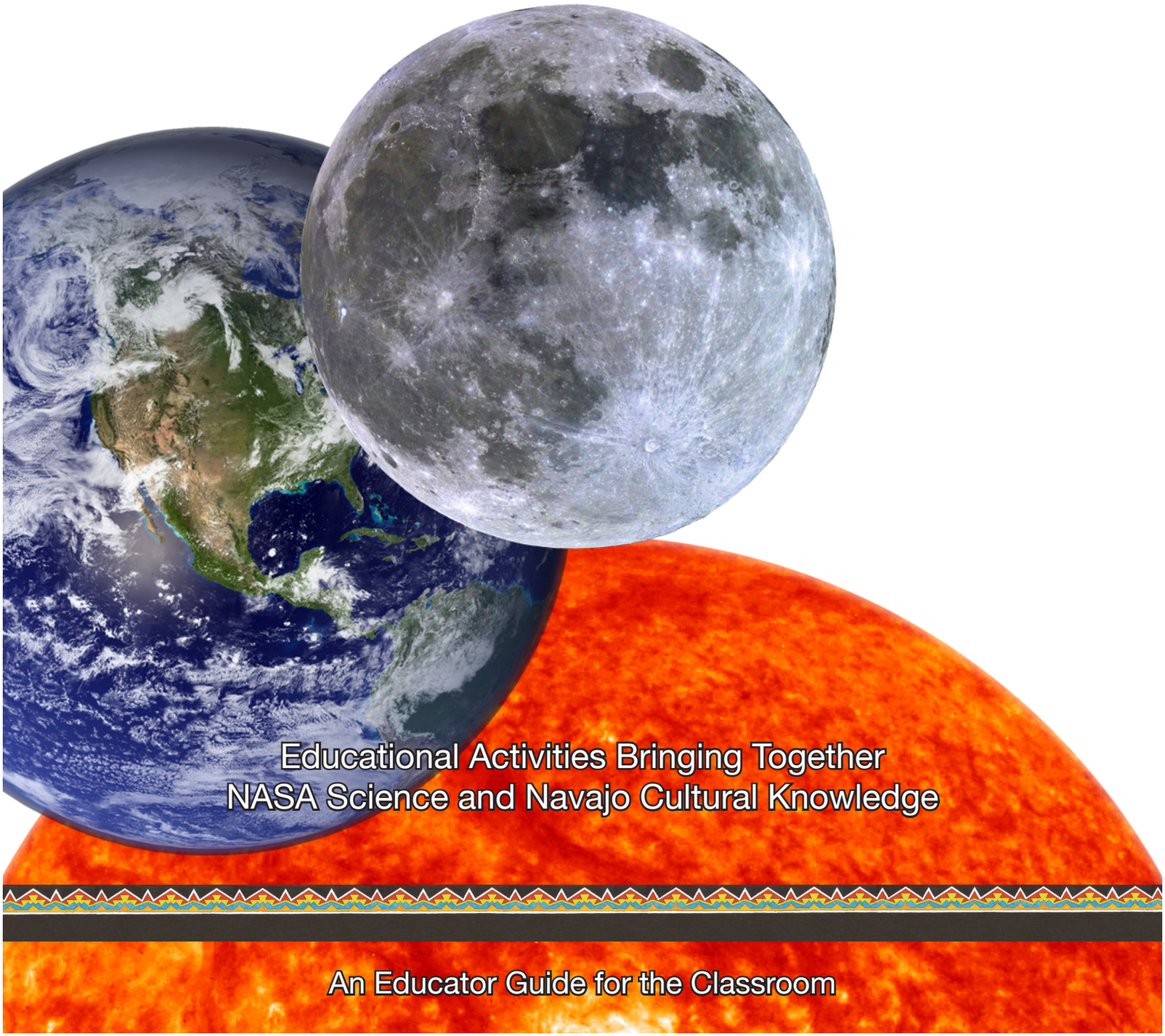
National Aeronautics and Space Administration

Tł'éhonaa'éí Nihemá
Navajo Moon



Educational Activities Bringing Together
NASA Science and Navajo Cultural Knowledge

An Educator Guide for the Classroom

Tł’éhonaa’éí Nihemá
Navajo Moon

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NASA Science and Navajo Cultural Knowledge

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Iiná Dóó Óhoo’ Aah Bindii’ A’

Overall Diné Education Philosophy

From the Diné Culture and Language Curriculum Framework
Office of Diné Culture, Language, and Community Services

Ni’hokáá’ Diyin Dine’é niidlį. Nahasdzáán nihimá dóó Yádiłhił nihitaa’ bita’gi nanihi’deelyá. Dził éí tsodizin dóó sin, nitsáhákees, nahat’á, iiná dóó siihasin bił hadít’éego nihighan ha’a’aahjigo ch’é’étiingo nihá’ályaa áádóó Diyin Dine’é saad niheiinílá. Díí bee nihidziil dóó chánah niidlį.

Tsodizin dóó sin, dóó nitsáhákees, dóó nahat’á, dóó iiná, dóó siihasin, kót’éego bił nanihi’deelyá éí bik’ehgo óhoo’aah dóó éé’deetįįh biniyé nihá niilyá. Tł’óódęę’ óhoo’aah dóó éé’deetįįh yá’ádaat’éhígíí éí bił ałhii’siláago kodóó náásgóó niha’áłchíní bee naniitin dooleeł. Bits’íís dóó binitsékees hadadít’éego yee iiná íidoolííł.

Díí bee nihitsijį’ hózhǫǫ dooleeł, nihikéédéé’ hózhǫǫ dooleeł, nihiyaagi hózhǫǫ dooleeł, nihik’igi hózhǫǫ dooleeł, nihinaa t’áa ałtso hózhǫǫ dooleeł, íinda bee nizaa hadahóózhǫǫd dooleeł. Díí bee Si’ąh Naaghái Bik’eh Hózhóón niidlįįgo náasjį’ kót’éego bee yiikah dooleeł.

Iiná Dóó Óhoo' Aah Bindii' A'
Overall Diné Education Philosophy

From the Diné Culture and Language Curriculum Framework
Office of Diné Culture, Language, and Community Services

We are the Holy People of the Earth. We are created and placed between our Mother Earth and Father Sky. Our home, the Four Sacred Mountains, with the entrance to the East, embodies our Way of Life. It provides strength and peace within us.

Spirituality, intellect, planning, and life have been instilled within us; through these attributes we attain knowledge and wisdom. We shall combine the best learning and knowledge of other societies with that of our own for the benefit of our future.

With that, our children will walk with beauty before them, beauty behind them, beauty beneath them, beauty above them, beauty around them, and will always be respectful and live in harmony with natural law. Our children will go forth in life endowed with what is required to achieve their ultimate aspirations.

NASA and the Navajo Nation Project

In 2004, ArtReach International conducted a NASA Explorer Institute "focus group." In the meeting, members of the Navajo Nation education community discussed needs and desires in partnering with NASA on educational initiatives. Specifically, bringing together NASA science and Navajo cultural knowledge was identified as a priority.

The 2006 Sǫ' Baa Hane'—Story of the Stars educator guide and film were the first manifestation of this priority, and marked the initiation of a collaboration between the Navajo Nation Department of Diné Education Office of Culture, Language, and Community Services and NASA. In those materials, NASA astrobiology science and Navajo cultural teachings relating to the stars are brought together to create a "dual-learning" environment wherein the cultural and scientific concepts are explored together, as equals.

We are proud to continue the collaboration with the presentation of these new materials, Tł'éhonaa'éí Nihemá—Navajo Moon, which are firmly grounded in the same philosophy.

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HOW TO USE THE ACTIVITIES IN THIS EDUCATOR GUIDE

Recommended Sequence of Lessons

The lessons in this educator guide were designed to be presented in a sequence, to build upon and reinforce one other. Taken together, all the lessons can be completed within the span of one month, which begins and ends with daily observations of the Moon throughout one lunar cycle. The lessons can be presented in other ways, too, and using your expertise and creativity is encouraged! Here is the recommended sequence.

1. Start with the **Phases of the Moon** unit.
2. Begin with lesson one which explores the crescent Moon as a symbol of 'the beginning,' and leads to questions about lunar phases.
3. Create the Moon calendar in lesson two, and begin the nightly Moon observations.
   Complete all the lessons below within the month while students are making their observations.
4. Complete lessons three and four of the **Phases of the Moon** unit. They draw out the fact that 'reflected light' is the reason we observe phases of the Moon, and so they link well with the essence of the **Reflection** unit. Once you complete them, begin the **Reflection** unit.
5. After completing both parts one and two of the **Reflection** unit, move on to the **Origins** unit.
6. After you complete the **Origins** unit, begin and complete the **Cradleboard** unit.
7. At the end of the month when students have completed their last lunar observation, revisit the completed Moon calendar from lesson two of the **Phases of the Moon** unit (part 9—page 18) which suggests creating a celebration by inviting a cultural expert to join the class to review vocabulary and discuss cultural knowledge related to the Moon. This lesson also suggests working with the students to "perform" the kinesthetic movements in lessons one and two of the **Origins** unit for their guest, and/or reciting from their "Color and Light, Unity and Diversity" essays from lesson four of part one of the **Reflection** unit (part 4—page 37), and/or displaying and discussing their cradleboards.

Standards Alignment

	Phases of the Moon					Reflection, Part One- Light				Reflection, Part Two- K'é		Origins				Cradle-board
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	
National Science Education Standards																
K-4 Science Content Standards																
PHYSICAL SCIENCE **STANDARD B: LIGHT, HEAT, ELECTRICITY, AND MAGNETISM:** Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.						X		X								
EARTH AND SPACE SCIENCE **STANDARD D: CHANGES IN THE EARTH AND SKY:** Objects in the sky have patterns of movement. The Sun, for example, appears to move across the sky in the same way every day, but its path changes slowly over the seasons. The Moon moves across the sky on a daily basis much like the Sun. The observable shape of the Moon changes from day to day in a cycle that lasts about a month.		X	X													
5-8 Science Content Standards																
PHYSICAL SCIENCE **STANDARD B: TRANSFER OF ENERGY:** Light interacts with matter by transmission (including refraction), absorption, or scattering (including reflection). To see an object, light from that object— emitted by or scattered from it—must enter the eye.						X										

	Phases of the Moon					Reflection, Part One-Light				Reflection, Part Two-K'é		Origins				Cradle-board
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	
PHYSICAL SCIENCE **STANDARD B: TRANSFER OF ENERGY:** The Sun is a major source of energy for changes on the Earth's surface. The Sun loses energy by emitting light. A tiny fraction of that light reaches the Earth, transferring energy from the Sun to the Earth. The Sun's energy arrives as light with a range of wavelengths, consisting of visible light, infrared, and ultraviolet radiation.							X		X							
EARTH AND SPACE SCIENCE **STANDARD D: EARTH IN THE SOLAR SYSTEM:** The Earth is the third planet from the Sun in a system that includes the Moon, the Sun, eight other planets and their moons, and smaller objects, such as asteroids and comets. The Sun, an average star, is the central and largest body in the Solar System.												X	X			
EARTH AND SPACE SCIENCE **STANDARD D: EARTH IN THE SOLAR SYSTEM:** Most objects in the Solar System are in regular and predictable motion. Those motions explain such phenomena as the day, the year, phases of the moon, and eclipses.		X	X													
EARTH AND SPACE SCIENCE **STANDARD D: EARTH IN THE SOLAR SYSTEM:** Gravity is the force that keeps planets in orbit around the sun and governs the rest of the motion in the Solar System. Gravity alone holds us to the Earth's surface and explains the phenomena of the tides.					X											

	Phases of the Moon					Reflection, Part One-Light				Reflection, Part Two-K'é		Origins				Cradle-board
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	
9-12 Science Content Standards																
EARTH AND SPACE SCIENCE STANDARD D: THE ORIGIN AND EVOLUTION OF THE EARTH SYSTEM: The Sun, the Earth, and the rest of the Solar System formed from a nebular cloud of dust and gas 4.6 billion years ago. The early Earth was very different from the planet we live on today.												X	X			
Diné Culture-Language Standards																
Readiness, Pre-School through 4th Grade																
STANDARD 1: CULTURE - Nitsáhákees																
S1C R1: PO7: Work independently and cooperatively to accomplish goals through the utilization of the traditional Navajo concept of K'é. **(Also Foundation, S1C F1: PO9 and S3C F1: PO8)**										X	X					
S1C R2: PO2: Identify Indian family principles and values that promote positive behavior; identify bad choices and judgements; display knowledge of consequences for bad and good choices.											X					
S1C R2: PO3: Identify and discuss current inappropriate and acceptable attitudes and behaviors within a family, classroom, dormitory, and community relationship.											X					
STANDARD 2: CULTURE - Nahat'á																
S2C R1: PO3: Indentify and analyze personal attitude, behavior, perception, and expectation of self and others.											X					

	Phases of the Moon					Reflection, Part One-Light				Reflection, Part Two-K'é		Origins				Cradle-board
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	
S2C R2: PO3: Explore, examine, and discuss the Protection Way Teachings by parents and clan relatives in the past.											X					
STANDARD 3: CULTURE - Iiná																
S3C R2: PO5: Compare and contrast different stories (hane') through significant occurrences with people, places, or situations; identify how the information contributes to the understanding of the past.															X	
S3C R3: PO2: Recognize and understand the traditional promotion for early to rise, perform physical exercize, form healthy eating habits, and begin a new day with meditation (focusing).	X															
S3C R4: PO2: Compare and contrast the traditional Navajo teaching on physical development in association with developing positive healthy attitude and behavior while eliminating laziness, jealousy, being deceitful and disrespectful for self and others.	X										X					
STANDARD 4: CULTURE - Sihasin																
S4C R2: PO5: Understand the significance and the use of fourness in many related areas of Dinéjí hane' (e.g., membership into the four clans, four directions, colors, seasons, mountains, phases in a day, four major stages in growth: baby, child, maturing adult, elderly).			X								X					

	Phases of the Moon					Reflection, Part One-Light				Reflection, Part Two-K'é		Origins				Cradle-board
	1	2	3	4	5	1	2	3	4	1	2	1	2	3	4	
STANDARD 5 :COMMUNICATION Listening and Speaking																
S5C R3: PO2: Listen to Navajo and other Indian songs, music, folklore, short stories and be able to participate in discussion for meaning and interpretations.	X									X	X			X		X
STANDARD 6: COMMUNICATION Writing and Reading																
S6C R1: PO2: Explore the significance of the traditional beliefs in child rearing practices (e.g., cradleboard and lullabies; the use of natural Earth salt at the baby's first laugh celebration; the baby's first anointing of corn pollen; receiving a Navajo name; losing the baby teeth).																X
Foundation, 5th through 8th Grades																
STANDARD 4: CULTURE - Sihasin																
S4C F1: PO2: Interact with elders and traditional practitioners in effort to compare the traditional hane' to scientific views and stories (hane') from other beliefs on the origins of life; principles and values; emergence and the settlement of the Indian people on the North American continent.												X	X	X	X	

Phases of the Moon

Lesson One: What Is the Crescent Moon?

Learning Objective: Students will understand the importance of the crescent Moon as "a beginning."

Description: In this unit-opener activity, students will discuss an image of the crescent Moon, hear a short story featuring the crescent Moon, and engage in a "Gallery Walk" to process its meaning.

Materials Needed: Crescent Moon Poster and Taking Deep Breaths short story, both provided in Supplemental Material below; four pieces of large flip-chart paper; markers.

How To

1) Begin by displaying the image of the crescent Moon. Ask students what they see in this picture. Make sure they recognize the Moon and perceive that it is a crescent Moon. Ask them what a crescent Moon is, and probe for their understanding of what it means. Look for answers that lean toward it being a "phase" of the Moon, and the beginning of the Moon's monthly cycle. Ask students what they know about phases of the Moon.

2) Read aloud (or have a student do so) the story Taking Deep Breaths, and/or pass out copies to the students.

3) Put one sheet of chart paper on each wall of the room, and write one of the following questions on each sheet:

- What is a crescent Moon?
- Why is the Moon in this story?
- What teachings did the grandfather convey?
- What do the teachings have to do with the Moon?

4) Divide students into 4 groups, and give each one a different color marker. Each group will begin at one of the chart papers and collectively write a short response to the question on that paper. Allow ~5 minutes to pass, then move each group to the next question. The groups should spend time at each sheet, contemplating each question and writing a response.

5) When the groups are at their final question and have finished writing their responses, ask someone from each group to read/summarize the responses on the paper. Return the students to their desks and facilitate a group discussion, probing as to why each team gave the responses they did. Focusing on this question, reinforce the teachings conveyed by the grandfather and the symbolism of the crescent Moon in the story:

- Why is the crescent Moon in this story?
    - The crescent Moon in this story represents the beginning—the beginning of the day, but also the beginning of one's path in life. The beginning of the day is a time to run and shout so one can begin the day well, but also develop and maintain strength throughout one's life to avoid mental, physical, social, and emotional illness.

6) End this activity by exploring the concept of phases of the Moon with students. Ask about and discuss what they know about phases. Explain to students they are going to record observations of the Moon every night for a month (or two) to explore what the phases of the Moon are.

Supplemental Material

Taking Deep Breaths

Johnson Dennison, Navajo Traditional Practitioner

"Take a deep breath four times" the grandfather says. A Navajo boy named Johnny was standing beside his grandfather facing east outside his Hogan at early morning dawn. Johnny noticed a bright crescent Moon in the eastern sky above the horizon. Johnny asked his grandfather about the significance of the crescent Moon in the Navajo culture. The grandfather began to tell a story.

My grandson, the crescent Moon in the sky represents a path of life. As you are born into this world you begin your journey to walk your own path of life. A child begins to start walking a year after birth. Learning to walk is a difficult task at that age but after a child learns to walk it is fun and soon, the child begins to start to run. Walking in your path of life is a very difficult task but it is also a very beautiful path to walk for the rest of your life. First of all you must be strong enough to withstand the pressure as you walk through life. You will meet many challenges in your life. In Navajo, we say you must have a strong endurance, ha'jólní. To become a strong person you must discipline yourself to wake up early in the morning at dawn and offer your prayer for positive life, hozhǫǫgo naashá'.

The elders' teaching is to run in the morning to the east after your prayer. While you're running, yell at the top of your voice so your voice will be heard by the total Universe, and so your wind will become stronger. In this way, you will be able to withstand hardships and all adversities in your life path. There are many fearful and destructive ones such as diseases and illnesses. You must be strong enough physically, emotionally, mentally, and spiritually, to overcome these adversities, ha'jólní.

Long ago, a child was trained by his parents. He was taught not to be "lazy" and sleep too long in the morning. A monster, laziness, can overcome our health. The laziness turns into illness: mentally, physically, socially, and emotionally. It will create conflicts and destroys family relationships. In Navajo it is called "hwoł yaa ninahwiildóóh." Abíínídąą' nijigháago éí iiná ya'át'ééhii hoosaa dooleeł. We were taught to run in the morning to be healthy and to walk in beauty. Before you run, take a breath four times.

"T'ááhwí Ajít'éego"

(It is really up to you)

Lesson Two: What Are Phases of the Moon?

Learning Objective: Students will understand that the Moon changes throughout the lunar cycle (phases), and that one lunar cycle relates to the monthly calendar.

Description: In this activity, students will create a Moon Journal in which they will record standard observations of the Moon each night for an entire lunar cycle (or two). It is encouraged to begin this activity on the New Moon.

Materials Needed: Navajo Moon Phases Diagram, Navajo Moon Phases Vocabulary Sheet, both provided in Supplemental Material, below; standard 8.5" X 11" paper (substitute with construction or other paper if you wish). Each student will need a notebook in which to record their observations. If you prefer, a Moon Observation Worksheet (black line master) is provided in Supplemental Material for students to use to record their observations; copies of this can be made.

How To

1) Organize the students into four groups, and give each group a copy of the Navajo Moon Phases diagram and several sheets of paper. Assign each group the task of drawing the Moon's appearance during each of the four major phases of the Moon's cycle, with each day on a separate sheet of paper: (1) from new through first quarter (waxing moon—6 drawings), (2) from first quarter through full (waxing moon—6 drawings), (3) from full to last quarter (waning moon—6 drawings), and (4) from last quarter through new (waning moon—6 drawings).

2) Create a Moon Calendar by arranging students' artwork in a large circle or oval on a large wall, resembling the outer circle of the Navajo Moon Phases diagram. Label the four quadrants of the calendar with the terms "waxing," "full," "waning," and "new."

3) Pass out or have students take out their Moon Journals, or pass out one recording sheet to each student. Explain that students will use this journal to record nightly observations of the Moon for one complete lunar cycle beginning with the New Moon. For the ~2 weeks between New Moon and Full Moon, the Moon appears in the evening sky. As a group, choose a time when all students will be making their observations (~7pm). It is important to note that for the ~2 weeks between Full Moon and New Moon, the Moon will not appear in the evening sky, but rather the morning/afternoon sky. Make sure the students change their observing time after the Full Moon, and/or take time during class to go outside so the students can make their observations. If they are still looking for the Moon in the evening, they will return "no data!"

4) If you are not using the provided Moon Observation Worksheet, have students open to the first page of their Moon Journals, and set up the standard form for each night of observing which they will repeat each evening in their journal. Have them prepare their first page with the following data fields, emulating the Moon Observation Worksheet.

- In the upper right corner, make a place for name and date.
- Leave most of the page blank for the drawings of their observations (if it is completely cloudy, note the date and time, students can write "cloudy, no data.").
- Near the bottom, make fields for the following:
  - Time
  - Direction of observation (north, northwest, south, etc.)
  - Miscellaneous observations: size, shape, color, location compared to the horizon, brightness, or location compared to the previous night
  - Prediction of what tomorrow's observation will be like
  - Navajo phrase and English translation

5) Explain that students will 1) sketch the phase they see the first evening, and 2) prepare to share a prediction about what they may see the following evening. If you are beginning the exercise on the New Moon, the students will reveal that they did not see anything on their first night of observing!

6) The next day in class, discuss what the students observed (the absence of an observation, the New Moon), and what they predict seeing that evening.

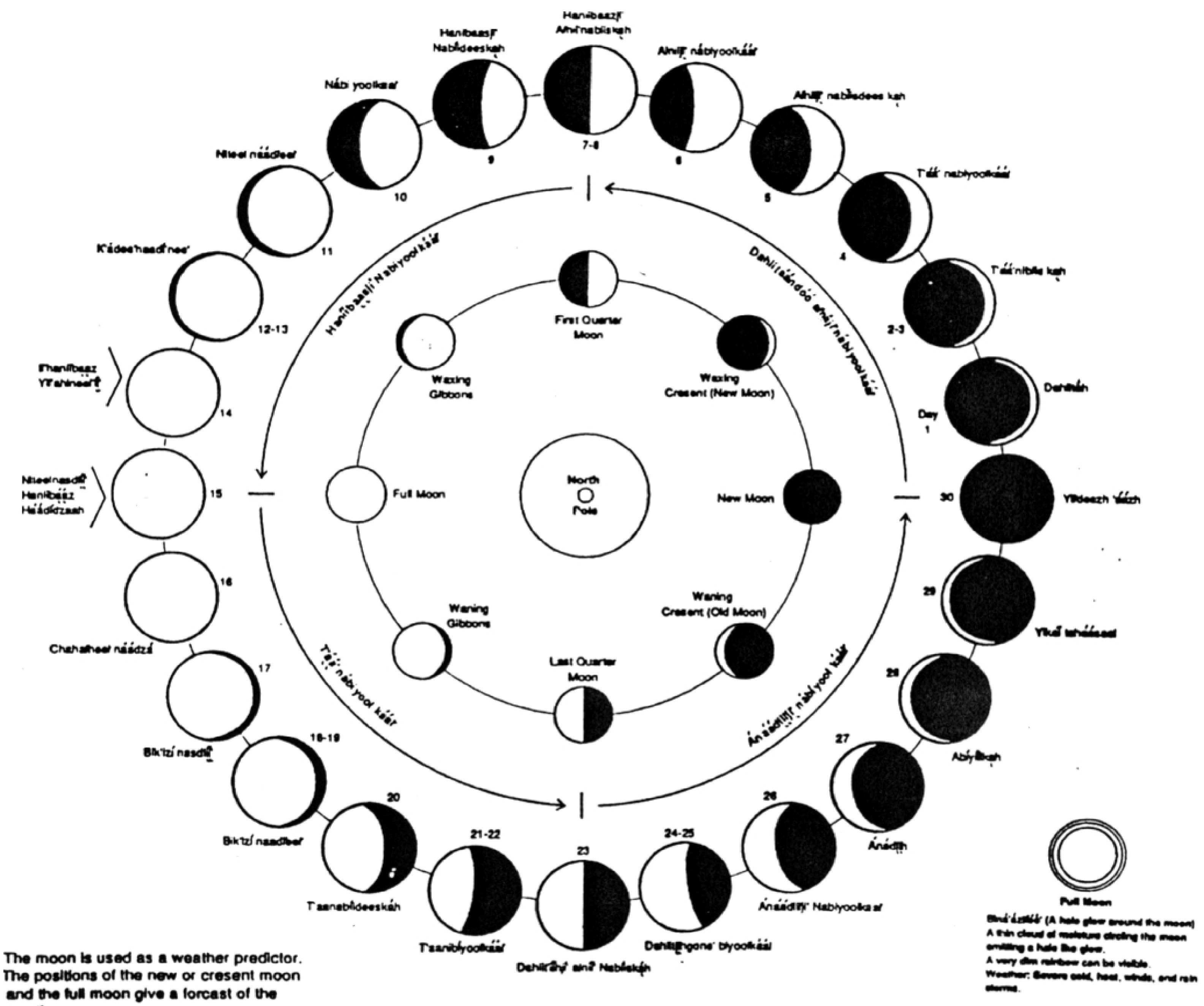
7) Each student will record their observation each evening. Facilitate sharing their data (sketches, time, date, direction, etc.) every few days at a designated time during class. One solid week of observations should result in firm predictions of a "growing" or waxing Moon. Ask the students, why are they seeing the Moon change shape in the sky every night? After the Full Moon, the discussion and predictions should center around the "diminishing" or waning Moon.

8) Another idea to maintain motivation throughout the month of observations is to conduct the Birthday Moon activity. Using this website: http://tycho.usno.navy.mil/vphase.html, students will look up the phase of the Moon on the date of their birth. The website will generate an image of the Moon. Students can draw or print out the image displayed by the website, match it with the corresponding image on the calendar on the wall, and correctly identify the phase of the Moon on the day they were born. If you wish, have each student write their name on a card or Post-it note, and tape it near or on the corresponding phase of the Moon on the calendar on the wall.

9) As a concluding celebration to the completion of one month of observations, invite a cultural expert to join the class, or make a field trip to visit a cultural expert and discuss how traditional practitioners watch the appearance of the Moon to predict things like the weather and the gender of a child to be born. The students can practice and deliver a special "performance" of the kinesthetic enactments of Solar System and Moon formation from the ORIGINS unit (pages 50 and 53). They can also read from their "Color and Light, Unity and Diversity" essays from the REFLECTION unit (page 37), and/or display and discuss their cradleboards (page 61).

Supplemental Material

Navajo Moon Phases Diagram



The moon is used as a weather predictor.
The positions of the new or cresent moon and the full moon give a forcast of the weather.

Navajo Moon Phases Vocabulary Sheet

Tł'éhonaa'éí Altah Ánt'ooníílgo Ałhééhédááh

DAY	DINÉK'EHJI	ENGLISH TRANSLATION
óá	Dahiitą	New Moon / Crescent
óą/óą	T'ąąnábíiską	The Crescent enlarging
óé	T'ąą'nábíyoolkáał	Moving to First Quarter Moon
óę	Ałníi'jį'nábíídeeską'	Approaching First Quarter Moon
óę	Ałníi'jį'nábiyoolkáál	Almost First Quarter Moon
ói /ói	Hanííbąązjį' Alníí'nábíiską	First Quarter Moon
ói	Hanibąąsji' Nábíídéeską	Begin movement to Full Moon
áó	Nábíyoolkáał	Approaching Full Moon
áá	Niteelnáádleeł	It is expanding to Full Moon
áą/áą	K'adę́ęháái'nééh	It is almost completely Full Moon
áé	Jíhanííbąąz	Daytime Full Moon
	Yił'áhinéél'íí	They looked at one another
áę	Hanííbąąz	Full Moon
	Niteelnásdlíí'	It has expanded to its fullest
	Háádizaa	It is complete
áę	Chahałeełnáádzá	It went back into darkness
ái	Bik'izínasdlíí'	Beginning into Last Quarter Moon
ái/ái	Bik'izínáádleeł	Going to Last Quarter Moon
ąó	T'áá'nábíídéeską	Approaching Last Quarter Moon
ąá/ąą	T'áá'nibiyoolkáał	Returning to Last Quarter Moon
ąą	Dahiitįįjį' Ałníí'nábíiską	Last Quarter Moon
ąé/ąę	Dahiitįįhgóne'biyoołkáał	Beginning of New Moon
ąę	Ánáádįįłjíí'nábíyookáał	It is disappearing
ąí	Ánádįįh	Can barely see a portion
ąį	Abíyíílką	It is gone with a new day
ąí	Yikáítaháásaal	New Crescent seen at dawn
ąó	Yiłdeezh'áázh	They are traveling together

Researched and written by: Peggy F. Scott and Mike Mitchell. Illustrated by: Pal Begaye, Produced by: Chinlé Curriculum Center

Moon Observation Sheet

Name:
Date:

Time of observation:

Direction of observation (north, west, southeast, etc.):

Miscellaneous observations (size, shape, color, location compared to the horizon, brightness, and/or location compared to the previous night):

Prediction of tomorrow's observation:

Navajo phrase, English translation:

Lesson Three: Why Do We See Phases of the Moon?

Learning Objective: Students will understand that we observe phases of the Moon because light from the Sun illuminates different portions of the lunar surface as the Moon orbits the Earth and the Earth orbits the Sun.

Description: In this "Kinesthetic Moon" activity, students will work in pairs, one will be the Earth and the other will be the Moon. They will enact prescribed movements around a light source (the Sun) to kinesthetically demonstrate the concepts of rotation, revolution, and gravity. It may be helpful to conduct this activity after the students have been observing the Moon nightly for awhile.

How To

1) Opening Discussion:
Write on the board and ask the question, What is observable about the Moon just by looking at it in the sky? Make a list on the board of students' responses. Discuss what they have been observing, making sure these general observations are covered:

- It appears to rise and set
- Sometimes it appears full
- Sometimes it's absent (new Moon)
- It changes shape (phases)
- It can be seen at night but also during the day
- It can be seen in all different parts of the sky
- The markings on the surface appear to be the same all the time
- We only see one "face" of the Moon all the time

2) Create a lighting situation in the classroom so that light is coming from one side of the room only, vs. from the ceiling or from two sides of the room. Letting in light through windows on one side of the room is best, or line up several lamps on one side of the room. This configuration will simulate the Sun. Or, go outside and work with the Sun itself—if you do, be sure to go out in the early morning or late afternoon when the Sun is close to the horizon vs. directly overhead.

3) Divide students into pairs and orient each pair against the light source. Have the students face one another. One is the Moon, one is the Earth. Start with the Earth facing the Moon, with the Moon's back toward the Sun, and the Earth facing the Sun. Have the Earth-student be the primary observer of what is happening to the light falling on the Moon-student's face.

4) In the initial position where the Earth is facing the Sun and the Moon is facing the Earth, point out that all the light is falling into the Earth's eyes, and none of the light is falling onto the Moon's face—it is completely in shadow. Ask what phase of the Moon is being seen by the Earth? The Earth observer sees a **new Moon**.

5) Have both students make 1⁄4 turn to the Earth's left (Earth stands in place and turns to the left [rotates about his/her own axis]; Moon actually walks to Earth's left [revolves around the Earth]). Point out that the left side of the Moon's face is now illuminated, and the right side of the Moon's face is still in shadow—this simulates how the **waxing half Moon** appears to an observer on the Earth.

6) Have both students now make another 1⁄4 turn to the Earth's left. As the turn happens, the Earth should observe that the shadow covering the right side of the Moon's face "disappears," and when the turn is complete, the entire face of the Moon is illuminated. This means that all of the sunlight is falling onto the side of the Moon that is facing the Earth—this simulates how the **full Moon** appears to an observer on the Earth.

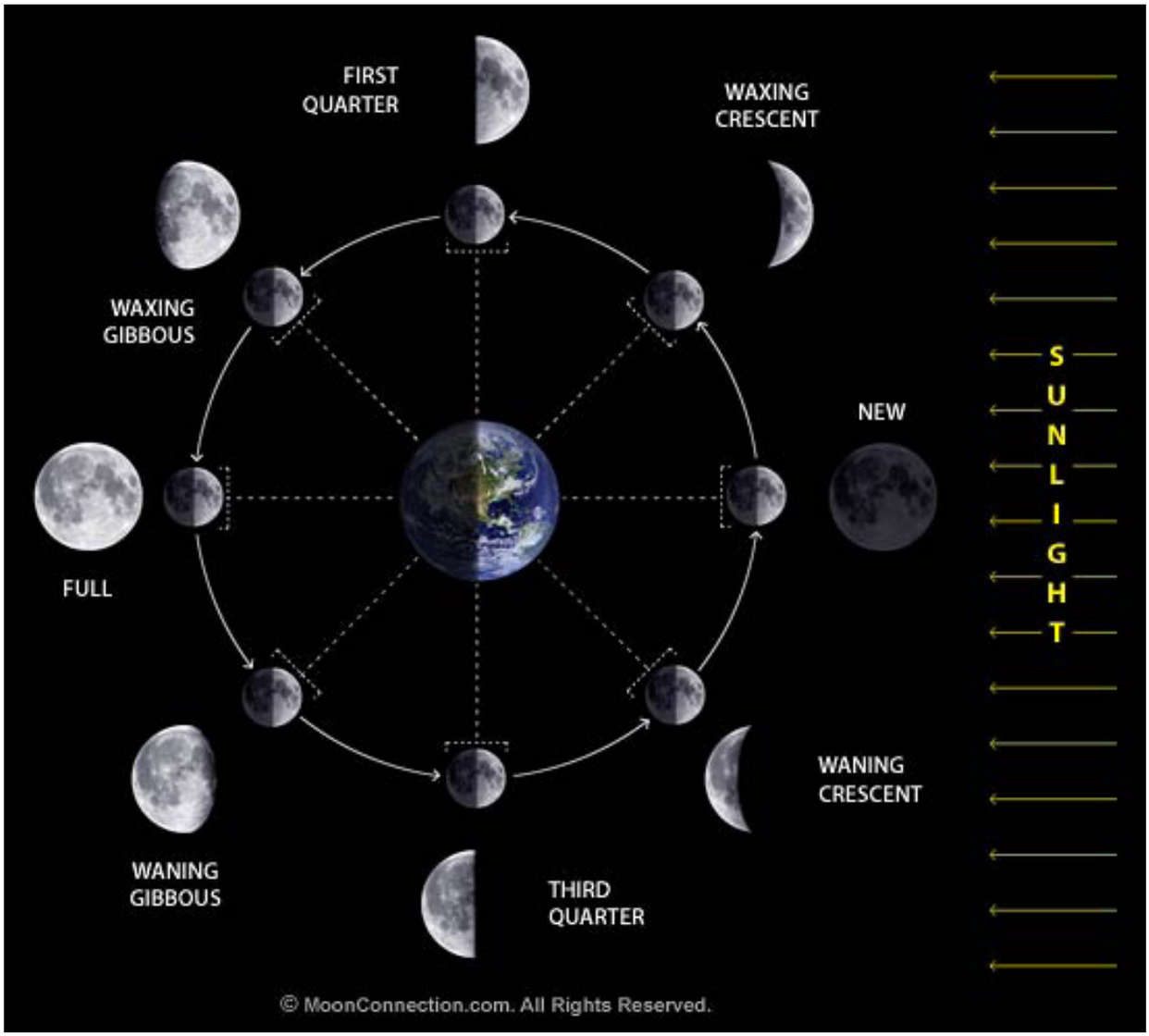
7) Have both students now make one final 1⁄4 turn to the Earth's left. Point out that the right of the Moon's face is now illuminated, and the left side of the Moon's face is in shadow—this simulates how the **waning half Moon** appears to an observer on the Earth.

8) Have both students make another 1⁄4 turn to the Earth's left, reentering the position from which they began, and once again observe the **new Moon**. Point out that this entire process takes ~one month, and is referred to as the lunar cycle. Switch the students so the Earth is now the Moon and the Moon is now the Earth, and repeat the exercise as often as you like to reinforce the observations.

Connection to REFLECTION activity: this is a natural point at which to bring up a crucial question which connects the outcome of this activity to the essence of the REFLECTION unit. In the preceding activity, students embodied the process through which phases are "created," which is that light from the Sun falls onto the surface of the Moon in different ways throughout the lunar cycle. But it remains to be demonstrated, how and why do WE SEE the phases of the Moon? The answer is because light from the Sun REFLECTS off the Moon's surface into our eyes on Earth (vs. the Moon generating its own light). The REFLECTION unit explores this concept. You may want to segue at this point to the REFLECTION unit, and resume with the other two exercises below afterward.

Background Material

The revolution of the Moon around the Earth makes the Moon appear as if it is changing shape in the sky. Therefore, different parts of the Moon's surface are illuminated at different times. These are called "phases" of the Moon. The Moon doesn't generate any light itself; it reflects the light of the Sun. The Moon appears to us in four major phases during a cycle that repeats itself every 29.5 days. The phases always follow one another in the same order.



Lesson Four: Why Do We Always See the Same Side of the Moon in the Sky?

Misconception: The Moon doesn't rotate (spin) about its own axis because we only see one side or "face" of the Moon.

Learning Objective: Students will understand that as the Moon revolves around the Earth, the Moon also rotates about its own axis. Students will understand that the reason we only see one "face" of the Moon is because the Moon's rate of rotation about its own axis is equal to its rate of revolution about the Earth, and that that rate is governed by the gravitational pull exerted by the Earth on the Moon.

Description: In this activity, students will work in pairs, one will be the Earth and the other will be the Moon. They will enact prescribed movements to kinesthetically demonstrate the concepts of rotation, revolution, and gravity.

How To

1) Start by having each student demonstrate the difference between rotating (spinning) and revolving. Place all students in a big circle and stand in the middle. Ask each student to stand in one place and spin (demonstrating rotation). Then have the students walk around you (demonstrating revolution). Then have the students rotate and revolve around you at the same time—not too much—it can be dizzying!

2) Now divide the students into pairs, one will be the Moon and one will be the Earth. Start by having the Moon walk casually (normally) around the Earth, so the Earth sees more than one side or "face" of the Moon.

3) Now have the Moon walk around Earth, with his/her face always facing the Earth (requiring the Moon student to "sidestep"). Explain that what is happening is that the Moon is actually rotating (spinning) as it revolves around the Earth, but the *rate* of spin is equal to the *rate* of revolution.

4) Ask students, Why is this the case? Is it an amazing coincidence? What is the reason behind it? Explain that this is a common phenomenon in the Solar System. Many of the planets in the Solar System have one or more moons. When we examine other planets and their moons, we see that there are many cases where the time that it takes for the moon to rotate on its axis matches the time that it takes to revolve around its planet. This phenomenon is due to the force of gravity. Gravity's pull is stronger on things that are closest to it. The Earth pulls on and stretches the Moon—the part of the Moon that is closest to the Earth gets pulled and stretched more.

5) To demonstrate this, have the Moon stand in profile with respect to the Earth with hands on hips so that one elbow is closer to the Earth than the other. The Earth reaches out and holds on to the Moon's elbow. Have the Moon student try to spin on his/her axis (aka rotate in place) but, because the Earth student's hand is on the

Moon's elbow, s/he cannot complete a spin. This is because Earth's gravitational pull (the tug of the Earth's hand on the Moon's elbow) is stopping it and slowing it down to the point where the Moon's rate of rotation (spin) is equal to its rate of revolution. Have the Earth remove his/her hand from the Moon's elbow, and allow the Moon to spin freely, then have the Earth put his/her hand back on the Moon's elbow and slow the spin again.

6) Therefore only one "face" of the Moon is shown to the Earth. (Side note: In this demonstration, the Earth isn't spinning—the arm coming out toward the Moon represents the gravitational pull, irrespective of spin). Switch the students so the Earth is now the Moon and the Moon is now the Earth, and repeat the exercise as often as you like to reinforce the observations.

Lesson Five: How Does the Moon Create Tides on the Earth?

Learning Objective: Students will understand that because of the gravitational pull of the Moon on the Earth, the water in the oceans on Earth forms tides.

Description: It may come up that students have heard that the Moon is responsible for the high and low tides on Earth. In this activity, students will work in groups of four. One student will be the Moon, and the other three will represent the Earth: one will be the middle of the Earth, and the other two will be points on the Earth's edge, representing the oceans. They will enact prescribed movements to kinesthetically demonstrate the concept of tides.

How To

1) Line up the three Earth students with the Moon in the same line, just several paces away, all three Earth students looking at the Moon. The middle Earth student has hands on hips. Explain that the middle student represents the center of Earth and other two students represent the oceans.

2) To demonstrate that the Moon has a gravitational pull on the Earth, and that that gravitational pull is strongest on the side of the Earth that's closest to the Moon, have the student closest to the Moon take 3 steps toward the Moon, have the middle Earth student take two steps toward the Moon, and the farthest Earth student take only one step toward the Moon. Explain that, just as in the prior demonstration where students learned that the Earth exhibits a gravitational pull on the Moon, and that the pull is strongest on the side of the Moon closest to the Earth, now we're observing that the Moon is doing the same thing. It is exerting its own gravitational pull on the Earth, and again, the pull is strongest on the side of the Earth that is closest to the Moon as evidenced by the first student taking three steps toward the Moon (vs. the other two students only taking two steps and one step).

3) Explain that the oceans, represented by the furthest and closest Earth students, are at high tide because the Moon's gravity pulls more strongly on the water on the closest side of the Earth than it does on the center of the Earth, which is further away. The Moon also pulls more strongly on the center of the Earth than it does

on the water on the furthest side of the Earth. As the Earth spins on its own axis throughout the day, different parts of the oceans will be closest and furthest from the Moon, therefore creating approximately two high and two low tides per day.

Reflection

REFLECTION, PART ONE – Light

Lesson One: How Do We See Objects, Like the Moon?

Learning Objective: Students will understand that we are able to see objects, like the Moon, because light from the Sun reflects off of them into our eyes.

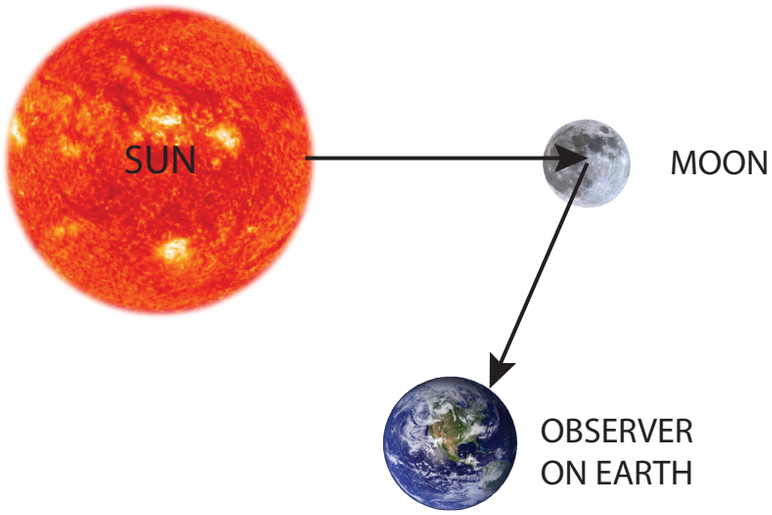
Description: In this activity, students will experience a demonstration involving a darkened room—a space in which total darkness can occur is ideal. The room is then suddenly illuminated, demonstrating that we see things because light reflects off of them.

Materials Needed: Blankets or towels to cover windows; flashlight (optional).

How To

1) Begin by asking students how they think they are able to see the Moon in the sky at night? Does the Moon, like the Sun and the other stars in the sky, generate its own light? Explain that the Moon reflects light from the Sun, just as objects on the Earth do. We see things such as trees and tables and each other because light from the Sun (or another source like a light bulb) shines on them and reflects off of them into our eyes. The Moon is no different. Conduct the following demonstration to illustrate this point:

2) Darken a room completely—hang towels or blankets over the windows if needed. You may find that using the school gym is a good solution. Ask students if they are able to see any of the objects in the room without any light shining on them. Then shine a flashlight, turn on the room lights, or remove the coverings from the window, and explain that the objects in the room are only seen because they reflect the light. Then draw a diagram on the board depicting the path of light from the Sun onto the Moon, then reflecting off the Moon and into the eyes of an observer on the Earth:



Lesson Two: What Is Light?

Learning Objective: Students will understand that visible light is part of the spectrum of energy that comes from the Sun.

Description: A discussion referring to a poster image and a demonstration with a prism will show that visible light is composed of several wavelengths, or colors, of energy of the electromagnetic spectrum. Students will hear The Navajo Story of the Rainbow and create small rainbow strips which will be used in the CRADLEBOARD activity.

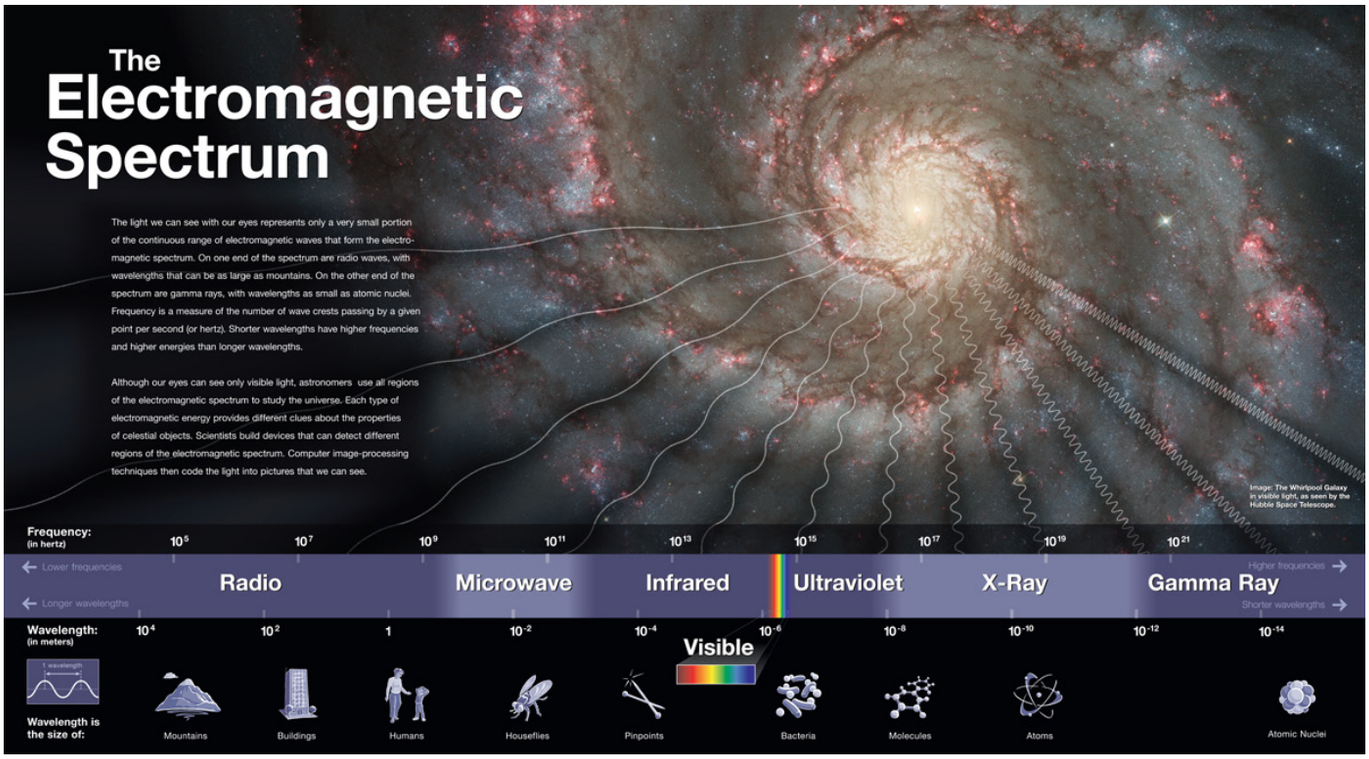
Materials Needed: Electromagnetic Spectrum Poster, provided as an external supplement to this Educator Guide; a prism (students can share); The Navajo Story of the Rainbow, provided in Supplemental Material, below; strip of paper, roughly 3” X 11”; crayons or markers.

How To

THE ELECTROMAGNETIC SPECTRUM

1) Referring to the diagram on the board (above), ask students, What is the light that comes from the Sun? Explain that light is only one of many types of energy emitted by the Sun and all other stars, too. Called the electromagnetic spectrum, this energy comes in many different wavelengths. The energy travels from the Sun to our eyes. Along the way, it bounces or reflects off of objects in its path, illuminating them.

2) Referring to the Electromagnetic Spectrum Poster, explain to students that the light we can see with our eyes represents only a very small portion of the continuous range of electromagnetic waves that form the electromagnetic spectrum. As the poster illustrates, all of the different types of energy within the spectrum travel in waves of different length. On one end of the spectrum are radio waves, with wavelengths that can be as large as mountains. On the other end of the spectrum are gamma waves, with wavelengths as small as the nucleus of an atom. Just about in the middle of the spectrum is visible light, with wavelengths about the size of a pinpoint.



An excerpt from the front of The Electromagnetic Spectrum Poster.

Please ensure students understand that the galaxy depicted in the poster is NOT the Milky Way galaxy in which our Solar System resides! We do not have the technology to travel beyond the boarders of the Milky Way to obtain such an image. Rather, the poster depicts the nearby Whirlpool galaxy.

Point out that some of these wavelengths of energy are familiar and present in their daily lives. We wear sunscreen to protect our skin from the Ultraviolet rays (UVA, UVB) emitted by the Sun. Doctors and dentists use X-rays that they generate from a machine to expose a film to image broken bones and teeth. Most households have a device that uses microwaves to heat food (a microwave oven!). We also sense infrared energy from the Sun as heat. Explain that although our eyes can see only visible light, we are subject to all the different types of energy emitted by our Sun.

Does our Sun emit all wavelengths of energy equally? No! The poster is representing the concept that all the types of energy are emitted collectively from all the types of stars in a given galaxy in the Universe, thereby illustrating the entire electromagnetic spectrum. Point out to students that the vast majority of the energy emitted by our Sun falls within the visible portion of the spectrum. No wonder we earthlings have eyes that see in the visible!

THE RAINBOW

1) Reinforcing and building on the first lesson, reiterate that humans see objects because visible light energy from the Sun reflects off of them into our eyes. Explain that while Superman may have had X-ray vision, the rest of us don't see objects illuminated by gamma rays, X-rays, ultraviolet light, infrared light, microwaves, or radio waves! Yet all those types of energy are being emitted from the Sun, too, albeit in small amounts. Again, the majority of energy emitted by the Sun is visible light. Point to the visible light area on the poster and ask what the students see (a rainbow).

2) Ask students if they've ever seen a rainbow. Ask them to describe what a rainbow is. Take the students outside into the sunlight, and with the prism, demonstrate how light can be separated into (and therefore is comprised of) all the colors of the rainbow. Explain that the visible light/energy from the Sun is passing through the prism and is being split into the colors Red, Orange, Yellow, Green, Blue, Indigo, and Violet. Explain that each color is a different wavelength of light—red being the longest (wavelength is ~650 nanometers) and violet being the shortest (wavelength is ~400 nanometers)….again, about the size of a pinpoint.

3) Back inside the classroom, pass out one ~3" X 11" strip of paper to each student, and using markers or crayons or the like, have them create a rainbow with it.

4) When they are finished making their rainbows, read aloud (or ask a student to do so, or distribute copies of) The Navajo Story of the Rainbow. It may be helpful to collaborate with a cultural expert here. Reflecting on the story, have students write what the colors and the rainbow itself symbolize on the back of their rainbow strips.

- Red represents Earth color
- Yellow represents pollen
- Blue represents the sky
- There are songs of the Rainbow in the Blessing Way Ceremony
- The Rainbow is used in the sand painting for healing
- Rainbow symbolizes protection of home and land

This rainbow strip will be used in the CRADLEBOARD activity, so you can collect them or ask the students to keep them in a safe place for later.

Supplemental Material

The Navajo Story of the Rainbow

Johnson Dennison, Navajo Traditional Practitioner

The rainbow is a significant symbol in the Navajo culture. It is a sacred image of a path between Earth and Heaven, the spirit world. The Navajo oral storyteller tells that the Hero twins were on a journey to see their father, the Sun, when they noticed a rainbow appeared in the eastern sky. The younger brother told his older brother that the rainbow was appearing for a reason. The wind spirit whispered into the older brother's ears and said, "Step up on the rainbow, it will lift you to the spirit world to visit your father, but your father is a dangerous person."

As they were told, they stepped onto the rainbow and it lifted them to a world above. They noticed it was a world identical to the Earth's surface. From there they visited their father, but he was angry with them and asked them to prove to him that they were truly his sons. He tested them through hardships such as trying to freeze them at a very cold place for the night, and trying to suffocate them in a sweat lodge with extreme heat. With the help of the spirit people, they survived. The last test was to make them smoke poison tobacco, but again a spirit helped them to overcome the poison tobacco. Today, there are two kinds of tobacco, one group of tobacco is used for healing and blessing and is used only in ceremonies. On the other hand, there are some dangerous tobaccos which cause mental and physical illnesses and they are not ritually used in ceremonies.

The final test was their knowledge of the Earth and Universe. They were asked many questions about the names and representations of the Earth's surface and the things in the Universe. One of many questions asked was the representation of rainbow and colors. Again, the wind spirit informed the twins that the red represents the Earth color, yellow represents pollen, and the blue is the color of the sky. They told their father when the Sun's rays and the water mix, the rainbow appears. It is most significant when two rainbows appear at the same time, as it represents both of the hero twins. For this reason, there are songs of the rainbow in the Blessing Way ceremony and the image of the rainbow is used in the sand painting for healing, too. The Talking God also uses the rainbow for protection of home and land. This is the reason Navajo's say the rainbow surrounds our land every day to protect us from any harm.

There was also a Spider Woman who lived in the ground where she was visited by the hero twins. The twins learned that the Spider Woman has the knowledge and skills to weave. The twins didn't learn to weave but later they asked their mother, Changing Woman, to learn to weave from the Spider Woman. She learned the art of weaving and later taught her children, the Diné, to weave.

However, the Spider Woman taught the twin boys that the colors of weaving threads are from the colors of the rainbow. The different colors of the Earth and Universe are the tapestry of creation. That is why Diné women have the ability and creativity to weave in the way creation was woven together by the Sun's rays, and is visible through the rainbow. In this way, the rainbow is the symbol of beauty and creativity. The Navajo women have been the best weavers for a long time, and the younger generation is still carrying on the art of weaving. It is a wonderful skill the Spider Woman taught the Changing Woman, who then taught the Navajo to become good weavers.

Lesson Three: What Determines the Color of an Object?

Learning Objective: Students will understand that the color of an object is determined by which colors (wavelengths) of light are absorbed by the object, and which reflect off it.

Description: A discussion and demonstration using a tennis ball or students' colored shirts.

Materials Needed: Tennis ball, optional.

How To

1) Recall that because of the first demonstration, the students now know how it is that we see objects (because light from the Sun reflects off of them), and because of the second demonstration, they now know that visible light is made up of colors, or energy of varying wavelength.

2) Ask the students, if all the colors of light are coming from the Sun, why are some objects green, and some blue, and some red? Explain that this is determined by the properties of the object that the light is falling upon. Bring out a tennis ball, or have a student who is wearing a solid color shirt stand up in front of the class. Ask why the students think the tennis ball is yellow or the student's shirt is of a certain color. Lead the line of questioning toward remembering prior discussions of reflection. Explain that all the colors of visible light are hitting the ball or shirt, but some wavelengths/colors are absorbed by the material the object is made of, and some wavelengths/colors are reflected off the object into our eyes.

Ask students which wavelength/color they think is reflecting off the ball or shirt into their eyes (the tennis ball reflects yellow for example). Ask students which wavelengths/colors were absorbed by the ball or shirt (all the others!). If there is a student wearing a red shirt, the answer would be that the red wavelength is being reflected, and all the other wavelengths of light are absorbed by the material the shirt is made of. What if the student's shirt is white? The answer is that ALL the wavelengths are being reflected and none are absorbed. If the shirt is black, then NONE of the wavelengths are being reflected, and they're all being absorbed. The discussion can be widened to discuss why snow is white or rock formations in the Southwest are red-orange.

Lesson Four: What Does Invisible Light Reveal?

Learning Objective: Students will understand that the light/energy from the Sun that reflects off the Moon can be collected by scientific instruments and analyzed to determine the rock types that comprise the Moon.

Description: In this activity, students will examine images of the Moon and discuss how the light/energy from the Sun, as it reflects off the Moon and into scientific instruments, reveals the mineral/rock composition of the Moon.

Materials Needed: Our Moon in a New Light poster, provided as an external supplement to this Educator Guide.

How To

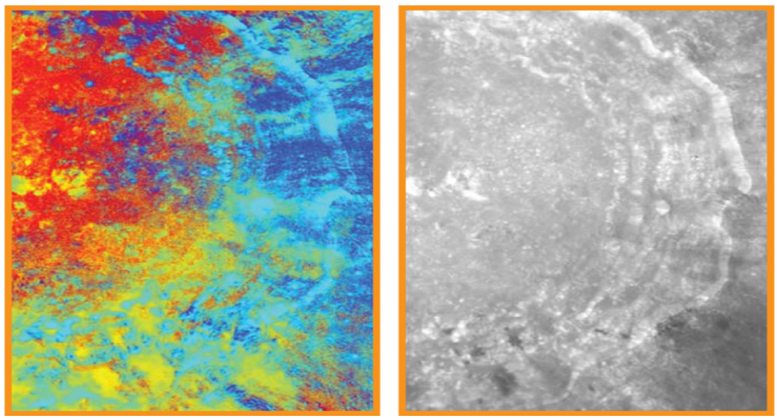
1) Referring back to the Electromagnetic Spectrum poster, reiterate that our eyes are good instruments for detecting the light/energy in the visible part of the spectrum. Ask students, Is it possible for us to "see" in other parts of the spectrum? Can we "see" in the infrared, for example? Can we "see," like Superman, in the X-ray? Explain that indeed there is a way—we use specialized instruments to detect the other forms of light/energy in the spectrum. For example, scientists use instruments called reflectance spectrometers to "see" the light/energy emitted in other parts of the spectrum. These spectrometers can be used to study the composition of objects like the Moon.

2) Explain that while our eyes observe a world of objects illuminated in countless combinations of colors, details of what those objects are made of are not revealed by visible light alone. But viewing the objects with light/energy of other parts of the spectrum, those details can be revealed.

Focusing on the Moon to explore this concept, ask students what colors they see when they look up at the Moon just with their eyes (point to the 'black and white' image of the Moon in the upper right hand corner of the Our Moon in a New Light poster). The answer is that most of what we see is white, therefore most of the rock that makes up the Moon's surface reflects all the colors of visible light. Some of what we see is dark or black, therefore reflecting none of them.

3) Now ask students what they think will be revealed if they pointed a reflectance spectrometer at the Moon (point to the large image of the Moon on the left center of the poster). More information about the Moon is revealed! Explain that the colors in the image REPRESENT different rock and mineral types that are revealed by the spectrometer's measurements. The red, orange, and yellow areas have more of iron-containing minerals, while the blue areas have more aluminum-containing minerals. By "seeing" the Moon in different wavelengths of light/energy, its geological complexity is revealed!

4) Conclude by explaining that while all we see of the Moon with our eyes are black and white rocks, there is actually a very rich diversity of rock types present.



Copernicus Crater as imaged by spectrometers onboard the Clementine spacecraft. The image on the left represents different rock types and shows the geologic complexity of the crater. The image on the right is approximately what is seen with the human eye. Image Credit: Brown University.

Homework (or In-Class) Assignment: Color and Light, Unity and Diversity

The students have learned several concepts in the last few lessons. Make the following list of things they have learned on the board:

- Color is a property of light.
- On Earth, we experience one light source (the Sun), which has many components (colors of visible light, ultraviolet light, infrared energy, etc.).
- Much can be revealed by "seeing" with invisible light/energy.

Have students "reflect" on these lessons and write a short essay about people "of color." With their new understanding that all the colors we see come from one light source, the Sun, have the students write about the idea that despite our different "colors," people are more unified than diverse. What can we learn about one another if we "see" each other in the invisible? Students can write their essay in their Moon Journals or on a separate sheet.

REFLECTION, PART TWO – K'é

Lesson One: Linking Light and Reflection to K'é

Description: This activity synthesizes the material covered above and links it to the upcoming material below. Building on the previous lessons of light, reflectance, and the Moon, this activity will invoke the principles of K'é that have to do with self awareness, and the awareness of others. Students will be introduced to the concept of K'é. They will hear a short poem about "reflections" and create a drawing to accompany it.

How To

1) To review the principles of reflection as demonstrated in the activities above, ask students what they have learned about light and reflection, creating a list on one side of the board that includes these concepts:

- We see objects because light reflects off of them into our eyes.
- Visible light is a type of energy emitted by the Sun.
- Visible light is made up of the colors of the Rainbow.
- There are other types of energy emitted by the Sun, but our eyes aren't sensitive to them.
- Scientific instruments that are sensitive to other types of energy can be used to reveal much more about an object than visible light alone reveals.

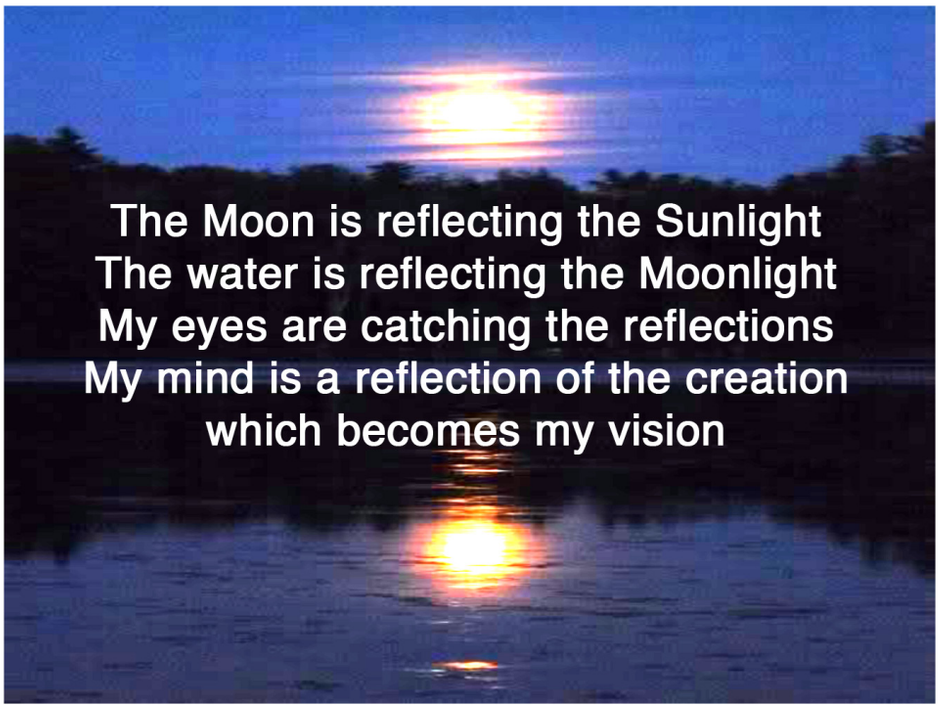
Ask if students have heard of K'é and what they know about it. Introduce the concept of K'é by reading aloud this excerpt from K'é—Positive Relationships (full text provided in Supplemental Material, below):

"The universal law of the Navajo cosmology is reflection. The things we see with our eyes are the reflections of everything that exists. If there is no reflection, we will not be able to see anything and it will be dark. The Sun's light is a source of reflection and shows us the world to guide us everyday. In our culture, there is another reflection which is very important and it is the reflection of our own personality. How we relate ourselves to people is how their attitude reflects back to us. If we treat people in a positive manner, they will treat us well in return. If we treat people in a negative manner, they will not want to be near us or treat us negatively. Therefore, the positive relationship becomes important in our culture so we will be able to have harmony and balance in our society. To practice positive relationship, we practice the concept of K'é."

2) Work the teachings in this excerpt into an interactive discussion. For example, ask students, What is a reflection? How do you think people will treat you if you treat them positively? If you treat them negatively? Create a list of their responses on the board next to the list above, including these concepts:

- One's personality reflects off others around us and the environment.
- How we relate ourselves to people is how the people's attitude reflects back to us.
- If we treat people positively, they will treat us well in return.
- If we treat people negatively, they will treat us poorly in return.

3) Share the short poem below with students by writing it on the board. Have them copy it down in their Moon Journals or on a separate sheet. As an in-class activity or homework assignment, have students create a drawing to accompany the poem.



Johnson Dennison, Navajo Traditional Practitioner

Lesson Two: What Is K'é?

Learning Objective: Students will understand that K'é is a system of relationships in which their actions reflect back onto themselves through their families, their communities, and their environment.

Description: Students will study and "act out" the concepts of K'é. In class or while looking in the mirror at home, students will create a list of characteristics and attributes to describe themselves. Then students will walk around the room and collectively create lists of characteristics and attributes they ascribe to each other student. These two lists will be used in the CRADLEBOARD activity.

Materials Needed: K'é—Positive Relationships and Empowering Values of the Diné Individual worksheet, both provided in Supplemental Material, below; a traditional Navajo basket, optional; one sheet of plain paper for each student, cut in half lengthwise; a strip of plain paper for each student, ~3" X 8.5".

How To

1) Begin by reading aloud the first section of K'é—Positive Relationships. It is strongly encouraged to collaborate with a cultural expert to discuss the concept of K'é with the students. The text briefly references the Navajo basket, which you may wish to bring in to show the students, or have them bring in examples from home.

2) When you come to the section of K'é—Positive Relationships that contains the First, Second, Third, and Fourth Teachings of K'é, read each one aloud (or have a student do so), pausing after each one to have students act out the principles discussed in each one. For example:

First Teaching of K'é: in this section the text talks about the value of self esteem, positive self awareness, and appreciating oneself. Choose two students to come up to the front of the room, standing in the East direction, and create a situation in which to model this behavior. In this suggested scenario, one student describes something that s/he does or participates in that raises his/her self esteem, and discusses why it raises his/her self esteem (sings in a chorus, plays on the basketball team, participates in ceremonies with relatives, etc.). The other student describes something s/he has done that caused him/her to appreciate him/herself (an act of kindness, "good Samaritan" work, volunteering, etc.).

Second Teaching of K'é: in this section the text talks about the importance of greeting people appropriately and respectfully, and expressing relationship appropriately. For example, select two students who know and can recite their own clan affiliation to come up to the front of the room, stand in the South direction, and create a situation in which to model this behavior. In this suggested scenario, the students pretend they are meeting for the first time. They greet one another by saying Ya'át'ééh and shaking hands. Then each one introduces him/herself by reciting his/her clan affiliation. Facilitate a discussion about how this behavior demonstrates respect and promotes positive relationship.

Third Teaching of K'é: in this section the text talks about the value of being part of a team and cooperating with others. Choose two or more students to come up to the front of the room, standing in the West direction, and create a situation in which to model this behavior. In this suggested scenario, three students pretend they are all brothers/sisters planning a surprise birthday party for another of their siblings. They discuss what each one is doing to contribute to making the party a success. Facilitate a brief discussion about how working together in this way illustrates cooperation, and the value of being part of a team (for example, when you're part of a team, you don't have to carry the burden of responsibility for everything on your own).

Fourth Teaching of K'é: in this section the text talks about the value of reflection, self analysis in a situation so improvements can be made, forgiveness in conflict, and trust. Choose three students to come up to the front of the room, standing in the North direction, and create a situation in which to model this behavior. In this suggested scenario, one student will be the teacher, and the other two are students in his/her class. Student 1 approaches the teacher and declares angrily that someone has stolen his/her favorite book. The teacher addresses the class, asking if anyone has the missing book. Student 2 comes forward and says that yes, s/he has it—s/he found it on the floor, didn't know it belonged to anyone, and took it. Student 2 gives the book back to student 1, apologizes for taking it, and admits that s/he shouldn't have assumed it didn't belong to someone. Student 1 thanks student 2, and admits that s/he should not have left his/her things laying around, and should not have automatically assumed someone had stolen it. Facilitate a discussion about how the behavior of both students demonstrates reflection and self analysis toward the promotion of trust.

3) As you lead the students through each of these four teachings, you may also wish to create a vocabulary diagram on the board that features the concepts discussed within each one, and the Navajo words for each

one. Such a diagram could take the shape of a circle, much like the Moon Calendar, with the First Teachings of K'é represented in the East, the Second Teachings of K'é represented in the South, the Third Teachings of K'é represented in the West, and the Fourth Teachings of K'é represented in the North. Include as much information in each direction as you wish, perhaps even mapping the information onto the Moon Calendar. For example:

East: Practice K'é by appreciating and accepting oneself, creating positive self esteem, building self confidence, and treating body, mind, and spirit in a respectful way.

South: Practice K'é by communicating your awareness of positive relationships to others by using the Navajo greeting "Ya'át'ééh," praising others, using positive language, and listening to others.

West: Practice K'é by respecting those around you, being loyal to your family, classmates, and community, being a team player, and working in cooperation.

North: Practice K'é by reflecting on your actions, engaging in self-analysis, forgiving others, and working to build trust.

Homework (or In-Class) Assignment:
To each student give one half of a plain sheet of paper, cut in half lengthwise so it's still 11" long. While looking at their own reflection in a mirror at home, ask students to reflect on what they see. Who, what do they think they are? Ask students to make a list on that sheet of paper of the characteristics and attributes that they think best describe them, such as tall, short, kind, generous, sarcastic, funny, quiet, or anything else that comes to mind. Suggest to the students that this is an opportunity to practice the first teaching of K'é. Make sure the students focus on more than just physical attributes. If given as homework, have students bring their lists with them to class the next day.

4) Afterward, or the next day in class, give each student the other half of the paper and a piece of tape, and have each student write their name at the top, and tape the paper to their desk. Then have all the students get up and walk around the room, and write at least one characteristic or attribute that best describes how they "see" each other student, thereby generating a second list of attributes for each student. Make sure they focus both on visible (physical) and invisible (personality) attributes, and ensure students understand this is an opportunity to be kind to one another. Both lists will be used in the CRADLEBOARD activity.

*Alternatively, give a single sheet of paper with a line drawn down the middle to each student. First have the students go around to each others' desks and write attributes about each other on the right side. Then, when students are back at their own desk, have each make a list about him/herself on the left side. This entire sheet will be used in the CRADLEBOARD activity.

5) Back in their seats, ask the students to put both lists on their desk. Have them examine the two lists, and write in their Moon Journal or on a separate sheet about how the two lists compare. Facilitate optional, in-class sharing.

6) At this point, pass out a copy of the Empowering Values of the Diné Individual worksheet to each student and ask them to read it carefully. Have students circle at least three values that they feel they need to embody more often in order to increase or improve their practice of K'é. Ask students to write in their Moon Journal or on a separate sheet about which values they chose, why they chose them, how they will enact them, and how enacting them will enhance their practice of K'é. Facilitate optional in-class sharing. You may wish to use some of the terms used in the Empowering Values sheet to create vocabulary assignments or lists on the board.

7) Pass out one ~3" X 8.5" strip of paper to each student, and have them write down their favorite attributes from both lists, as well as the three Empowering Values they chose for themselves. This paper will be used in the CRADLEBOARD activity.

8) As a capstone exercise to bring together both the Light and K'é parts of the REFLECTION unit, have students revisit the essays they wrote in the Color and Light, Unity and Diversity homework assignment. Recalling the lists on the board created in the Linking Light and Reflection to K'é lesson, and the circular diagram of K'é teachings created in the What is K'é lesson, have students add to their essays, and discuss how—just as the Sun emits light which reflects off of objects and illuminates them—we project our personality onto others, and their attitudes and behaviors reflect back to us, illuminating ourselves.

Supplemental Material

K'é, Positive Relationships

Johnson Dennison, Navajo Traditional Practitioner

The Navajo basket is woven from the natural plant of the Navajo land, sumac. The basket design depicts earth, mountains, water, and sky. The red streak surrounding the inner circle symbolizes the Earth. The center where the weaving of the basket starts and spirals upward symbolizes the emergence of the Holy People as they have emerged into this world from the world underground. It is also a symbol of how a human being emerges into the world through birth. But when the deities emerged into the world from the world below, they found themselves standing on a little island, surrounded by water. They saw a red streak surrounding the water's edge which was the Earth soil. The mountains surrounding the water reflected down on the water's surface. The Navajo basket was designed accordingly.

The universal law of the Navajo cosmology is reflection. The things we see with our eyes are the reflections of everything that exists. If there is no reflection, we will not be able to see anything and it will be dark. The Sun's light is a source of reflection and shows us the world to guide us everyday. In our culture, there is another reflection which is very important and it is the reflection of our own personality. How we relate ourselves to people is how their attitude reflects back to us. If we treat people in a positive manner, they will treat us well in return. If we treat people in a negative manner, they will not want to be near us or treat us negatively. Therefore, the positive relationship becomes important in our culture so we will be able to have harmony and balance in our society. To practice positive relationship, we practice the concept of K'é.

The Navajo concept of K'é is well organized, but it can also be complicated, much as the Universe and our bodies are well organized, yet complicated as well. For example, the human body has relationship with the Universe. When we see the morning star, our heart beats to keep our body in motion with the energy.

Partnership: the Earth and sky are in partnership to create things in place so there will be life. This means that the Earth and the sky cooperate through positive relationship. The teaching of K'é will establish a partnership through positive relation, whether it's with a spouse, colleague, classmate—something we call socialization.

Stabilization: good relations create a stable relationship. To have a positive relationship among our family, we learn to work together, socialize together, and support each other which will give us a feeling of worthiness. All of the principles above are the practicing of the positive relationship, which is simply worded, K'é.

The Navajo philosophical perspective of life is based on the natural phenomenon of the Universe. It begins with a respect of the Sun that rises in the East, travels the Southerly direction, and sets in the West. The Navajo have always believed that the supreme spiritual forces that move and govern all living things on Earth come from the light energy of the Sun and stars. All living beings depend on this energy—that includes animals, plants, reptiles, and humans. The Navajo have a belief system and practices to respect the spirit of the Sun by greeting the sunrise every morning. To practice this belief system, one must rise before the Sun rises and go out of the Hogan door which faces the East in the direction of where the Sun rises daily. This is why the Navajo live and dwell in the Hogan with an entrance to the East.

The approaching sunlight creates predawn light. The Navajo believe that when the dawn light appears in the eastern sky, it is the beginning of the new day and ending of the previous one—unlike Western practices where the day ends at midnight. In Navajo culture, when a day begins at dawn, the universal mind also appears with the dawn light. It is a time to rejuvenate your mind by getting out of bed and offering your prayer during the dawn light, and run or walk to exercise your mind, body, and spirit. In this way, new ideas come into your mind and your ability to think is stronger throughout the day. This is why we use corn pollen at dawn to offer our prayers, run, and exercise to nurture our bodies so that we will be strong and develop good thoughts and good plans throughout the day.

The most fundamental principle of living a good life is positive relationships. We are related to the Earth, Sun, Universe, and all living beings. This principle reminds us to have a good positive relationship with oneself, which is having positive self esteem. In this way, we build self confidence. When we have confidence with ourselves we have good confidence in our relationships with others. According to the Navajo four cardinal directions, East represents thought, South represents

planning, West represents accomplishing, and North represents reflection. These are the ways that we practice positive relationship, K'é.

The First Teaching of K'é:

Being conscious of positive relationships comes into our mind and is represented by the East. When we're conscious of positive relationship, then we are aware of our surroundings and we interrelate with them as nature or people. There are several principles to practice being conscious of positive relationship and they are:

- Adaa'ákohwiinidzin: One must always have a good, positive self awareness as you go along to live or work with people.
- Hwił'ílį: One must always be respectful of other people you meet everyday. This includes being respectful of your surroundings at home, in the classroom, and in your community.
- Há'áhwiiníti'į: One must always be cheerful and positive with others. Always have a smile and greet people appropriately. In Navajo culture we shake hands and say "Ya'át'ééh." In western culture we say "Good Morning." One of the ways to be cheerful is learning how to greet people. One must always be generous and courteous when greeting another person or receiving a visitor in your home or at workplaces and schools.
- Háhózhǫ́: One practices being pleasant and the best practices are verbal greetings, a smile, or a hand shake.
- Ahééhjinízin: One must learn to appreciate oneself and others. When you appreciate yourself then you develop positive self esteem. To begin appreciating yourself is to accept yourself as a person. To treat your body, spirit, and mind in a positive respectful way. So that your body will be happy and your mind will be happy. In the Navajo culture, one must not abuse his or her body and mind. To appreciate others means to begin to accept others as brothers and sisters in your family or accept your classmates as the way they are. In this way you will be admired by other people. This will energize your spirit. Be appreciative of your life, relatives, friends, home, and the opportunities to make the best use of everything you have and use.

The Second Teaching of K'é:

Communicating and expressing your consciousness of positive relationship to others. The first principle from the South is to say "ya'át'ééh" which is a Navajo greeting. The literal translation is all things are in place—the creation is all in place. The second principle is that one should not hesitate or be reluctant to use positive language like "I'm glad you're here." It is always appropriate to praise someone. Through using positive language, we will always remember and value a relationship with a person who practices positive expressions. One maintains the principle through listening to and understanding others. It's important to listen to your relatives and parents when

they talk and listen to the people you meet. It doesn't matter if you agree with what they're saying but you should always respect them and listen to them.

- K'é bee yájíłti': It is always important to express your relation by using the kinship names at home; Shimá—my mother, Shizhe'é—my father, Shicheii—my grandfathers, Shádí—older sister, Shideezhí—younger sister, etc.
- Saad yá'át'éhígíí bee yájíłti' k'é jiníigo: Always use appropriate and respectful language to relate to your family, classmates, and other people.
- K'é binahjį' áká'anijílwo': Practice the role of taking care of others and help others when needed.
- Ałhiz diits'a' dóó ałk'ehojí: One must use the appropriate language for understanding and working together.

The Third Teaching of K'é:

This teaching is represented by the Westerly direction where the twilight appears in the evening and a sacred mountain. The teachings of the elders is to maintain how to have a respectful relationship in the family and with all relatives. The principles are:

- K'é bee ádaa'ákohwiinidzin: It is always a good practice being dedicated and loyal to your family, classmates, and community through positive relationship. It is like a team.
- Diné hwił nilí: It is important to respect each member of your family, classmates, and community members so when they are respected, they will respect you in return.
- Ałk'ehojíl'į: It is very important to have a cooperating relationship with your family, classmates, and coworkers to maintain positive relationship.

The Fourth Teaching of K'é:

This teaching is represented by the North direction, and it is to keep the relationship strong by self analysis so you could make changes and improvement. Your self analysis will show you how people perceive your personality. In this way, the reflection of your personality is known by your family members, classmates, or your co-workers. Generally speaking, most people will refer to a person as a nice person or a grouchy person. These are the principles:

- Diné baa jijooba': It means you have a sense of being part of a group relationship. If there is a conflict, you can forgive to strengthen the relationship.
- Nizhónígo ałhąą nitsáhákees: It is very important that you have positive thoughts about your family members, classmates, and people in general.
- Ałhizhjótą': It is always good to have a trusting relationship which builds teamwork at home or in the workplace.

K’é is a window of opportunity to show you interesting people. Not everyone is mean and grouchy! You will find some very friendly people who are willing to teach you and help you. These were the basic teachings of the Navajo people as they socialized, worked together, and lived together.

Empowering Values of the Diné Individual

Hózhǫǫjík'ehgo Nanitin
(Blessing Way Teachings)

Há áhwiinít'į
Be generous and kind.

K'ézhnidzin
Acknowledging and respecting kinship and clanship.

Hane'zhdindzin
Seek traditional knowledge and traditions.

Hwił (hol) ilí
Respecting values.

ádá hozhdílzin
Respecting the sacred nature of the self.

Hazaad baa áhojilyą
Having reverence and care of speech.

Hazhó'ó ajítsts'ąą'
Being a careful listener.

Ahééh jinízin
Being appreciative and thankful.

Hanitsékees k'ézdongo ájósin
Having a balanced perspective and mind.

Há hózhǫ
Showing positive feelings toward others.

Dloh hodichí yá'átéhígíí hazhó'ó bee yájíłti'
Expression of appropriate and proper sense of humor.

ádił jídlí
Maintaining strong reverence of the self.

Hanaanish ájíłíinii bízhneedlí
Maintaining enthusiasm and motivation for one's work.

Hanaanish baa hąąh jinízin
Protect and care for one's work.

Naayée'eek'ehgo Nanitin
(Protection Way Teachings)

Doo hwil hóyéeda
Never be lazy.

Doo ádahozhdeeláa da
Never be impatient.

Doo t'áadoole'é bich'í' ni' jílí da
Do not be hesitant.

Doo hání jizh'ąą da
Never be easily hurt.

Doo ák'e' jidlíi da
Never be overly emotional.

Doo ni' na'áhozhdiilté da
Do not be overly reluctant.

Doo adááh yájiłti' da
Never be overly argumentative.

Dadílzinii jidísin
Respect the sacred.

Doo t'áadoole'é áde' ájilnéeh da
Do not overburden the self.

ázhdíltł'is
Have self discipline and be prepared for challenges.

Na'ádízhnítaah
Asserting the potential.

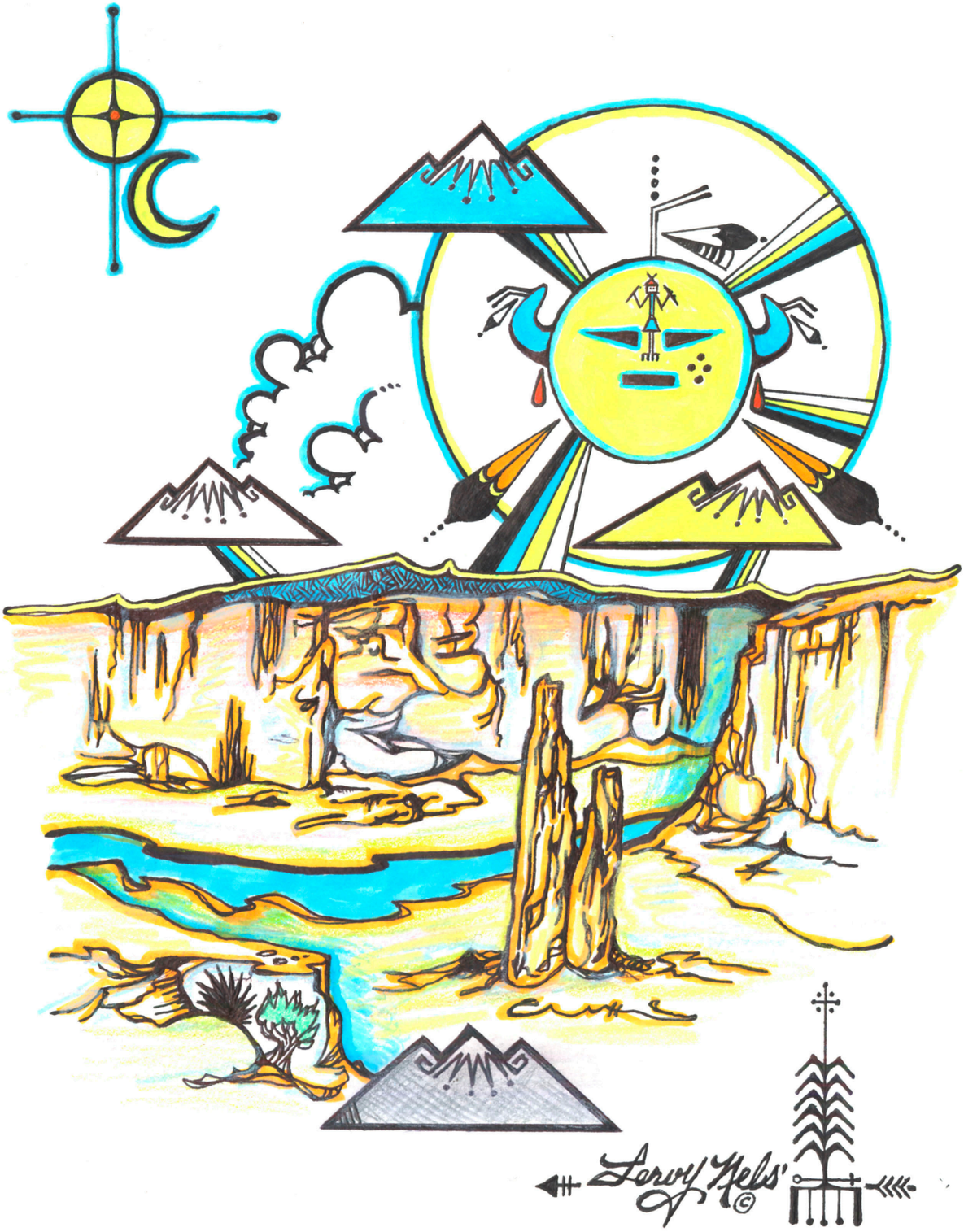
Doo yázhnízin da
Do not be shy.

Doo njichxǫ' da
Do not get mad.

Doo ách'í' ni'jódlíi da
Do not carry around expectations of negative circumstances.

Office of Diné Culture, Language, and Community Services, Navajo Nation Department of Diné Education

Origins



Lesson One: How Did Our Solar System Form?

Learning Objective: Students will understand that the Sun, planets, and other bodies in the Solar System were all formed together as a system, and that the process of star and planetary system formation is a cycle.

Description: In this activity, students will watch a video and enact a prescribed set of movements to simulate the scientific explanation of the formation of the Solar System. You may want to precede this activity with the CYCLES IN THE CARDS activity from the Sǫ' Baa Hane' booklet.

Materials Needed: Star and Planetary System Formation clip on DVD, provided.

How To

1) Begin by asking students what they know about how our Solar System formed. Ask them what they think of when they hear the word "system." Explain that the Sun, planets, and other bodies like comets and asteroids in our Solar System all formed together, at the same time, as a system, and are therefore all related. Explain that the raw material needed for the system to form was put in place by older stars as they died (supernova).

2) Play the Star and Planetary System Formation clip on the DVD. This sequence explains the basic concepts involved in Solar System formation (see Background Material section below for more information), which you can discuss during or after the video. *Be sure to emphasize the concept of supernova portrayed in the DVD—that a dying star blasts it outer layers into space, and how that material is the raw material from which new stars and planetary systems (and even life!) can form.* It may be helpful to play the DVD clip more than once.

3) You may wish to do this activity outdoors or in a large space such as a gym. Gather all the students together, standing up, and explain that they are going to act out the formation of a planetary system like our Solar System (note, this activity builds upon the MOVING WITH THE STARS activity from the Sǫ' Baa Hane' booklet).

4) Assign half of the students to be the STAR, and the other half to be the PLANETS (note, in reality, much more than 50% of the material in the disk will become the star). It works best if you can form at least two PLANETS. If you have 30 students, consider assigning 15 to be the STAR, and 5 each to PLANET 1, PLANET 2, and PLANET 3. Work with the students and have fun deciding which kind of planet each group wants to be (gaseous like Saturn or Jupiter, rocky like Mars or Earth, icy like Jupiter's moon Europa, etc.). If you decide that the planets should be of differing size, assign more or fewer students to each planet.

It may be helpful to assign students their roles and practice each role beforehand, perhaps the day before. It will also help to organize the students by color, for example, the STAR students could wear yellow shirts, the rocky planet students could wear green, the gaseous planet students could wear orange, etc.

All the students will begin as random particles zooming around. With different color shirts on, it will become clear how the material in the disk is initially mixed, but then becomes organized as the STAR and PLANETS form. Each student should be randomly wandering around the space, sometimes touching, mostly on their own, moving in all directions—but not too far away from one another—mimicking the random movement of particles in a nebula. The teacher, or another person who is not moving around randomly, then moves through the group, arms out wide, mimicking the energy-wave of a nearby supernova event.

This person moves in one direction, quickly, through the group (for example, left to right), as a shock wave. All the randomly moving students respond to this energy. In its wake, the STAR students begin to cluster, and spiral in toward each other. First, two people find each other and stick together. Then more join them in a swirling pattern. Eventually all the STAR students are together, very tightly packed into a round shape in the center of the space – mimicking a sphere; the shape of the Sun.

Meanwhile, the PLANETS students respond to the energy as well. They, rather than falling into the center and coalescing into a tight sphere like the STAR students, begin to create the circumstellar disk by swirling *clockwise* around the young star in the center. The motion of the PLANETS students is still random, even though they have begun to "orbit" the star.

The individual movements of the STAR students in this tightly packed group are fast—arms and legs and heads and torsos swaying randomly, everyone pressing together and moving throughout the sphere, but maintaining the shape of a sphere. On cue from the teacher, the STAR students raise their arms above their head and begin wiggling their fingers—mimicking the "ignition" of the star.

As the STAR students go through the process of ignition, the PLANETS students are meanwhile crashing into one another, first two students collide and stick together, then another joins, and perhaps another—all while still orbiting the star in the center. Planets can continue to begin to form before the star ignites and continue afterward. At the end, all the PLANETS students should be grouped into a few planets of different size, each planet orbiting the star in the middle, but at a different distance from the star, again, much like the planets in our Solar System do. As this process finishes, the STAR students should remain ignited.

5) Ask students to write in their Moon Journals or on a separate sheet about what they learned by acting out the scientific theory of Solar System formation. You may wish to use some of the terms used in the video and/or in the Background section below to create assignments or vocabulary lists on the board. Here is a list of terms and definitions:

Accretion: the process of growth or enlargement by gradual build-up. In star and planetary system formation, material accretes (or aggregates or accrues) together to form the star and each of the planets and other bodies in the system like asteroids or moons.

Circumstellar Disk: also called a protoplanetary disk, it is a flat, CD-shaped disk composed of gases and dust that spins around a young star much like a record spins on a record player. The material in the disk will give rise to any planets and bodies that eventually orbit the star.

Gravitational Pull: is the force one body exerts on another, attracting it. The force of the pull is directly proportional to the mass of the object; the more mass an object has, the more gravitational pull it can exert.

Nebula: from the Latin word for cloud, a nebula is a large, diffuse cloud in space composed of gases and dust. Many nebulae (plural) are regions of active star formation.

Planetesimal: a solid object within a circumstellar disk that formed through the process of accretion of gas and dust grains. After it reaches a certain mass, its gravitational pull attracts more and more material from the disk to it, increasing its size. If enough material is gained, it can become a protoplanet, and maybe even a planet.

Supernova: an extremely luminous stellar explosion in which the outer layers of an old and very large star are blasted off, expelling much of the star's material and a burst of radiation, driving a shock wave into the surrounding space.

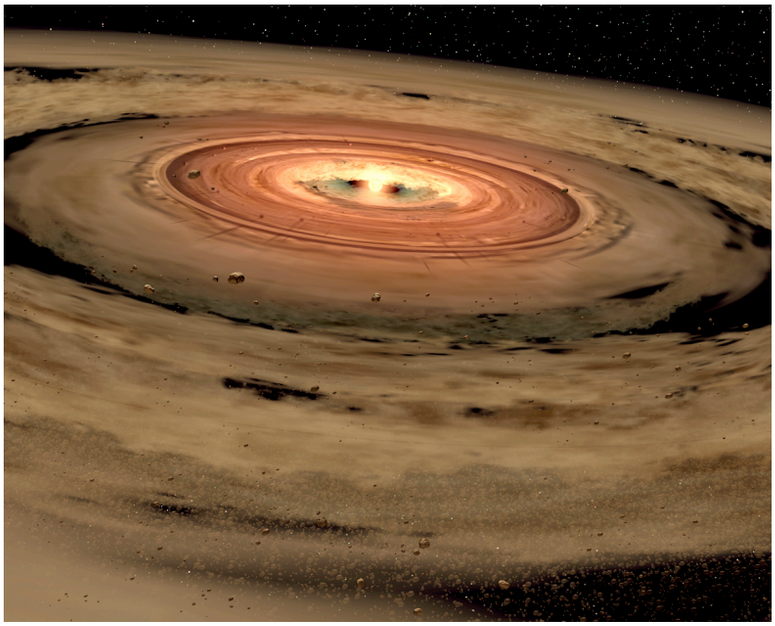
Background Material

Stars and their planetary systems form in regions of space called nebulae, where the raw material (provided by a previous generation of stars) and conditions necessary for formation (often provided by the energy/shock wave from a nearby dying star) are present. The raw materials consist of 1) **gases** such as carbon monoxide and hydrogen gas, 2) **dust**, meaning small rocky particles such as silicates like beach sand, minerals such as olivine, carbon-containing particles like charcoal dust, and 3) **ices** such as water ice.

The particulate matter and gases are extremely diffuse and have a random motion. A pressure blast, or "wind" such as the radiation produced from a nearby dying star (supernova) can cause the diffuse material to begin to coalesce and increase in density. At a certain point, when enough material has come together, it will eventually become a discreet star. The small, growing star is often surrounded by a circumstellar disk of dust and gas, spinning around it like a music CD or Frisbee, with the young star in the center (circumstellar means "around a star"). Through a process called accretion, the material will condense further into the growing star. The more mass it gains and the larger it gets, the more material will be attracted to it via its gravitational pull. In this way, it gains even more mass and gets even larger. Eventually, the density of material reaches such a high level that the nuclei of the atoms in the gas and dust are under such pressure that they fuse, and begin to form new elements. Huge amounts of energy are given off in the process which we observe as heat and light.

As the diffuse material in the circumstellar disk continues to spin around the young star, small bodies may begin to form within the disk. Most of the gases and dust grains in the disk indeed continue to "fall into" the young star, but some of it also begins to collide within the disk and, also by the process of accretion, "planetesimals" start forming. Just like the star, the larger the planetesimals get, the more gravitational pull they have, the more

matter they can attract and accrete, therefore the larger they get, and so on! Some of these planetesimals may yet be accreted by the growing star in the middle but some may go on to become discreet planets which will eventually orbit the star, just as the planets in our Solar System orbit our Sun today.



Artist's conception of the formation of a star and planetary system. Image Credit: JPL

Lesson Two: How Did the Moon Form?

Learning Objective: Students will understand that the formation of the Moon was part of the initial formation of the Solar System.

Description: This activity builds on the prior one. In this activity, students will watch a video and enact a prescribed set of movements to simulate the scientific explanation of the formation of the Moon.

Materials Needed: Moon Formation clip on DVD, provided.

How To

1) Ask students, having just experienced how the Solar System formed, how they think the Moon formed. Explain that the formation of the Moon took place inside the circumstellar disk that they just acted out. Explain that one of the planetesimals/small bodies that was forming within the disk (about the size of Mars, smaller than Earth) collided with the young Earth—a great cosmic collision!

2) Play the Moon Formation clip on the DVD. This sequence explains the basic concepts involved in the formation of the Moon (see Background Material section below for more information), which you can emphasize during or after the video. Reinforce that what they are seeing on the DVD is going on within the circumstellar disk that they just acted out. You may wish to play the DVD clip more than once.

3) This activity repeats most of the movements in Lesson One, with a few minor adjustments to bring in the Moon formation simulation. But before bringing the Moon-forming collision into the series of movements, practice the collision first! Again, you may wish to do this activity outdoors or in a large space like a gym.

Assign ~1/3 of the students to be the SUN, another 1/3 to be the PLANETS (at least two groups, one gaseous and one rocky), and divide the final 1/3 into the EARTH and the MOON (at least 4-5 students each for the Earth and Moon). If you do both this activity and the first one in the same day, you may want to ask some students to bring a different color shirt (white?) so they can play the role of the Moon in this part. Ask the EARTH and MOON students to come forward to practice their roles while you (or another student) stand in the center, representing the Sun:

Begin the practice session by having the MOON and EARTH students each individually orbiting clockwise around a single student representing the Sun. One by one, they are drawn to and collide with each other, forming two small planetesimals: the MOON students coming together and the EARTH students coming together. Once both groups are coalesced into small planetesimals, have them prepare to collide. Set them on a collision course!

As in the video, stage the collision dramatically! When the MOON group hits the EARTH group, have *all* the MOON students and *one or two* of the EARTH students break up and for a moment seem like they're going to zoom away and join the larger circumstellar disk, but then come in closer to the EARTH and begin to individually "orbit" it, creating *a mini-disk within the larger disk*. Remember that the new EARTH/MOON system should still be orbiting around the Sun in the middle!

As the disk of individual MOON students orbits the EARTH group, have them one by one be drawn together and collide, eventually forming the whole MOON, which is still orbiting the EARTH. As the MOON students are colliding and re-forming, the EARTH students that scattered after impact can rejoin the EARTH group.

When everyone is ready for the real thing, begin again. As before, all the students will begin as random particles zooming around in a nebula.

> Following the same directions as in Lesson One, guide the students through the ignition of the star and the initial planet formation within the circumstellar disk. Have the MOON, EARTH, and PLANETS students form as before, spinning around the SUN. SUN students should go ahead and reach ignition. The MOON and EARTH students should be coalesced into small planetesimals, and be ready to collide. Make sure the PLANETS students have created enough space in the disk for the MOON and EARTH to collide.

As they practiced, again stage the collision dramatically! Make sure students take their time, and act out the formation of the MOON (and reformation of the EARTH) carefully after impact. Remember that the new EARTH/MOON system should still be orbiting around the young SUN in the middle! Meanwhile, the SUN should remain ignited, and the PLANETS should finalize their formations. Sounds chaotic, right? At the end, there should be a couple of fully formed PLANETS, and the EARTH with its MOON orbiting it—all orbiting an ignited, shining SUN.

4) Back in their seats, lead a discussion with students about the relationship between how the Solar System formed and how the Moon formed, steering the discussion toward a realization that the formation of the Moon was part of the larger process of Solar System formation (disk within a disk). Building upon what they wrote at the end of Lesson One, ask students to write in their Moon Journal or on a separate sheet about what they learned by acting out the scientific theory of Moon formation.

Background Material

Still frame from the Moon Formation clip depicting the debris from the Moon-forming impact orbiting the young Earth and beginning to coalesce. Image Credit, AMNH.

We have strong evidence that within the circumstellar disk of the early Solar System, the young Earth was forming and orbiting the young Sun. Other planetesimals and small chunks of rock were doing the same thing, some of those chunks gaining size and mass. The orbit of one such planetesimal, about the size of Mars, crossed the orbit of the Earth, and the planetesimal collided with the Earth.

Most of the debris and molten rock resulting from the collision fell back onto Earth, but the rest of it began orbiting the Earth (Earth's gravitational pull held it close by). This new "disk" orbiting the Earth is part of the circumstellar disk orbiting the young Sun—indeed, this is a disk within a disk! And within this new disk orbiting the Earth, the same small collisions leading to larger and larger chunks were happening. Eventually, the large chunks all coalesced into the Moon, a process that, in total, is thought to have taken less than one month!

Lesson Three: Navajo Story of the Sun and Moon

Learning Objective: Students will understand that the origin of the Sun and Moon created an understanding of the natural cycle of birth, death, and rebirth for the People on Earth.

Description: Students will hear the Navajo traditional story "Jóhonaa'éi doo Tł'éhonaa'éí—Sun and Moon," and discuss its meaning. You may want to precede this activity with part or all of the GEMSTONE CONSTELLATIONS activity from the Sǫ' Baa Hane' booklet.

Materials Needed: Jóhonaa'éi doo Tł'éhonaa'éí—Sun and Moon story, provided in Supplemental Material, below.

How To

1) Ask students if they have heard any traditional Navajo stories about the origin of the Sun and Moon. Discuss what they have heard. Then read aloud the Jóhonaa'éi doo Tł'éhonaa'éí—Sun and Moon story, or have a student(s) do so. It would be ideal to engage a cultural expert for this activity.

2) Engage the students in a discussion about what the meaning of the story is. Ask them to recount the events in the story. Steer the discussion toward a recognition that through the process of the origin of the Sun and Moon, the People learned to understand the natural process of birth, death, and rebirth.

3) Building on what they wrote at the end of Lessons One and Two, have students write in their Moon Journals or on a separate sheet about what they learned from discussing the story.

Supplemental Material

Jóhonaa'éi doo Tł'éhonaa'éí

Sun and Moon

Told by Miller Attakai, 1956
Transcribed by Sylvia Jackson

A time system by which to understand the passage of time was discussed in the Nahat'á Hooghan by the Holy Ones. The system by which the Earth surface people would understand the passage of time: birth, aging, dying, death, and returning to Mother Earth, was determined—by the Yát'ááh Naazléi, the heavenly bodies: Sun, Moon, and Stars.

Traditional hane' tells of light that seemed to revolve around the People in a clockwise fashion. Morning, mid-day, and evening were not notable. The Holy Ones came together and talked about a need for more lighting in the Nahat'á Hooghan. They tried several means, methods, and ways, but all failed to be reliable. Sun was made from ember carried past many tribes, and a strong person was sought out to carry the light across the sky, an ideal position from which to light up the world. The Holy Ones had been meeting for a length of time and were running out of suggestions when they noticed a slim young man sitting near the entrance, attending all the meetings, and refraining from contributing. He sat quietly and observed. One curious individual finally asked the young man to identify himself and tell everyone why he was not contributing to the discussion. The Holy Ones asked him to come forth, swing the light element Jóhonaa'éi, Sun, over his shoulder, mount a palomino stallion, and ride into the horizon. He did and was able to do so with grace, ease, and flexibility. Everyone was happy with his ability to carry the daylight-giver. They agreed that he should be the caretaker of the daylight-giver. He became the Sun Bearer. The Holy Ones discovered the young man had been the caretaker of fire in the underworld and was acquainted with the power and energy of fire and light.

Next, the Holy Ones discussed light for the nighttime. The night creatures requested more light at night, just enough light to see by while the day creatures slept. An element with lesser lighting was discussed and created. A question was asked, "Who is going to be the caretaker of this element?"

Young ones were observed for their abilities, strengths, and enthusiasm. Again an individual, quiet and aloof, who did not contribute to the discussion was noted sitting near the entrance of Nahat'á Hooghan. They asked the young person to come forth. He did and was told to

swing the element with lesser lighting over his shoulder, mount a bay mare, and ride into the horizon. He did so with ease and satisfaction. Everyone agreed he should become the caretaker of the Tł'éhonaa'éí. The shy young man became known as the Moon Bearer. He had been the caretaker of cinder and ash in the underworld. The Holy Ones now had a brighter daytime and nighttime light. They were happy with the results of their work.

Jóhonaa'éi came up on the first day from the east and rose into the sky. It was remembered as one of the most beautiful days. People busied themselves with eagerness to get much done in the bright and warm daylight. The Sun rose to mid-morning, but then returned to the horizon. The People became alarmed and asked one another, "What is the meaning of this? Who will answer for this occurrence?"

Everyone came together to discuss what had just occurred and tried to understand what should be done to correct it. Another person interrupted the discussion by saying "Asdzą́ą́ Naat'ááh is missing. She is nowhere to be found. Has anyone seen her?"

Older people continued the discussion to understand why the Jóhonaa'éi failed to reach mid-day. Two young people were sent out to look for the missing person. First Boy and First Girl went to the place of emergence and found that Asdzą́ą́ Naat'ááh had returned to the underworld. She sat with her back to them, brushing her long black hair. They asked her why she had returned to the underworld and she responded that the wage for the Sun Bearer would be lives of the Earth surface people. There would be a beginning and ending for everyone and everything on the Earth surface. All will return to the Mother Earth. First Boy and First Girl returned to the group that was discussing why Sun Bearer failed to reach mid-day. They told them they had found the missing person. She had returned to the place of emergence and reentered the underworld. Elders in discussion asked, "Why has she done this?"

First Boy and First Girl explained to the council what Asdzą́ą́ Naat'ááh had told them. The People understood and agreed. The Sun rose again, and this time, the first day completed without any further interruptions.

The first evening came with the Tł'éhonaa'éí rising in the east. Again the people said it was a beautiful evening and they continued to work by the bright light it gave off. There was much to be done and every passage of time was important. Then, the light began to fade and disappear into the horizon. Again, Tł'éhonaa'éí failed to reach mid-sky. It returned to the east and the evening became dark. The People understood the wage for Moon Bearer to provide light was to take life from the living on the Earth's surface. Those that return to Earth at night would be wages for Moon Bearer. However, those that are born to Earth surface people would replace those leaving. The process of death, dying, and rejuvenating life was understood. There would be a renewing process with the process of time. The People agreed that this was fair. The Moon rose again and completed the first night providing light for the night creatures.

Lesson Four: How Do These Two Ways of Knowing Relate?

Learning Objective: Students will understand that both the scientific theory of the formation of the Solar System and the Navajo knowledge of the Sun and Moon reinforce the lifecycle of birth, death, and rebirth.

Description: In this activity, students will engage in a "Gallery Walk," visiting each of the four areas and writing answers to questions for each one.

Materials Needed: four pieces of large flip-chart paper; markers.

How To

1) Put one sheet of chart paper on each wall of the room, and write one of the following questions on each sheet:

- What is the relationship between the Sun, Earth, and Moon?
- What is the relationship between the Sun, Moon, and the Earth People?
- How does the scientific theory illustrate a lifecycle?
- How does the Navajo knowledge illustrate a lifecycle?

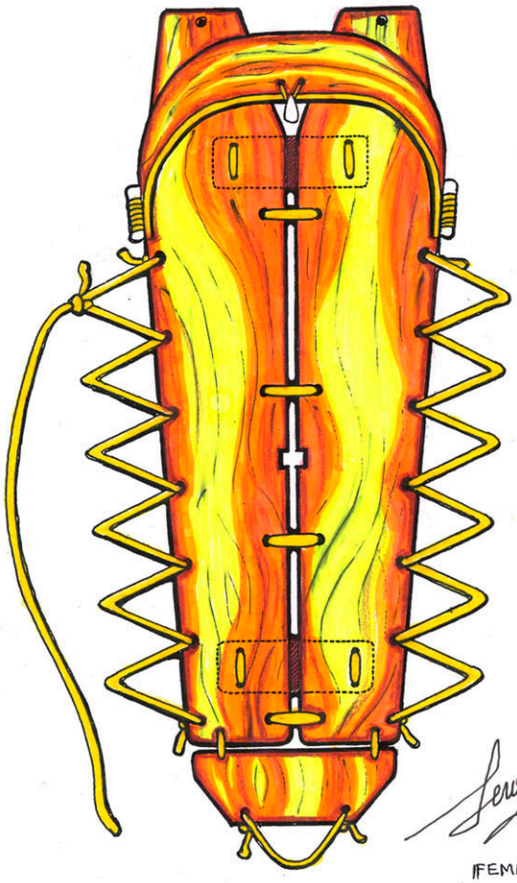
2) Divide students into 4 groups, and give each one a different color marker. Each group will begin at one of the chart papers and collectively write a short response to the question on that paper. Allow ~5-10 minutes to pass, then move each group to the next question. Each group should spend time at each sheet, contemplating each question and writing a response.

3) When the groups are at their last sheet and have finished writing their response, ask someone from each group to read/summarize the responses on the paper. Facilitate a group discussion, probing as to why each team gave the responses they did. Focusing on these two questions, reinforce how each way of knowing depicts and discusses lifecycle:

- How does the scientific theory illustrate a lifecycle?
  - If it weren't for the stars that "lived" and "died" before our Solar System formed, the raw material and the energy needed to "kick start" the process of star/planetary system formation would not have existed. When they die, large stars eject their outer layers in dramatic explosions called supernovae, dispersing the new elements they've made during their life into the surrounding space, and potentially "seeding" new stars and planets.
- How does the Navajo knowledge illustrate a lifecycle?
  - In the Navajo story, the movement of the Sun and Moon across the sky is linked to the natural cycle of birth and death and rebirth of the People on Earth. The Sun and Moon Bearers cannot complete their journeys without the death of People on Earth, but the People realize that those who are born while the Sun and Moon are making their journeys replace those who die.

4) Building on what they wrote at the end of Lessons One, Two, and Three, have students write in their Moon Journals or on a separate sheet about how both the Navajo knowledge and scientific theory illustrate a lifecycle.

Cradleboard



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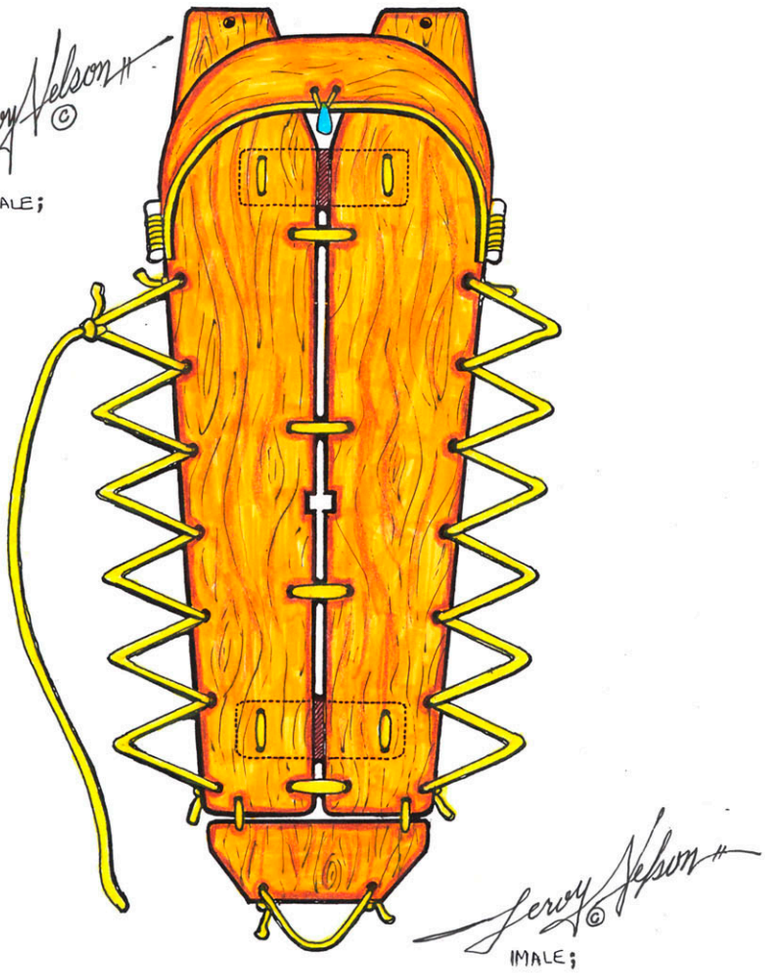


MALE;

Description: The principles and teachings in the ORIGINS and REFLECTION units, especially K'é and the concept of the lifecycle, are extremely fundamental. To symbolize this, each student will use some of the products created within these activities to create a cradleboard for him/herself according to the traditional instructions.

Materials Needed: These have already been created by each student: the two 'reflection' lists, the rainbow strip (3" X 11"), and the 'values' strip (3" X 8.5"). Also needed are tape; brown yarn cut into one-foot lengths—3 will be needed for each student; a hole puncher; string; crayons/markers; cradleboard diagram and story, both provided in Supplemental Material, below.

How To

1) Ask students what they know about the cradleboard. Read aloud the cradleboard story, and (optional) pass out copies of the cradleboard diagram. Explain to the students that they are going to synthesize many of the teachings they've learned in the previous activities into an individual cradleboard. You may wish to create small groups for the students to work in.

2) Have each student collect the two lists, rainbow, and 'values' strip on their desk. Begin by having each student hold up the two lists to his/her chest. The list each student made for him/herself should be held up against the right side of the body. Have them mark it lightly with an "R" in one corner. The list their classmates made for them should be held up against the left side of the body. Have them mark it lightly with an "L" in one corner. Then have them put both sides face up on the desk—the list marked "R" will be on the left and the list marked "L" will be on the right because as they look down at the lists, they are seeing a reflection of themselves.

*If, during the REFLECTION—K'É activity, the alternate pathway was followed to create the two lists, then have each student take out the single sheet of paper with both lists on it and place it face up onto their desks. The list that each student made for him/herself should be on the left side, and the list made by all the students should be on the right.

Explain that the right side represents Mother Earth and the left represents Father Sky. Have them tape the two lists together, placing pieces of tape all along the center seam, except for up at the top. As in the diagram, they should fold back or cut off the top inner edges of each list, creating a "V" in the cradleboard. *(Note, anywhere tape is used, holes can be made with the hole puncher and string can be used to fasten.)*

3) Students should attach their 'values' strip across the bottom of the board, taping it to the main board, so it will serve as the foot board. As in the diagram, they should fold back or cut off the lower outer edges of each side of the strip. Explain that the foot board represents universal values the children need to obtain.

4) As in the diagram, have female students color a small circle on the headboard on the right side of where the rainbow arch will go representing white shell (using yellow crayon or marker). Male students should use a

blue crayon or marker, representing turquoise, and should color their circle on the left side of the cradleboard. Explain that these gems are for the development of good hearing.

5) Again using the diagram as a guide, have students tape their rainbow strips across the top of the cradleboard to make an arch over where the infant's head would be. Using the hole punch or scissors, students should create a hole at the top of the arch. Explain that the rainbow represents light and is there to protect, but also to empower the development of good sight and intellect.

6) Using (sharing) a hole puncher or other implement, each student should create several holes on the outer edges of each list. Pass out 3 lengths of yarn. Weave one length of yarn through the holes on one side of the cradleboard, creating several loops. Repeat with the other side. Take the third length of yarn and tie it to the top loop on one side of the cradleboard: girls will tie theirs to the right side and boys will tie theirs to the left side. Then use it to "lace up" the loops, creating a zig-zag pattern as they go. Explain that this represents lightning.

Supplemental Material

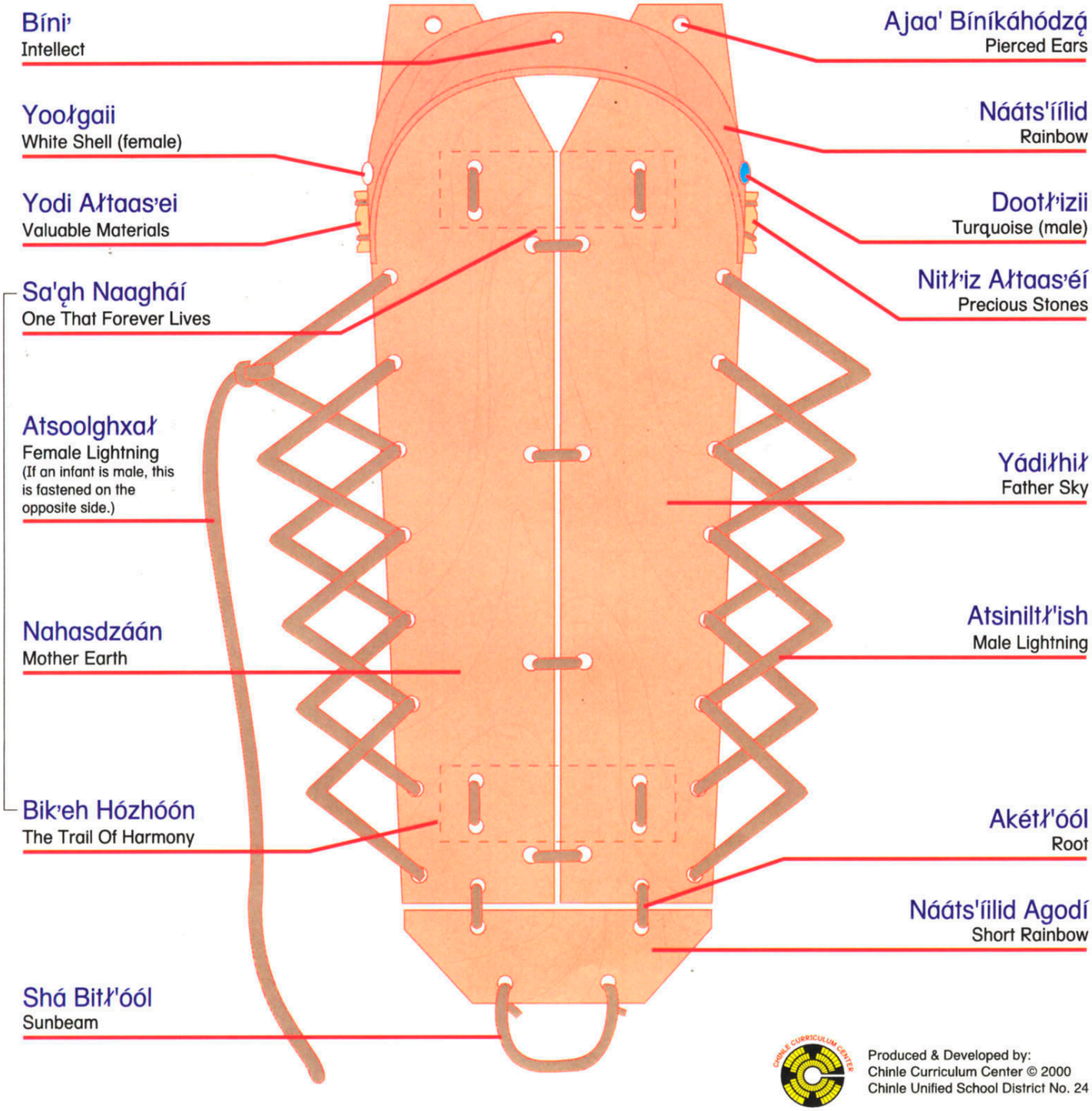
The Cradleboard

Adapted from the Chinlé Curriculum Center

Long ago, the first cradleboard was made for Asdzą́ą́ Nádleehí, Changing Woman, when she was born. A piece of Yoołgaii (white shell) was fastened on the right side of her head board on the cradle, representing female. When a boy is born, a piece of Dootł'izhii (turquoise) is fastened to the left hand side, representing male. The wrappings of the infant inside the cradleboard represent K'os diłhił, dark clouds. The covering over the whole cradleboard, initially buckskin, now white or beige cloth, represents K'os, white clouds. An infant is securely wrapped in the cradleboard for protection. This helps the infant grow up to be a strong-willed person.

An affectionate lullaby is sung for an infant as it is being wrapped and tied in the cradleboard. The song is for comfort and for the infant to learn love. For this reason, today, the cradleboard is still used as a baby carrier by the Navajo People.

Cradleboard Diagram



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