MONTANA SKIES

CROW ASTRONOMY

Montana Office of Public Instruction
Denise Juneau, Superintendent

opi.mt.gov

Dear Friends,

I am pleased to provide Montana's public schools with *Montana Skies: Crow Astronomy. Montana Skies* integrates traditional Crow oral star stories with ethno-astronomy and contemporary astronomy concepts guided by Crow keepers of that knowledge. *The Montana Skies* DVD and Teacher's Guide can serve as a resource to implement Indian Education for All (MCA 20-1-501) in Science, Social Studies, and the Arts.

The Montana Skies: Crow Astronomy DVD contains three traditional Crow stories, each a part of Crow oral history, told by Crow elders and students. The *Montana Skies* Teacher's Guide provides suggested activities and resources linked to the *Essential Understandings Regarding Montana Indians* and Montana's Content Standards in Science, Social Studies, and the Arts. *The Montana Skies: Crow Astronomy* resources will add an important perspective to Montana classrooms.

Thank you for working to include both historic and contemporary portrayals of American Indian issues and perspectives into your curriculum.

Sincerely,

opi.mt.gov

Denise Juneau

Denise Juneau, Superintendent of Public Instruction

MONTANA SKIES
Crow Astronomy

Developed by Lynn Moroney

2011

Montana
Office of Public Instruction
Denise Juneau, State Superintendent

opi.mt.gov

MONTANA SKIES
Crow Astronomy

Table of Contents

Crow Acknowledgements 1

Cultural and Science Connection 2

Essential Understandings and Montana Content Standards 3

Listening to the Crow Stories 4

Planetarium Possibilities 5

Crow Stories and Science Stories

Sun and Moon 7
Moon Rotation and Moon Phasing
Activities – Jump to the Moon and Grandmother Moon

The Seven Stars: The Story of the Seven Bulls 18
Constellations / Star Maps
Activities – Earth Maps and Star Maps

The Twins and the Hand Star 28
Constellations / Mapping
Activities – Constellation Creation & Creative Writing

Say It In Crow 38

Resources 39

CROW ACKNOWLEDGMENTS

Ahoó - Thank you Crow Elders!

Thank you Crow members Jennifer Flat Lip, Lawrence Flat Lip, Timothy McCleary, Newton Old Crow, Jr., and Loretta Three Irons for providing direction for initiation of this project. Even more, thank you each and every one for your kindness, your hard work, and your willingness to share some of the ways of Crow people. Especially for the rich conversations that provided insights and understandings of the importance and ever present relationship between the Crow people and the heavens.

Special thanks to Jennifer Flat Lip, principal coordinator who brought us together and kept us on track.

Thank You

Tim Bernardis - Director of the Little Big Horn College Library, who guided us through the Crow Collection

Cedric Black Eagle - Crow Tribe Chairman

David Yarlott - President of Little Big Horn College

CROW STORYTELLERS

Sun and Moon
Recorded by Jennifer Flat Lip and Loretta Three Irons
Scripted from Alma Hogan Snell's story references and fragments in The Stars We Know: Crow Indian Star Astronomy and Lifeways

Seven Stars
Recorded by Jennifer Flat Lip and Loretta Three Irons
Scripted by Loretta Three Irons and Jennifer Flat Lip

The Twins and the Hand Star
Recorded by Newton Old Crow, Jr.
Scripted from story versions and fragments told by Barney Old Coyote Jr., Mickey Old Coyote, and Vincent Goes Ahead, in The Stars We Know: Crow Indian Star Astronomy and Lifeways

CULTURAL CONNECTION

Thousands of years before Europeans knew about the land we now call America, Native peoples with rich cultures were living here. Such was the case of the Apsáalooke people, now known as the Crow people, who had as keen an understanding of the heavens as did the Greeks, Romans, and many early astronomers.

The Crow people had names and stories for the Sun and Moon, the visible planets, prominent stars and star groups. Today, Crow knowledge of the sky continues to be passed from one generation to the next.

Sky Beings are present in the everyday life of the Crow people who live with, rather than under, the sky.

SCIENCE CONNECTION

The hands-on and art activities are designed to further and deepen the students' understanding of the science phenomena referred to in each of the three teaching units.

Introduction

The stories on the enclosed DVD are presented as an invitation to learn about Crow culture and Astronomy. We are able to touch upon only a small part of the rich traditions of the Crow people and their deeply rooted relationship with the Sun, the Moon, and the Stars.

Both the traditional tales and the science explorations are offered with the understanding that neither story is superior to the other. Rather, the stories are presented together so that each, in its own way, may deepen the mystery of the human story and the universe in which we live.

Many Crow members and elders have proudly and generously shared their oral tradition of storytelling and their understanding and knowledge of the skies so that the children of Montana may know something of their Crow families and neighbors.

For more information on the Apsáalooke Nation and the Crow Tribe go to: http://www.crowtribe.com.

MONTANA SKIES

Crow Astronomy

Links to Montana Essential Understandings and Content Standards

Essential Understanding Regarding Montana Indians

Essential Understanding 1- There is great diversity among the 12 tribal Nations of Montana in their languages, cultures, histories and governments. Each Nation has a distinct and unique cultural heritage that contributes to modern Montana.

Essential Understanding 3 - The ideologies of Native traditional beliefs and spirituality persist into modern day life as tribal cultures, traditions, and languages are still practiced by many American Indian people and are incorporated into how tribes govern and manage their affairs.

Additionally, each tribe has its own oral histories, which are as valid as written histories. These histories pre-date the "discovery" of North America.

Science Content Standards

4th Grade-

Science Content Standard 4. Students through the inquiry process, demonstrate knowledge of the composition, structures, processes and interactions of Earth's systems and other objects in space.

Benchmark 6. Identify objects (e.g., moon, stars, meteors) in the sky and their patterns of movement and explain that light and heat comes from a star called the sun

Essential Learning Expectations:

A. Define and model revolution and rotation

B. Model the orbit of the planets around the sun

C. Identify the patterns of movement between a planet, its moon, and the sun

D. Identify changes in the appearance of the Earth's moon over the course of a month

E. Identify other objects in the solar system (meteors, comets, and asteroids)

Science Content Standard 6. Students understand historical developments in science and technology.

Benchmark 1. Give historical examples of scientific and technological contributions to communities, cultures and societies, including Montana American Indian examples

Essential Learning Expectations:

B. Identify and discuss historical examples of scientific or technological contributions that impacted a community, a culture and a society; including Montana American Indians

Social Studies Content Standards

4th Grade-

Social Studies Content Standard 6. Students demonstrate an understanding of the impact of human interaction and cultural diversity on societies.

Benchmark 2. Describe ways in which expressions of culture influence people (e.g., language, spirituality, stories, folktales, music, art, dance).

8th Grade-

Social Studies Content Standard 6. Students demonstrate an understanding of the impact of human interaction and cultural diversity on societies.

Benchmark 2. Explain and give examples of how human expression (e.g., language, literature, arts, architecture, traditions, beliefs, spirituality) contributes to the development and transmission of culture.

LISTENING TO THE CROW STORIES

For the Teacher:

Here are some suggestions to help prepare your students for the experience of listening to the stories on the enclosed DVD, Montana Skies: Crow Astronomy.

- Explain that the stories they are about to hear come from the Crow people and are told at night and during the winter.
- Darken your classroom as much as possible.
- Because of the high level of significance of oral stories in traditional and contemporary Crow culture, it is imperative that listeners come to the stories with an equal level of respect. Communicate the expectation that students listen quietly and respectfully.
- Explain that they will hear Crow stories told by members of the Crow Tribe, and told much as they would be told to friends and family on a winter night.
- It is best to plan this activity during a time when the stories will not be interrupted by school bells or announcements.
- Students will listen as they view only a starry night. This will seem unusual for students who are accustomed to TV.
- Explain that as with any stories that you (the teacher) or a visiting storyteller might tell, they will simply hear them and not see illustrations on the TV screen. Encourage your students to use their imaginations to create their own pictures as they listen to the stories.
- Some students may wish to close their eyes while listening.
- **Science Stories:** Watch the screen! Images are provided to help illustrate the concepts.

PLANETARIUM POSSIBILITIES

If possible, students' experiences would be greatly enhanced if they are able to hear the Traditional and Science stories while seated in a planetarium chamber. Use regular screen or side wall of planetarium as the screen, and seat children unidirectionallly. Ask planetarium educator to have a very slow "Daily Motion" during the Traditional stories. After the Story units are over, enlist the help of the planetarium educator to enlarge upon the information presented.

Montana Planetaria / International Planetarium Society '09/'10

1. Starlab Planetarium / 30 seats
Billings Public Educ. Foundation
415 North 30th Street #313
Billings, MT 59101-1252 USA
(406) 255-3567
Judy Henry/Stephanie Smith

2. Planetarium
Boulder School
P.O. Box 176
Boulder, MT 59632 USA
+1 (406) 225-3316
Shirley Elliot

3. Taylor Planetarium / 104 seats
Museum of the Rockies
600 W. Kagy Blvd.
Bozeman, MT 59717 USA
+1 (406) 994-2251 museum
+1 (406) 994-6874
www.montana.edu/wwwmor
J. Eric Loberg
+1 (406) 994-6891 Planetarium Manager
+1 (406) 994-2682 fax / eloberg@montana.edu

4. Starlab Planetarium / 30 seats
School District #1
215 South Sixth Street West
Missoula, MT 59801 USA
+1 (406) 728-2400x1077
+1 (406) 728-2400x1056

5. Starlab Planetarium / 30 seats
University of Montana
Missoula, MT 59812 USA
+1 (406) 243-2073
+1 (406) 243-5283
diane.friend@umontana.edu
j.naylor@mso.umt.edu

CROW STORIES AND SCIENCE STORIES

Recordings of the stories are on the enclosed DVD

SUN AND MOON

STAR BIRTH – MOON PHASING

SEVEN STARS

CONSTELLATIONS

THE TWINS AND THE HAND STAR

CONSTELLATIONS – STAR MAPS

SUN AND MOON

MOON ROTATION AND MOON PHASING

Activities – Jump to the Moon and Grandmother Moon

I•SAAH•KA•XAA•LIA **Ee•sah•cah•xah•leah** **SUN**	**KAA•LI•XAA•LIA** **Caw•lee•xah•leah** **MOON**

Teacher Guide:

The following activities may be used to reinforce your teaching of Moon phases, as well as to explain why we always see the same face of the Moon.

Who? Students Grades 3-4

How long will it take? 60-90 minutes

Life Lessons:

- Cycles are a part of life, whether it is the cycle of the Moon's phases or the phases in our own lives.
- Life is all about cycles.
- In "Jump to the Moon" you learned that even though you cannot see the new moon, it is still there.
- Likewise, even when you cannot see your family and loved ones, they are always present, just as Grandmother Moon in the story.

Science Lessons:

- Our Moon goes through phases each month.
- There are patterns to the Moon's phases.
- The Moon revolves around the Earth.
- The Moon's rotation and revolution periods are unique as both are approximately 28 days (unlike other planets and moons).
- The Moon's rotation is extremely, uniquely, slow.

Vocabulary:
Review the vocabulary to determine any needed terminology/concept pre-teaching.

- waxing
- waning
- crescent
- revolution (revolve)
- rotation (rotate)
- quarter moon
- gibbous
- continent
- counterclockwise
- axis

Resources:

Books:

Aldrin, Buzz. *Reaching for the Moon.* Harper Collins. ISBN 0060554452. 2005. Ages 7-12.

Branley, Franklyn M. *The Moon Seems to Change.* Harper & Row. ISBN 0064450651. 1987. Ages 4-8.

Bredeson, Carmen. *The Moon.* Franklin Watts Publishing, ISBN 0531203085. 1998. Ages 8-12.

Fraknoi, Andrew and Schatz, Dennis. *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook.* Astronomical Society of the Pacific. ISBN 1886733007. 1995. Ages 6-18.

Graham, Ian. *The Best Book of the Moon.* Kingfisher/Houghton Mifflin. ISBN 0753451743.1999. Ages 7-10.

Krupp, E.C. *The Moon and You.* HarperCollins. ISBN 0688178189. 2000. Ages 8 to adult.

Miller, Ron. *The Sun.* 21st Century Books. ISBN 0761323554. 2002. Ages 9-14.

Moroney, Lynn. *Moontellers: Myths of the Moon from Around the World.* Northland Publishing Company. ISBN 0873586018. 1995. Ages 9-13.

Murphy, Patricia J. *Why Does the Moon Change Its Shape?* Powerkids Press. ISBN 0823962342. 2004. Ages 5-10.

Tomecek, Steve M. *Sun (Jump Into Science).* National Geographic. ISBN 0792282000. 2001. Ages 4-8.

Vogt, Gregory. *The Sun.* Millbrook Press. ISBN 1562946005. 1996. Ages 6-11.

Websites:

Aspire- A website from The University of Utah shares information about lunar phases, including a lunar cycle animation for children ages 10 and up. Also available in Spanish. http://aspire.cosmic-ray.org/index.php. This website has been changed to: http;//aspire.cosmic-ray.org/.

The Cosmic Classroom- Offers multiple lesson plan ideas and games for teachers on lunar phases. A PowerPoint is also included. http://virtuallibrary.stao.ca/sci-tie-data/lessons/1100_1199/1173.htm.
This website has been changed to: http://stao.ca/VLresources/sci-tie-data/lessons/1100_1199/1173.htm.

Enchanted Learning- For younger and older children along with the explanations for different Moon "names" and a brief narrative of Moon phases. Also available is a blank Moon-phases diagram for labeling, a Moon coloring page and quiz, and links to several other Web sites. http://www.enchantedlearning.com/subjects/astronomy/moon/Phases.shtml.

NASA's Space Science Resource Directory- Provides educators with lesson plans, curriculum support materials, and a list of Sun resources. http://teachspacescience.org/cgi-bin/ssrtop.plex.
This website has been changed to: http://imagine/gsfc.nasa.gov/docs/resources/pathways.html.

NASA's StarChild- Offers an interactive game with Moon phases that will also test the viewer's skill in identifying them. http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/moonlight.html.

NASA's StarChild-_Includes student activities, graphics, and a glossary for children of all ages and is offered in several languages. http://starchild.gsfc.nasa.gov/docs/StarChild/solar_system_level2/sun.html.

NASA's Sun-Earth Connection-_Presents a profusion of resources for educators, children, and the general public. http://sunearth.gsfc.nasa.gov/sunearthday/2003/educators_guide2003/index6.html.

Songs of Higher Learning UTube Phases- Rap engages children of all ages with informative – and fun - songs and graphics. http://www.youtube.com/user/songsofhigherlrng#p/a/u/0/AQRNzepe4wI.

The Stanford Solar Center- Ages 9-18 will enjoy an "Interview with Mr. Sol" plus solar folklore, posters, and other resources are offered. http://solar-center.stanford.edu/index.html.

Windows to the Universe- Offers a variety of Sun topics on all levels. The site includes a section on Sun myths and stories from around the world. http://www.windows2universe.org/sun/sun.html.

SUN AND MOON

MOON ROTATION AND MOON PHASING

Activity 1 – Jump to the Moon!

What will you need?

For each group of 10 children:

- 8 white paper plates (not plastic)
- 8 popsicle or craft sticks (large, if possible)
- Crayons or markers as follows: 8 black, 1 yellow, 1 blue and 1 green
- Tape
- An image of the 8 primary phases of the Moon (below is an example).
- Plenty of space for the children to spread out
- 1 Earth globe or image/map of the Earth

Before beginning Jump to the Moon:

- Write each phase name on a separate piece of paper. Also include separate pieces of paper with "Sun" and "Earth" respectfully.
- Place these 10 pieces of paper in a container. After you divide them into groups, each child will reach into this container for the image they will represent.
- You may want to have the groups work at tables or on the floor.
- Make one copy of the Moon Phases image for each group.

Teacher Guide:

1. Divide the children into groups of 10. Explain that each child in the group will either be coloring and representing:
   a) One of eight Moon phases
   b) The Sun
   c) The Earth

2. After dividing the children into groups, have each child pull a piece of paper from the container to see which image he/she will represent.

3. After each child has drawn, distribute the paper plates, appropriate colors (the Full Moon child will not need a color at all), craft sticks, and glue.

4. Distribute one illustration page of the Moon phases (above) to each group, and have each child write his/her name on the moon phase he or she will be coloring on their paper plates.

5. If you are coloring a Moon phase, use your black color to shade the darker portion of the Moon as seen in your special Moon phase image.
   If you are a New Moon, you will color your entire plate.
   If you are the Full Moon, you will not color your plate at all.

   Teacher: *You may wish to ask the Full Moon children to help the New Moon children color his/her plates. Share with the Earth child that he/she will not need to include details on their Earth picture, just the basic outlines of a few continents in green and the oceans around the continents in blue. Ask the children to memorize their phase name, but not to label their plate.*

6. After coloring it, place the craft stick on the back of your plate – toward the bottom edge of the image that is on the other side – so that enough of the stick is hanging below the plate for you to grasp with your hand. Secure it in place with several pieces of tape.

   Teacher: Check to be sure the children have taped their craft stick in the correct place on their plate… so when they turn it over, the darkened portion is in the correct position. (If they flipped their plate the wrong way before taping, it could end up in the exact opposite position of what was intended.)

7. After coloring and taping the stick on your plate, pick a place in the room and – using your Moon phase image as a guide – assemble yourselves in a circle, in the following counterclockwise order.

   Teacher: Explain to the children that the Moon revolves around the Earth in a counterclockwise direction. Your Earth should be in the center, and your Sun should be outside the circle, 4-5 feet behind the New Moon child, and directly facing the Full Moon child. After the children are in place, invite them to pause and see what patterns they can observe in relation to the positions of the Moon phases. Invite them to share their observations with the class.

   Discuss:

   - **Where is the waxing crescent in relation to the waning crescent?**
   - **Where is the waning gibbous in relation to the waxing gibbous?**
   - **Where are the new and full moons?**
   - **Where are the first and third quarters?**
   - **Are both waxing and waning moons on the same side of the sun?**

   The children should observe that both waxing moons are on the same side and come before and after the first quarter moon, and the two waning moons are just the opposite.

   They should also observe that the waxing and waning gibbous moons fall just before and after the full moon, and that the waxing and waning crescent moons fall just before and just after the new moon. Recognizing these patterns will help the children to more easily recollect the order of the moon phases.

   You may wish to give them a few moments to memorize the order and/or share any other observations or questions they might have.

8. Now it's time to **"Jump to the Moon!"**

   Teacher: *Remind the children of the Crow custom about jumping to the moon.*
   Read aloud the following:
   Each month when the moon appears as a thin crescent of light in the western sky, adults of the Crow people call the children to come and see the new moon. The children then jump as high as they can while saying, "By the next moon I'll be <u>this</u> tall." They jump over and over to see how high they can jump.

   First, hold down your moon phase plates, then *in order* – one at a time beginning with the waxing crescent – hold up and call out the name of your moon phase.

   But when it again gets to the waxing crescent phase, all children should jump as high as possible!

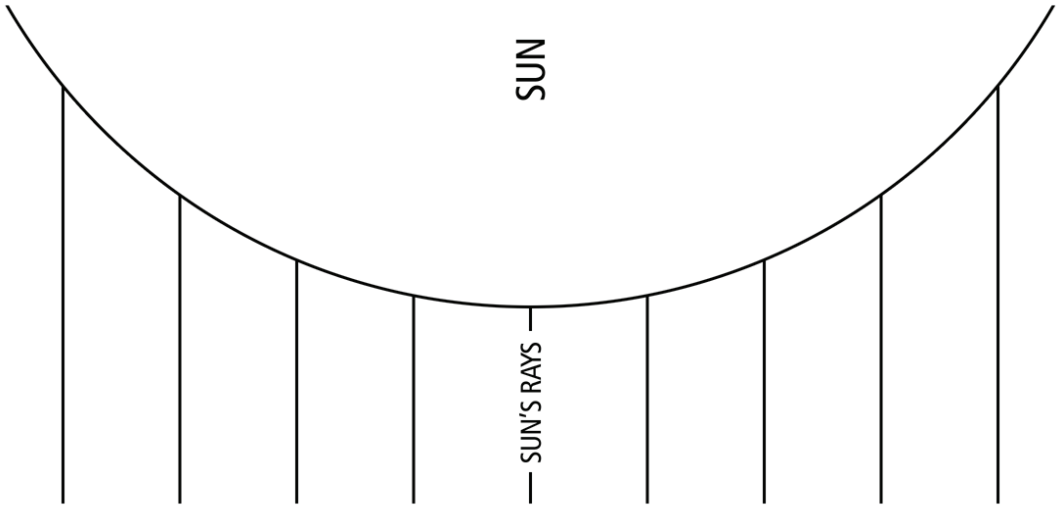
9. Now, complete one more round of Jump to the Moon! And remember, when you see the next new thin crescent, you may have grown to be as tall as you jumped!

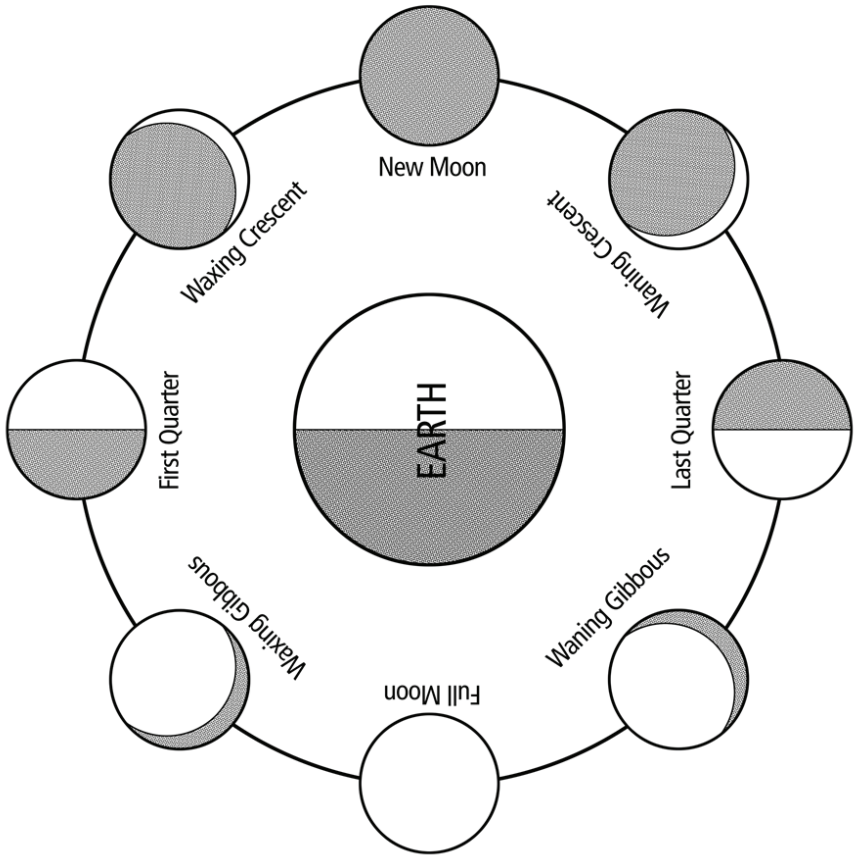
Activity 1 Extension: Memorable Moon Phases

1. After all groups have "jumped to the moon," and when your teacher gives the signal, quickly trade plates with another group, making sure that only one trade is made (in other words, no one should trade plates, then trade again with a different person). As soon as you have your new plate, get back with your original group – but DO NOT show anyone in your group which plate (phase) you got and DO NOT get in phase order yet!

2. When your teacher gives the signal, each group should arrange itself in the correct order of moon phases, with the Sun in the correct position to the new and full moons, and the Earth in the center. As soon as your group is in order, have your teacher check for accuracy.

   Invite the children to repeat the moon phase order chorally if time permits.


SUN
SUN'S RAYS


MOON PHASES
New Moon
Waxing Crescent
First Quarter
Waxing Gibbous
Full Moon
Waning Gibbous
Last Quarter
Waning Crescent
EARTH

SUN AND MOON

MOON ROTATION AND MOON PHASING

Activity 2 – Grandmother Moon

What will you need?

For each child:

- 1 regular size white paper plate (not plastic)
- 1 small white or yellow paper plate
- A variety of colored pencils, crayons, or markers
- 1 dark colored marker
- The following photographs, if possible. However, please remind children they need their parent(s) permission. If children are not able to obtain photographs and permission, they may draw pictures.
    - A photograph of a grandparent or parent
    - One photo of themselves
    - One or more photos of their family members

For the Teacher:

- Prior to beginning the activity, distribute one small and one regular size paper plate and the rest of the supplies to the children.
- Explain that in this activity the larger plate represents Earth and the smaller plate represents the Moon.
- Tell them from this activity they will gain an understanding of how it is that - regardless of the phase – it is the same face, or side, of the moon that always points toward us on Earth.
- And Grandmother Moon watches over the people of the earth month after month and year after year.

Observe the children to make sure they understand and are following this procedure. Be sure all the children have moved their moon plate one complete revolution around the Earth and back to the position where it started.

Discuss with the class the following questions:

What did the arrow show you about the Moon? The arrow showed that the same side of the Moon always faces the Earth.

Did your Moon make a complete rotation? (In other words, did the Moon turn in a complete circle all the way around its axis?) Yes

If you do the demonstration again, with the Earth missing, you will clearly see that the Moon made one "complete" turn, or rotation. If time permits, and to help the children see it more clearly, you may want to have them demonstrate this.

How long does it take the Moon to revolve around the Earth? One month.

How long does it take the Moon to make one complete rotation? One month.

Do the Moon's rotation and revolution take the same amount of time (one month)? Yes.

Can you explain, then, why we always see the same face, or side, of the Moon? Answers will vary, but should include that we always see the same side of the Moon because the Moon rotates so slowly around the Earth.

WOMAN ON THE MOON

Photograph courtesy of Brian Paino

Grandmother Moon

STUDENT WORKSHEET

1. After receiving your supplies, glue your family picture(s) in the center of your small paper plate, leaving the edge blank.

   If you do not have a picture, draw a picture of a parent, grandparent, aunt or uncle, or anyone in your family who takes care of you.

   At the very top, **label this plate "Grandmother Moon" or "Family Moon."**

2. Around the outside edge of your family plate, color or sketch objects or designs that are meaningful to you and your family. Perhaps you have a family pet, or your family loves the mountains. Be creative. Be sure, however, to leave a one inch space on the left side of your family plate blank.

3. In the blank space on the left side of the smaller plate, using a dark colored marker, draw an arrow facing away from the picture(s) on the plate, toward the outside edge.

4. Now, glue the image of yourself on the *larger plate.* Again, if you do not have a picture, you may draw a picture of yourself and label it with your name.

   Label this plate, "Me, on Earth."

5. Once you have finished both plates, place the smaller family plate a few inches from the ***right side*** of the Earth plate with your picture on it.

   The arrow on the family plate should be pointing toward you.

   The arrow is a *guide* that will help you understand how the same side of the Moon always faces Earth, no matter where it is in its monthly cycle around the Earth.

6. After your plates are in place, you will demonstrate one monthly revolution of the Moon around the Earth.

   To do this, very slowly begin to move the small plate around the big plate counterclockwise.

   The arrow on Grandmother Moon (your small plate) must *always* face you. So, no matter where the Moon is in its revolution, your arrow should always face the Earth.

THE SEVEN STARS

The Story of the Seven Bulls

CONSTELLATIONS / STAR MAPS

Activities – Earth Maps and Star Maps

IHKA•SAH•PUA
Eeh•ka•sah•puah
SEVEN STARS

For the Teacher:

The following activities may be used to explain horizontal latitude lines and vertical longitude lines as well as horizontal declination lines and vertical right ascension lines.

Who? Students Grades 4-5

How long will it take? This activity is divided into two parts. Each part may take 1-2 class periods of 30 - 45 minutes each.

Life Lessons:

- Remind the students that The Seven Stars of the Crow Story of the Seven Bulls are the Seven Stars in the group of stars called "The Big Dipper. "
- The Crow story tells that these Seven Stars were once the Seven Bulls who went to live in the sky where they now watch over the Crow people.
- These Seven Stars have many names. Sometimes the name will refer to the number of the stars as in the Crow Story. Sometimes they are named after their shape. For example, in many countries the Seven stars resemble a cart or wagon.
- **What is the name of the star that Buffalo Boy became?** Hint: It is the Constant Star.
- **What do scientists call that star?** Polaris

Science Lessons:

- The Earth is measured by lines of latitude- the horizontal lines that encircle the Earth and measure degrees North or South from the Earth's equator- located at 0º.
- The Earth is measured by lines of longitude– the vertical lines that extend from the north to the south Poles and measure the 360º of a circle.
- The Sky is measured by lines of north or south declination- horizontal lines that encircle the sky and measure degrees north and south of the sky equator.
- The Sky is measured by lines of right ascension- the vertical lines that extend from the north to the south Poles and measure 24 hours of time.

- The names and figures given to star groupings or constellations vary from culture to culture. So even though there are 88 names given to the constellations, according to western science, you can name and put together any group of stars you want and form your own special constellation for yourself and friends or for your family.

Vocabulary:
Review the vocabulary to determine any needed terminology/concept pre-teaching.

- Seven Stars
- Big Dipper
- Seven Bulls
- Constant Star
- Polaris
- latitude right
- longitude
- cartographer
- vertical
- celestial
- declination
- ascension

Resources:

Books:

Kerrod, R. Starwatch: *A Month-By-Month Guide to the Night Sky.* Barron's Educational Series, Quarto, Inc. ISBN 0764156667. 2003. Ages 10-15.

Peters, S. *The Little Dipper.* Powerkids Press. ISBN 082396163X. 2003. Ages 8-12.

Rey, H.A. *The Stars: A New Way to See Them.* Houghton Mifflin Co. ISBN 0395081211. 1973.

Sneider, C. *Earth, Moon, and Stars Teacher's Guide (from Great Explorations in Math and Science).* Berkeley: Lincoln Bergman and Kay Fairwell, Lawrence Hall of Science, University of California. 2001. Ages 10-13.

Vogt, G. *Constellations (Galaxy)*. Bridgestone Books. ISBN 0736813829. 2002. Ages 4-8.

Websites:

Astronomy in Your Hands- Provides lessons and activities about the North Star for ages 10–15. http://www.astronomyinyourhands.com/activities/activities.html.

NASA Quest Learning Technologies Channel- Explains the roles of Polaris and the Dippers in guiding slaves to freedom. A variety of activities for ages 8–16 explore using stars and constellations for navigation. http://quest.arc.nasa.gov/ltc/special/mlk/mlkarchive.html.

Skymapper- For a personalized sky view from your location, just click on http://www.skymapper.co.uk/html/your_sky_now.html.

THE SEVEN STARS

The Story of the Seven Bulls

CONSTELLATIONS / STAR MAPS

Activity 1 – Earth Maps

What will you need?

For each child:

- Earth Map Activity Student Worksheet #1

For the teacher:

You will need a globe or map of the world with lines of latitude and longitude.
Montana is located between longitude 104° west and 116° west and latitude 44.5° north and 49° north.

Before you begin, set up a globe or map of the world with latitude and longitude lines.

The discussion questions appear in bold print.

Use the map or globe to point out the lines of latitude and longitude as you guide the children through the explanation.

Discuss:

Do you see the lines going across the map? Yes.

Are there really lines going around the Earth like that? No. These are imaginary lines.

What are these lines called?

- They are called lines of latitude and longitude.
- Lines of latitude are horizontal lines that measure degrees north and south of the Equator (which is zero degrees).
- Latitude lines measure degrees north from the equator to the North Pole (which is located at 90° north latitude) and south from the equator to the South Pole (which is located at 90° south latitude).
- Lines of longitude are vertical lines that measure east and west degrees. They are vertical lines that are drawn lengthwise–up and down - from the top (North Pole) through the town of Greenwich, England to the bottom of the Earth (South Pole). This line is labeled 0 degrees.
- Longitude lines measure from 0° to 180° west longitude and from the same zero to 180° east longitude where they meet at The International Date Line, in the middle of the Pacific Ocean.
- When you add the east and west longitude lines you get the exact number of degrees in a circle.

What is the purpose of latitude and longitude lines? Lines of latitude and longitude help people locate specific places on Earth. They are particularly helpful when trying to locate a precise spot in a body of water - where there are no addresses.

Provide each child with a copy of the student worksheet #1

1. Carefully observe the map below. It is a map of the United States with latitude and longitude lines. Montana is located between longitude 104° west and 116° W and latitude 44.5° north and 49° north. Locate Montana.

2. Helena, the capitol of the State of Montana is approximately 47° north and 112° west. Can you find it?

Teacher: Allow the children to ask questions and share their guesses, making sure to correct any misunderstandings.

3. Once you have located Helena, take a guess about where your own town is located. After you have located the latitude and longitude of your town, draw a star on your map that corresponds as closely as possible to where you live.

Extension Activity: Find the Cities

Students will need a detailed map of the United States with latitude and longitude lines.
Locate and mark these cities on the map using latitude and longitude degrees listed below.
Note: The latitude and longitude degrees listed below are estimates for ease of finding.
For exact lat & long go to: http://www.realestate3d.com/gps/uslatlongdegmin.htm

LAT	LONG	CITY	LAT	LONG	CITY
45	107	Crow Agency, MT	42	83	Detroit, MI
39	77	Washington, DC	46	109	Harlowton, MT
33	112	Phoenix, AZ	43	101	Valentine, NE
35	92	Little Rock, AR	36	115	Henderson, NV
34	118	Los Angeles, CA	33	108	Alamogordo, NM
24	81	Key West, FL	40	74	New York City, NY
43	116	Boise, ID	48	97	Grand Forks, ND
42	87	Chicago, IL	44	123	Eugene, OR
37	101	Liberal, KS	40	75	Philadelphia, PA
30	90	New Orleans, LA	42	71	Providence, RI
33	80	Charleston, SC	48	123	Port Angeles, WA
44	103	Rapid City, SD	43	88	Milwaukee, WI
35	102	Amarillo, TX	43	106	Casper, WY
41	112	Salt Lake City, UT			

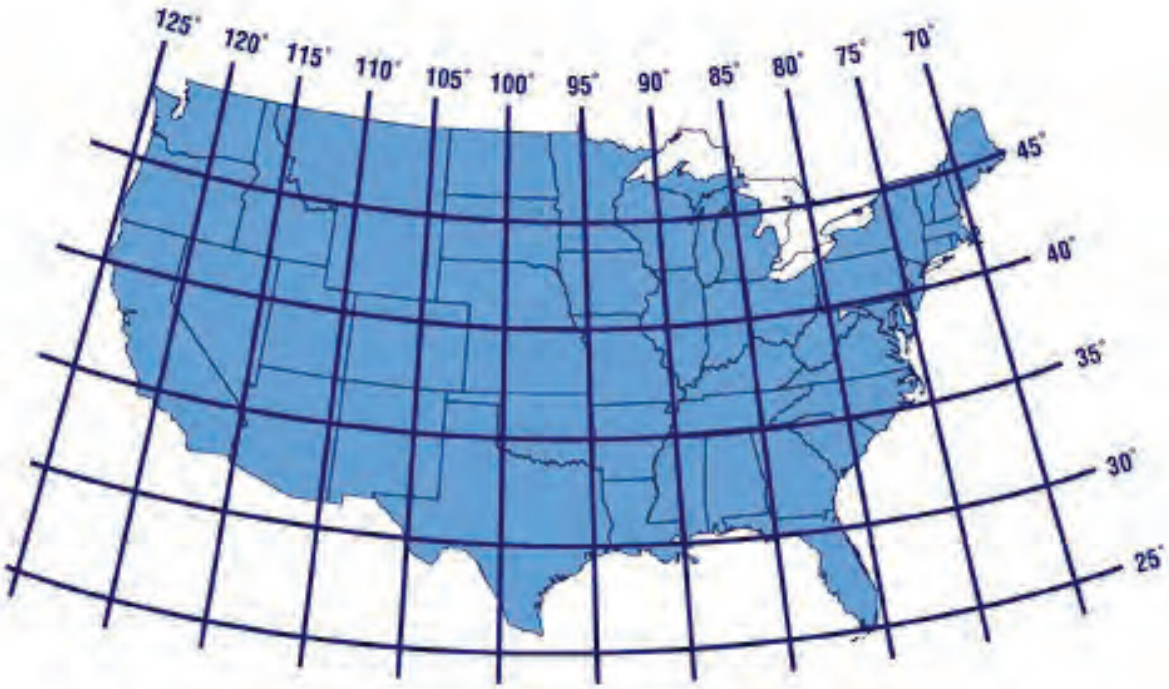
Earth Maps
STUDENT WORKSHEET #1

Activity (PART I): Earth Map

1. Carefully observe the map below. It is a map of the United States with longitude and latitude lines. Montana is located between longitude 104° west and 116° west and latitude 44.5° north and 49° north. Locate Montana.

2. Helena, the capitol of the State of Montana is approximately longitude 112° west and latitude 47° north. Can you find it?

3. Once you have located Helena, take a guess about where your own town is located. After you have located the latitude and longitude of your town, draw a star on your map that corresponds as closely as possible to where you live.



Map courtesy of www.hightunnels.org

THE SEVEN STARS

The Story of the Seven Bulls

CONSTELLATIONS / STAR MAPS

Activity 2 – Sky Maps

What will you need?

For each child:

- Sky Map Student Activity Worksheet #2
- Star Map

For the teacher:

- Hand out a copy of the Star Map along with a copy of Sky Map Student Activity Worksheet #2.
- Remind the children about what they learned in the Seven Stars science story regarding how scientists have mapped the sky in the same way cartographers (map makers) mapped the Earth.
- On a sky map, however, the horizontal lines that measure the sky's latitude north and south of the sky celestial equator have a different name. On a sky map, these lines are not called latitude lines.
- These horizontal lines are called declination lines. Declination lines measure degrees from the sky equator 0° to 90° at the north or south poles, as do Earth's latitude lines.
- On a sky map, the vertical imaginary lines from the sky North Pole down to the sky South Pole also have a new name.
- These vertical lines are called right ascension lines. <u>They do not measure degrees</u>.
- Right ascension lines measure time (in hours).
- Right ascension lines do not start at a line on Earth such as Greenwich England, rather they begin at 0 and measure time from 0 hours, to 1 hour, 2 hours, 3 hours and on around the sky map until they reach 23 hrs. The next hour is back to 0 for 24 hours of measured time.

Teacher: Ask your students: What does 24 hours remind you of? A day. A sky map is broken up into 24 hours.

Sky Map- Teacher Guide

1. Carefully, examine your star map. What do you notice?
The giant circles have numbers. The circles are the declination lines.

2. On this map the circles are labeled from Dec. +50° to Dec. +85°. Find and mark these degrees:
- Dec. +70°
- Dec. +55°
- Dec. +90°

3. The straight lines are the right ascension lines (RA) Find and mark these RA hours:
- RA 2 hr
- RA 12 hr
- RA 22 hr

4. The Big Dipper is located between RA 11 hr and RA 14 hr and between 65° and 55° declination. Find and mark the Big Dipper on your map.

5. Find and mark the right ascension and declination for the following:

Star	Right Ascension	Declination
Dubhe	RA 11 hr	Dec. +61°
Alkaid	RA 14 hr	Dec. +49°
Mizar/Alcor	RA 13 hr 30 min	Dec. +55°

The middle star in the handle of the Big Dipper is Mizar whose companion star is Alcor. Look for this small star in the dipper handle on any clear night.

STAR MAP

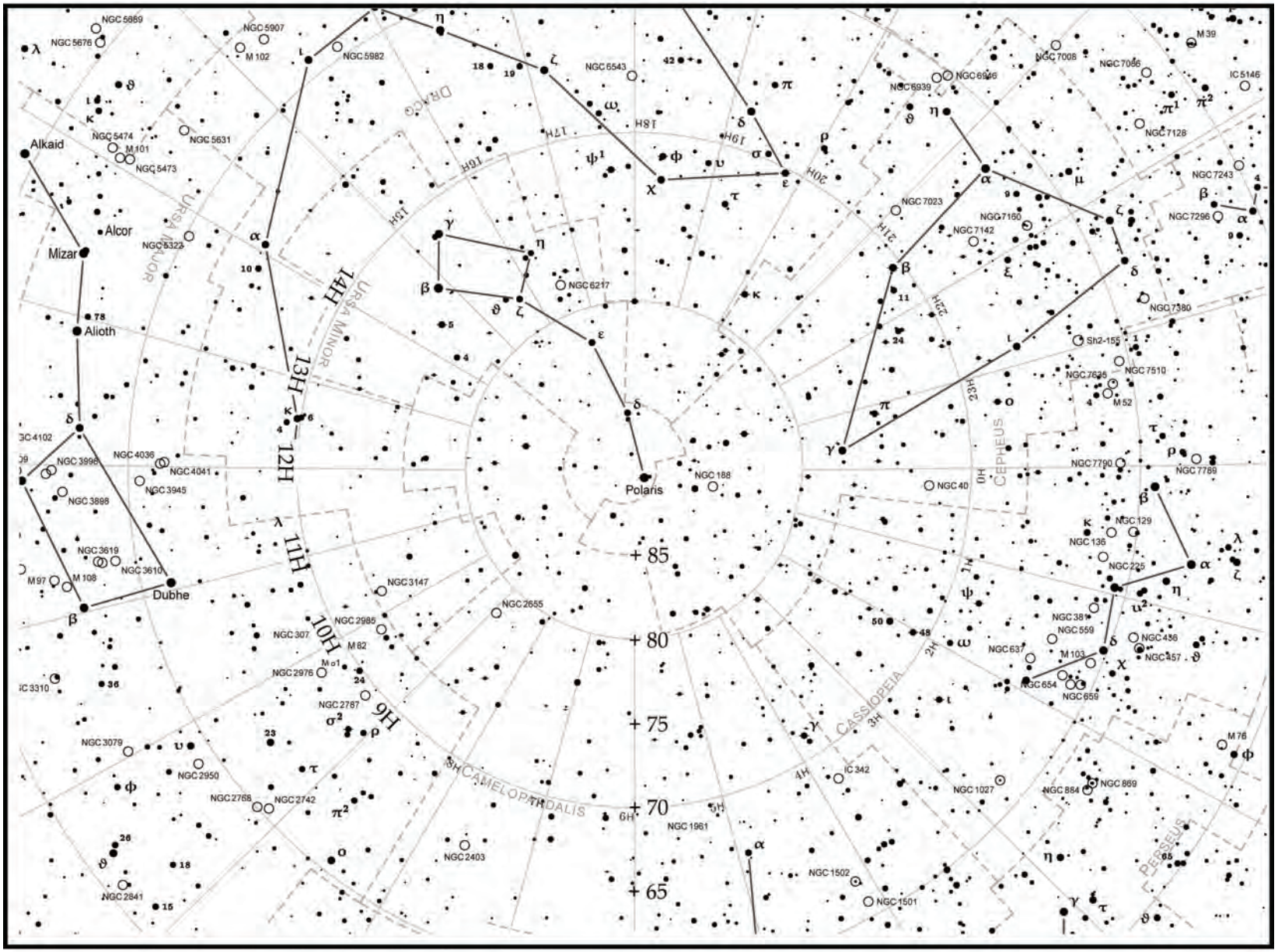


Chart 1: *Declination North of* $+65^o$
http://www.cloudynights.com/item.php?item_id=1052

Magnitude: 0.0 1.0 2.0 3.0 4.0 5.0 6.0 7.0

With permission: Copyright © 2005 Andrew L. Johnson

Sky Maps

SKY MAP STUDENT ACTIVITY WORKSHEET #2

1. **Carefully, examine your star map. What do you notice?**

_____

_____

_____

_____

2. **On this map the circles are labeled from Dec. +50° to Dec. +85°.**
   Find and mark these degrees:
   - Dec. +70°
   - Dec. +55°
   - Dec. +90°

3. The straight lines are the right ascension lines (RA)
   Find and mark these RA hours:
   - RA 2 hr
   - RA 12 hr
   - RA 22 hr

4. The Big Dipper is located between RA 11 hr and RA 14 hr and between 65°and 55° declination. Find and mark the Big Dipper on your map.

5. Find and mark the right ascension and declination for the following:

Star	Right Ascension	Declination
Dubhe	_____	_____
Alkaid	_____	_____
Mizar/Alcor	_____	_____

The middle star in the handle of the Big Dipper is Mizar whose companion star is Alcor.
Look for this small star in the dipper handle on any clear night.

THE TWINS AND THE HAND STAR

Constellations / Mapping

Activities – Constellation Creation and Creative Writing

Thrown Behind the Tipi Lining BI•TAA•LA S•SHIA•ALIT•CHIAS•SHI•TUASH Bee•dal•la•shia•a•leech•chee•shee•doosh	**Thrown Into the Spring BA•HAA•AWUUAS•SHII•TUUASH Bah•ha•ah•wush•shee•doosh**

The Hand Star
IH•KA•LIS•CHE
Ih•ka•lis•je

Who? Students Grades 4-6

How long will it take? 60-90 minutes

What will you need?

For each child:

- 8.5 x 11 sheet of white paper (copy paper works well)
- 1 sheet of construction paper
- a pen or pencil
- 8 to 10 small beans (rice or corn kernels may be substituted)
- glue or 2-sided tape
- colored pencils or markers (optional)

Life Lessons:

- People "see" things differently. And this is not just with beans on a page or pictures in the sky…it also applies to the different ways in which we view situations, problems, or even people.
- Many people pay no attention to the sun, moon or stars. But for the Crow people, the stars and the stories that go with them are of great importance.
- Many Crow people have come to know the stars and in so doing, they know themselves.
- In the story of the Crow Twins we learn of a family's love and that evil can be overcome.

Science Lessons:

- The names and figures of star groupings (or constellations) were created by people and therefore, vary from culture to culture. It is just like when you create your "star" bean picture. The picture you see your beans form will probably differ from the picture someone else might see. And so it is with constellations.

- To avoid confusion, scientists have agreed upon one name by which each constellation will be known within western science. But, when you look into the night sky and spot the three special stars in a straight line, you may call it Orion's Belt (from western science) or you can turn to a friend, and say, "I see the Hand Star (from Crow culture) in the sky."

Vocabulary:
Review the vocabulary to determine any needed terminology/concept pre-teaching.

- constellations

Resources:

Books:

Branley, F. *The Sky Is Full of Stars.* HarperTrophy Publishers. ISBN 0064450023. 1983. Ages 4-8.

Dickinson, T. *Nightwatch: A Practical Guide to Viewing the Universe.* Firefly Books Ltd. ISBN 1552093026. 1998. Ages 11 and up.

Kerrod, R. *Starwatch: A Month-by-Month Guide to the Night Sky.* Barron's Educational Series. ISBN 0764156667. 2003. Ages 8 to adult.

Kimble, E. and Kimble, L. *Constellations Dot-to-Dot.* Sterling. ISBN 0806923970. 2001. Ages 9-12

Miller, D. *Stars of the First People: Native American Star Myths and Constellations.* Pruett Publishing Company. ASIN 0871088584. 1997. For adults.

Mitton, J. *Once Upon a Starry Night: A Book of Constellations.* National Geographic. ISBN 0792263324. 2004. Ages 5-9.

Rey, H.A. *Find the Constellations.* Houghton Mifflin. ISBN 0395244188. 1976. Ages 9-13.

Sasaki, C. *The Constellations: Stars & Stories.* Sterling Publishing. ISBN 0806976357. 2001. Ages 12-15.

Thompson, C.E. *Glow-In-The-Dark Constellations: A Field Guide for Young Stargazers.* Grosset & Dunlap. ISBN 0448412535. 1999. Ages 9-11.

VanCleave, J. *Janice VanCleave's Constellations for Every Kid: Easy Activities that Make Learning Science Fun.* Wiley. ISBN 0471159794. 1997. Ages 9-12.

Vogt, G. *Constellations (Galaxy)*. Bridgestone Books. ISBN 0736813829. 2002. Ages 4-8.

Websites:

"Constellations" link from Windows to the Universe- Offers everything from constellation images to sky myths, games, movies, and animations on three reading levels. http://www.windows2universe.org/the_universe/Constellations/constnavi.html.

Enchanted Learning- Provides a wealth of information for children 8-15 about stars, including the 88 constellations. http://www.enchantedlearning.com/subjects/astronomy/stars/constellations.shtml.

Family Education.com, The Night Sky- Allows family members to interact through night sky observing. A multitude of resources are available for both parents and children at this website. http://fun.familyeducation.com/astronomy/childrens-science-activities/32950.html?ssb.

NASA's Space Place- Children ages 8-12 can make their own Star Finder Cootie Catcher for any month of the year. This site also explains the difference between astronomy and astrology and the criteria for being considered a constellation. http://spaceplace.nasa.gov/en/kids/st6starfinder/st6starfinder.shtml.

National Geographic Online- Will virtually transport viewers ages 10 and older to their destination of choice among the stars. They may also view Hubble images as overlays on a nighttime star chart. http://www.nationalgeographic.com/features/97/stars/index.html.
This website has been changed to: http://science.nationalgeographic.com/science/space/universe/stars-article.html.

Skymapper- For a personalized sky view from your location click on http://www.skymapper.co.uk/html/your_sky_now.html.

Teacher Guide:

1. Each student will need a copy of the printable star map from:
   http://www.kidsastronomy.com/astroskymap/constellations.htm

   Before printing this star map, make sure to choose "December" as the month and 8:00 p.m. as the time. (You may want to make copies of the star maps on card stock paper or laminate them so they may be reused several times.)

2. Print a copy for each child of the "Orion and the Hand Star" sheet. It will be used later in discussion.

3. Each student will need a copy of the student worksheet "Constellation Creation."
   Important: Have the children complete only Step 1 of the activity. Then, while the glue is drying, hand out the star maps and engage the students in the discussion below.

THE TWINS AND THE HAND STAR

Constellations / Mapping

Activity 1 – Constellation Creation

Teacher Guide
In the activity "Constellation Creation" the students will create a book cover (that they can use as part of the Activity 2 – Creative Writing Activity), by randomly dropping beans (that will represent stars) onto a sheet of paper, and then deciding what picture they can create from them.

Step 1. Center the white paper on the construction paper and securely glue or tape it into place. Then fold it in half like a book, crease well and unfold so that the "book cover" is flat for the bean-dropping/constellation forming activity.

Stop For Discussion. Look again at your star map.

Distribute the star maps (December, 8:00 PM) to the children and initiate a discussion with the following questions:

What do the dots on the picture represent? Stars.

What are the lines connecting them? These are imaginary lines that show how certain star groups are connected to form constellations. Some of these traditional constellations were adopted from the ancient Greek, Middle Eastern, and Roman cultures and some were identified and named later by astronomers from other countries. In 1930, however, scientists determined that every star surrounding Earth should be part of a constellation – even if it was not a part of a traditional sky picture, like Orion the Hunter. They divided the sky into 88 parts, like pieces in a jigsaw puzzle. Included within each constellation region are some star groups with which we are familiar, along with other stars that were placed with them to help scientists arrange the sky into sections. The ones in your star map are the constellations you can see from your home in the Northern Hemisphere. There are many more constellations that can only be seen from the Southern Hemisphere. And some stars within the 88 constellations are not visible with the naked eye at all and can only be seen with powerful telescopes.

On the star map you have been given, can you locate the constellation Orion the Hunter? Orion is on the west – or left – side of this star map and is a constellation we can most clearly see in the winter. This is an illustration of the way the constellations appear from your home in December.

Teacher: At this time, provide a copy of "Orion and the Hand Star" drawing to each student.
You will find the image at end of this activity.

Explain to your students:

- The Crow people connect some of the stars of Orion to make a picture of a left hand in the southern winter sky. This Crow constellation is called The Hand Star. Ask them to look at the stars in Orion and see if they can find the 3 stars that form a wrist. The stars that make Orion's dagger make a thumb. The bright star, Rigel, is the tip of the index finger. No star is at the tip of the ring finger, so we (like the Crow

people) can imagine a ring finger.

- While we use the title "Orion" as it is shown on an official star map, the configuration of the Crow constellation of The Hand Star is no less authentic.

Step 2. Place the beans in your hand and make a fist.

Step 3. Make a constellation-with the fingers in your fist pointing down – about 2"- 4" above the right-hand side cover of your book. Open your fist and drop the beans. This is your constellation. Don't worry if some of the beans didn't land on the book.

Step 4. Carefully glue each bean (star) in place. Let them dry well.

Step 5. Now observe your constellation a few moments and decide how you can connect the stars to form a picture. Your picture or constellation can be anything – any object or figure you see it forming. Be creative.

Step 6. Use a marker or colored pencil to connect the stars to form the object in your constellation. Then, name it.

Step 7. Be prepared to discuss with your class how constellations are created.

For the Teacher: After completing the activity, have the students fill in their worksheets.
Invite them to share their insights and answers.

1. **Before you dropped the beans, did you know how they would land or what picture they would form?** No.

2. **Would you say that your beans (stars) just landed randomly, with no particular order in mind?** Yes. But some answers may vary.

3. **How does this relate to the stars in the sky?** Answers will vary, but should include that the stars also were created in the sky, and many people from different cultures see designs or pictures from their perspectives.

4. **Who decided how your stars should be connected and what picture they would make?**
   You did. You have a different experience and way to see the stars.

5. **If someone else had looked at the way your star/beans fell on the paper, do you think they might have seen a different picture?** Probably.
   [Note: If time allows, students may view one another's constellations and see if they can identify alternate pictures.]

6. **How did the stars in the sky become connected as constellations?** Answers will vary, but should include that many people from cultures and places around the world looked at the same star groups, but saw different pictures in those same stars. They saw different constellations based on their experiences with the world, the stars, and life. The stories explaining constellations are different for these reasons also.

THE TWINS AND THE HAND STAR

Constellations / Mapping

Activity 2 – Creative Writing

Teacher Guide

Guide students in writing a story including the character(s) from the Crow Constellation story but addressing a contemporary issue. They can place their completed stories in their "Constellation Creation" book covers.

Create a contemporary story using the character(s) from the Crow story of the constellation. What kind of situation from today's world might your characters have to explore? Will your story be adventurous, funny, scary, a family story, or something else? That is up to you. But whatever type of story you write, make sure to include the following five elements.

1. **CHARACTERS** - Characters are the main players in your story. What do they do in your story? Remember that your characters should be the same characters that are in the Crow story.

2. **SETTING** - This is the time and place of the story. Sometimes the setting can change.

3. **CONFLICT** - This is a special kind of problem. At least two of your characters want their own way about something, but it is impossible for both to have their way. What do your characters want their own way about?

4. **CHANGE** - (or Crisis) Something happens to change the circumstances of the story. What happens in your story that changes everything and lets the conflict or problem be solved?

5. **RESOLUTION** - How does your story work out? How will you solve the special kind of problem in your story? The problem is usually resolved toward the end of the story.

Remember to have fun and be creative. Have no more than three or four characters and let your story be short.

For the Teacher: After completing their stories, have the children share them with the class or in groups.

Constellation Creation
Student Worksheet

Step 1. Center the white paper on the construction paper and securely glue or tape it into place. Then fold it in half like a book, crease well and unfold so that your "book cover" is flat while you create your constellation. (Later, you might write a Constellation Story, and you can put it in this book cover you are creating now.)

Stop For Discussion. Your teacher will give you a star map.

Activity continued:

Step 2. Place the beans in your hand and make a fist.

Step 3. Make a constellation--with the fingers in your fist pointing down – about 2"- 4" above the right-hand side cover of your book. Open your fist and drop the beans on your book. This is your constellation! Don't worry if some of the beans didn't land on the book.

Step 4. Carefully glue each bean (star) in place.

Step 5. Now observe your constellation a few moments and decide how you can connect the stars to form a picture. Your picture or constellation can be anything - any object or figure you see it forming. Be creative.

Step 6. Use a marker or colored pencil to connect the stars to form the object in your constellation. Then, name it.

Step 7. Be prepared to discuss with your class how constellations are created.

Write your answers below:

1. Before you dropped the beans, did you know how they would land or what picture they would form? Explain. _____
_____

Could you say that your beans (stars) just landed randomly, with no particular order in mind? Explain.
_____
_____

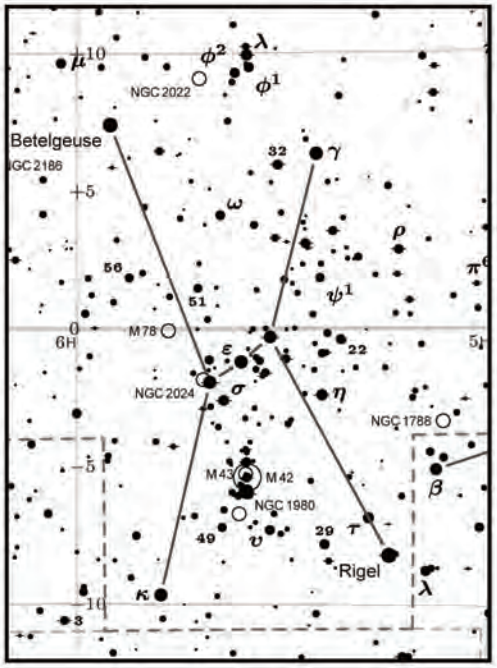
2. How does this relate to the stars in the sky? _____
_____
_____

3. Who decided how your stars should be connected and what picture they would make? _____
_____
_____

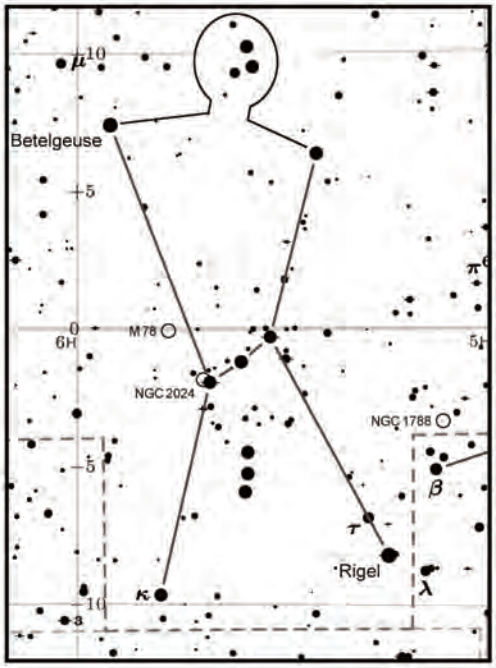
4. If someone else had looked at the way your star/beans fell on the paper, do you think they might have seen a different picture? Explain. _____
_____
_____
_____

5. How did the stars in the sky become connected as constellations? _____
_____
_____
_____
_____

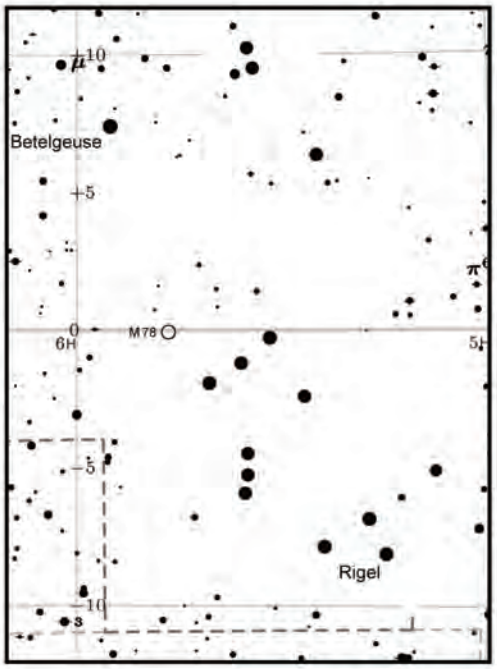
Orion and the Hand Star



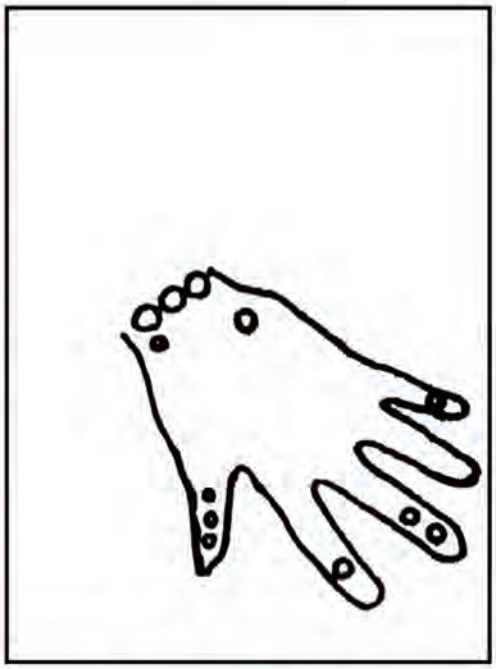
STAR MAP



ORION



THE HAND STAR



THE HAND STAR
(Drawing)

http://www.cloudynights.com/item.php?item_id=1052
With permission: Copyright © Andrew L. Johnson

Creative Writing
STUDENT WORKSHEET

Write your own story including the character(s) from the Crow Constellation story, but addressing a contemporary issue. What kind of situation from today's world might your characters have to explore? Will your story be adventurous, funny, scary, a family story, or something else? That is up to you. But whatever type of story you write, make sure to include the following five elements.

1. **CHARACTERS** - Characters are the players in your story. What do they do in your story? Remember that your characters should be the same characters that are in the Crow story.

2. **SETTING** - This is the time and place of the story. Sometimes the setting can change.

3. **CONFLICT** - This is a special kind of problem. At least two of your characters want their own way about something, but it is impossible for both to have their way. What do your characters want their own way about?

4. **CHANGE** - (or Crisis) Something happens to change the circumstances of the story. What happens in your story that changes everything and lets the conflict or problem be solved?

5. **RESOLUTION** - How does your story work out? How will you solve the special kind of problem in your story? The problem is usually resolved toward the end of the story.

Remember to have fun and be creative. Have no more than three or four characters and let your story be short. When you are finished, you can put your story in the "Constellation Creation" book cover you made.

SAY IT IN CROW!

ENGLISH	CROW LANGUAGE	SOUNDS LIKE
SUN AND MOON		
Sun	I•saah•ka•xaa•lia	Ee•sah•cah•xah•leah
Moon	Kaa•li•xaa•lia	Caw•lee•xah•leah
SEVEN STARS		
Seven Stars	Ihka•Sah•pua	Eeh•ka•sah•puah
Buffalo Boy	Bi•shee•shi•kaa•kash	Bee•shea•shee•ga•gush*
Star	Ihka	Eeh•kah
THE TWINS AND THE HAND STAR		
Thrown into the Spring	Ba•haa•awuuas•shii•tuuash	Bah•ha•ah•wush•shee•doosh
Thrown Behind the Tipi Lining	Bi•taa•las•shia•alit•chias•shi•tuash	Bee•dal•la•shia•a•leech•chee•shee•doosh
The Hand Star	Ih•ka•lis•che	Ih•ka•lis•je

*rhymes with hush'
NOTE: x is as German (k) - ich, ach

RESOURCES

Linderman, F. *Old Man Coyote.* New York: John Day Co. 1931.

Lowie, R. *Myths and Traditions of the Crow Indians.* Lincoln, NE: University of Nebraska Press, Bison Books. 1993.

Lowie, R. *Crow Texts*. Berkeley: University of California Press. 1960.

McCleary, T. *The Stars We Know, Crow Indian Astronomy and Lifeways.* Long Grove, IL: Waveland Press Inc. 1997.

Hubble Images courtesy of:
National Aeronautical and Space Administration (NASA)

The Space Telescope Science Institute (STSci)

Star Maps courtesy of:
Andrew L. Johnson - Mag - 7 Star Atlas Projects- http://www.cloudynights.com/item.php?item_id=1052

MONTANA SKIES: Crow Astronomy Team

Jennifer Flat Lip - Crow Tribe Coordinator

Steve Beckett - Ghede Sound

Louise Goldberg – Musician / Composer

J.D. Mc Pherson - Graphic Designer (DVD)

Lynn Moroney – Concept Designer

Becky Nelson – Teacher's Guide

Michael Wallo - Graphic Designer, (Teacher Guide)

Wayne Wyrick - Science Consultant

The Office of Public Instruction is committed to equal employment opportunity and nondiscriminatory access to all our programs and services, and will take necessary and appropriate steps to insure that the workplace and OPI programs and services are free of discrimination and sexual harassment. For information or to file a complaint, contact OPI Title IX/ EEO Coordinator at (406) 444-3161 or opipersonnel@mt.gov.

Copies of this public document were published at an estimated cost of $. per copy, for a total cost of $ .00, which includes $ .00 for printing and $0.00 for distribution

Montana Office of Public Instruction
Denise Juneau, Superintendent

opi.mt.gov

Design: Ellen Leidl