarize a claim made by the author that you thought was very strong.
2. What information or reasons were given to support this claim?
3. Briefly summarize a claim made by the author that you thought was weak.
4. Explain what it was about the support, reasons, or examples given that did not persuade you to accept the author's claim?
5. What additional support might the author have provided that would have caused you to see the claim more favorably?
6. Rate how well this author provides support/reasons/examples for the claims that are made: **Weak 1 2 3 4 5 Strong**

Name _____ Date _____

SCIENCE ACTIVITY: A Star Is Born

Record the sequence of events required for a star to form. Explain why stars do not form in some regions of space, and give examples.

First
Next
Then
Finally
Explanation and Examples

Name _____ Date _____

SCIENCE QUIZ: A Star Is Born

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

1. What is the estimated mass of the atoms in space in our galaxy?

A. one hundredth the mass of the sun

B. equal to the mass of the sun

C. 1–4 billion times as massive as the sun

D. 5–10 billion times as massive as the sun

2. Which is NOT something that gravity does?

A. Gravity keeps Earth falling around the sun.

B. Gravity keeps a star from forming.

C. Gravity holds air close to Earth.

D. Gravity pulls everything toward Earth's center.

3. What is special about space cloud Bernard 68?

A. It weighs three times as much as the sun.

B. It has given birth to thousands of stars.

C. It looks like an empty blob in space.

D. It appears dark because of the density of the gases it contains.

4. What is the relationship of buckyballs to young stars?

A. Buckyballs have no relationship to stars.

B. Buckyballs are large carbon molecules in the molecular clouds.

C. Buckyballs are one of the substances found in nebulae.

D. Buckyballs are made up of ammonia and water.

5. A nebula is

A. a term that describes the disk of gas around a young star.

B. the molecular cloud in which many stars form.

C. a gas shell left behind by an old star.

D. a homogeneous area of space dust.

Your Ideas: Create a flowchart that shows the sequence of star formation.

Mega Cave

LANGUAGE ARTS

Objectives

- Students will determine the meaning of words and phrases as they are used in a text, including vocabulary specific to the text's topic.
- Students will use a variety of techniques to understand the figurative, connotative, and technical meanings of words in a reading passage.
- Students will cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.

Resources

- Vocabulary Activity Master (page 24)
- Language Arts Activity Master (page 25)

Summary

The article "Mega Cave" identifies how water shaped the world's largest cave—Hang Son Doong—located beneath the forests of Vietnam.

BUILD VOCABULARY AND CONCEPTS

- **calcite**
- **erosion**
- **limestone**
- **rimstone**
- **sinkhole**

Display the vocabulary words. Remind students that using context clues such as the sentences before and after an unknown word and photographs on the page can help them figure out what the unfamiliar word means. Students should read the article to build an understanding of each of the words.

Give each student a copy of the **Vocabulary Activity Master** and have each complete it independently. Students will devise their own definitions for each term and scramble their position in the chart. Stress that drawings and background knowledge can be used when writing definitions.

Have students exchange papers and independently match each vocabulary word with its definition. Then student pairs should discuss their efforts and clarify with explanation. As a summary, teams of students can compare their definitions to ones given in the Wordwise and discuss the attributes of a good definition.

READ

Remind students that the purpose of this article is to explain how the world's largest cave was shaped by water. Guide the class to recognize that words can have different figurative, connotative, and technical meanings based on how they are used. Help students understand that the tone or meaning of a text passage can be determined by the author's use of figurative and/or technical language and connotations. Encourage students to read the text closely. Explain to students that they will learn how to examine words in four ways:

- words that set tone (e.g., ". . . you know the real adventure has begun")
- words that have figurative meanings (similes and metaphors; e.g., ". . . like a giant three-toed paw")
- technical language or words that clarify a process (e.g., ". . . the tiny sphere grows"); and
- connotations (words that evoke a feeling).

Marking the text is a powerful tool that helps students to read closely. You might elicit a text coding strategy or suggest placing a *T* above words that set tone; an *F* above examples of figurative language; a *TL* above words that describe technical language; and a *C* above connotations. Consider modeling the coding of examples at the beginning of the article. Once students have coded Mega Cave, they can transfer their efforts to the **Language Arts Activity Master** and describe their reasoning for their coding. Encourage those that find more than four examples to use the back of the sheet. Once finished, have students discuss how the examination of words in the four different categories impacts their understanding and enjoyment of the article.

Mega Cave

LANGUAGE ARTS

READ

(continued)

Display page 17 of the **Projectable Magazine**. Model filling in an example on the **Language Arts Activity Master.**

Words That Set Tone	Figurative Language	Technical Language	Connotations
Hidden deep within these forested mountains is the largest cave of them all—Hang Son Doong.			You're sweaty, dirty, tired, and super excited!

TURN AND TALK

Have students turn and talk to share their efforts on the **Language Arts Activity Master** and discuss their examples. Encourage them to compare their results as a class or in small groups. Students might add additional examples on the back of their sheets for a more complete listing.

Explain Concepts

Elicit from volunteers examples of the technical language and ask them to explain what processes are occurring within the cave. Then, encourage other volunteers to give examples of figurative language and connotations that help them clarify those processes or otherwise make them more concrete in their minds. Other students might suggest phrases that simply make the text more enjoyable to read. Ask students to summarize the overall tone of the article and describe how that impacted their comprehension.

Textual Evidence

Point out that inferences result when a stimulus, in the form of printed text in this case, activates some information stored previously. Have students turn and talk to review some of the inferences they made when reading the article. Prompt discussion with questions such as: *Which type of text structure promoted making inferences? Why did some text structures hinder making inferences? Did you make more inferences during the early part of your reading or more as you got into the text passage?*

WRITE AND ASSESS

You may want students to write about what they learned to assess understanding. Encourage students to reflect upon what they read and how it affected their ideas about the topic.

- How would you describe the process that created Hang Son Doong?
- What surprised you about what you read?

Mega Cave

SCIENCE

Objectives

- Students will identify how the movement of water can cause underground formations.
- Students will understand the time scale required for formation of underground caverns.
- Students will compare and contrast various cave features and how they are created.

Resources

- Science Activity Master (page 26)
- Science Quiz Master (page 27)
- "Path of a River Cave" poster (Teacher's Guide)
- Mega Cave Interactive Whiteboard Lesson (website; optional)

Science Background

The USGS defines a cave is a natural opening in the ground extending beyond the zone of light that is large enough for people to explore. There are several different types of caves on Earth. Most caves are solutional in nature and form in limestone. The limestone is dissolved when acidic groundwater seeps through it. Other solutional caves form when hydrogen sulfide gas rises from oil reservoirs below and mixes with groundwater to form sulfuric acid. These caves are formed when limestone dissolves .

Other types of caves form in different ways. Lava caves form when lava cools at the surface but continues to flow beneath it. The lava below sometimes drains out, leaving caverns behind. The continuous motion of ocean and lake waves can attack weaker rock formation on the shore, resulting in the creation of caverns that people can explore. Melting ice and flowing water can also create caves within glaciers.

Regardless of how a cave forms, they seldom have regular features. The cave in the article is described as a huge opening below the ground. It has huge chambers that were carved out by a flowing river. Solutional caves like Hang Son Doong have some consistent features. Two common dripstone features are stalactites and stalagmites.

ENGAGE

Tap Prior Knowledge

Elicit from students their experiences, observations, or opinions about caves. Create a list and have students mark those that are fact and those that are opinion. Revisit the list as you continue through the article and delete those facts that are erroneous.

EXPLORE

Preview the Lesson

Invite students to read the headline and examine the photo on pages 2–3 and the blue heads, pictures, and graphics on the remaining pages. Ensure students have a general understanding of the words *calcite, erosion, limestone, rimstone,* and *sinkhole.*

Challenge students to predict what the article is about specifically. Discuss with students whether or not they find the fact that moving water was able to create the world's largest cave, and all of the amazing features in it, surprising or even true. Encourage students to elaborate on their answers with some explanation. Prompt students to think about whether their explanation is based on fact or opinion.

Display the "Path of a River Cave" poster. Have students systematically discuss the data on the poster and summarize the value of the map as a tool.

Set a Purpose and Read

Have students read the article to learn how water shaped the largest cave on Earth.

Mega Cave

SCIENCE

EXPLAIN

Moving Water

Hang Son Doong means "mountain river cave." Sometimes the river dips below the floor, carving out lower passages, only to reappear farther along the cave. Water is also instrumental in creating most speleothems (cave formations). Have students review "Mega Cave" to refresh their memories as to how caves form. They may need to do additional research to find out more about the time scale over which formations develop. Distribute the **Science Activity Master.** Have teams of students make annotated drawings of the cave formations, which will be shared with the class.

Time Scale

In the article, students meet the "Hand of Dog." The name fits because the stalagmite looks like a giant three-toed paw. The middle toe rises 20 stories through the cool cave air, making it the tallest stalagmite in the world. Students might calculate how long it has taken for the middle toe to form. Research would tell them that 0.13 millimeters is a good average for the yearly growth rate of a stalagmite. The average story in a building is 3.05 meters. Using these numbers, tudents should arrive at a figure that is around 470,000 years!

Compare and Contrast Cave Features

Have students create and complete a two-column chart that will compare and contrast cave features. Their efforts could focus on stalactites, stalagmites, cave pearls, flowstone, and rimstone.

ELABORATE

Find Out More

Display the "Path of a River Cave" poster. As you review the information, have students compare and contrast the different features depicted. Challenge them to identify how each feature was created. Students can learn more about these formations with the **Mega Cave Interactive Whiteboard Lesson.**

Extend Your Thinking About Caves

Have students extend their thinking about caves by doing research on other cave types such as lava tubes and glacial caves. Students might produce illustrated print or electronic presentations detailing the great variety of caves, how they form, and the time scales over which they form and reform.

EVALUATE

Assess comprehension of science concepts mentioned in the article using the **Science Quiz** alone or in combination with the following questions. Have students record their answers in their science notebooks or on the back of the Science Quiz.

- **How did Hang Son Doong get its name?** (The Rao Thuong River flows throughout the cave and is responsible for its name. The words *Hang Son Doong* mean "mountain river cave.")
- **What is significant about the Hand of the Dog?** (It is a stalagmite that looks like a giant three-toed paw. The middle toe of the formation rises 20 stories through the cool cave air, making it the tallest stalagmite in the world.)
- **Why is the Great Wall of Vietnam not so great?** (The wall is so dangerous to climb that Hang Son Doong explorers don't use the west exit of the cave that is just above it. Instead, they reverse the route they followed to get to it and walk back nine kilometers to the cave's entrance.)

If your classroom is so equipped, use the **Mega Cave Interactive Whiteboard Lesson** for a whole-class summary of the article. Even if you don't have an interactive whiteboard, the Interactive Whiteboard Lesson can be projected and is fully functionable with the mouse of the computer connected to the projector.

Name _____ Date _____

VOCABULARY ACTIVITY: Mega Cave

Write your own definition for each word in one of the blank boxes. Scramble their position in the chart. Exchange papers with a partner. Draw lines to match the definitions to the correct word.

Word	Definition
calcite	
erosion	
limestone	
rimstone	
sinkhole	

Name _____ Date _____

LANGUAGE ARTS ACTIVITY: Mega Cave

Write an example word, phrase, or sentence from the article. Tell how it sets tone and shows figurative and/or technical language or connotations.

Words That Set Tone	Figurative Language (similes and metaphors)	Technical Language (clarifies a process)	Connotations (relates a feeling or ideal)

Name _____ Date _____

SCIENCE ACTIVITY: Mega Cave

Make a drawing of each feature left behind after water is finished with its creative effort.

Feature	Drawing	Process / Time Scale
Hang Son Doong		
stalactite		
stalagmite		
cave pearl		
rimstone		

Name _____ Date _____

SCIENCE QUIZ: Mega Cave

Circle the correct answer for questions 1–5. Then write your response to Your Ideas.

1. How was Hang Son Doong formed?

A. Sulfuric acid dissolved the limestone.

B. Flowing water eroded the limestone.

C. Freezing and thawing crumbled the limestone.

D. Both A and B

2. The following process creates which cave formation? Water drops cling to the ceiling. When the water evaporates, each drop leaves behind a speck of calcite that connects to the ceiling. Drop by drop, speck by speck, a rocky deposit of calcite builds downward.

A. rimstone

B. cave pearls

C. stalagmite

D. stalactites

3. Why are sinkholes not a problem when exploring Hang Son Doong?

A. The sinkholes found in Hang Son Doong are less than 0.5 meter in diameter.

B. Sinkholes are filled in as quickly as they are found.

C. The cave expeditions travel in areas that are free of sinkholes.

D. The sinkholes are found in Hang Son Doong's ceiling.

4. Why are all of the rocks you would walk on in Hang Son Doong not covered in moss?

A. The supply of water is inadequate to allow grass to grow everywhere.

B. Moss only grows beneath the two sinkholes that let light into portions of the cave.

C. Moss only grows on specific types of rock in Hang Son Doong.

D. Moss does not grow in the acidic cave climate.

5. Why is calcite important to the physical landscape of Hang Son Doong?

A. It is the substance of which most cave features are formed.

B. It causes the colorful displays seen on the cave walls.

C. It absorbs carbon dioxide generated by the cave explorers.

D. It is water soluble.

Your Ideas: Explain and justify what you think is required for a cave to be classified as a mega cave.

Explorer - Extreme

ANSWER KEY

Okavango Adventure

Vocabulary Activity, page 8

Games will vary but should all include the boldface terms—*delta, sediment,* and *wetland*. Students might include other terms as well, such as expedition and trek. After playing their own game and one or two others, students should be able to gauge the relative success of the effectiveness of their own for learning new vocabulary terms.

Language Arts Activity, page 9

Students' responses will vary but should be logical in the relationship of the text to their idea about how it conveys the author's point of view. Evaluate each for accuracy and sense.

Science Activity, page 10

Students will have their own ideas about the relative importance of any given adaptation to survival. Evaluate students' responses based on whether they reflect fact or opinion and the logic behind them.

Science Quiz, page 11

Answers: **1.** C **2.** D **3.** D **4.** B **5.** A

Your Ideas: Students' answers will vary, but should include facts and a logical rationale.

A Star Is Born

Vocabulary Activity, page 16

Students should record usage of the terms from the Wordwise feature—*atom, constellation, dense, molecule,* and *gravity*.

Language Arts Activity, page 17

The claims and support students cite will vary; however, they should be logically connected.

Science Activity page, 18

Sample response: First, old stars die and cast away oxygen, iron, and other materials into space. Next, the materials form space clouds called nebulae. Then, gravity begins to pull the materials together causing the cloud to collapse. Finally, the center of the cloud becomes hotter and hotter until it glows.

Science Quiz, page 19

Answers: **1.** D **2.** B **3.** C **4.** B **5.** B

Your Ideas: Students' responses should reflect sequence similar to:

Old star dies → space clouds form → gravity pulls molecules in clouds together → center of cloud becomes dense and hot → new star glows

Mega Cave

Vocabulary Activity, page 24

Students' definitions will vary, but should reflect those in the Wordwise of the boldface words—*calcite, erosion limestone,* and *sinkhole*, and others of their own choosing, such as rimstone. Evaluate them for accuracy.

Language Arts Activity, page 25

The claims and support students cite will vary, however they should be logically connected.

Science Activity, page 26

Students' responses will vary but should be logical in their relationship to the examples chosen. Evaluate responses on their logic and sense.

Science Quiz, page 27

Answers: **1.** B **2.** D **3.** D **4.** B **5.** A

Your Ideas: Answers will vary. Look for logical support in the students' rationales.