The Moon and Tides: Multiple Perspectives

A Research-based Curriculum
Developed by
Margaret Russell Ciardi, Ed.D.
and
John J. Crowley, M.S.
New Bedford ECHO Project

In Collaboration
with
The Bishop Museum
Honolulu, Hawai`i

Adapted from
Cycles and Hawaiian Traditions
by
Hui Malama o Mo'omomi and the
Pacific American Foundation

The Moon and Tides: Multiple Perspectives
An Introduction

The *Moon and Tides: Multiple Perspectives* curriculum is made possible by the Education through Cultural and Historical Organizations (ECHO) Act, a federally-funded educational and cultural enrichment initiative annually serving hundreds of thousands of children and adult learners in Alaska, Hawai`i, and Massachusetts. Established by Congress as part of the No Child Left Behind Act of 2001, ECHO brings innovative programs to culturally diverse audiences.

The ECHO Project brings together groups that are geographically distant, but culturally and historically connected. First brought into contact with each other through tall ships, today's partner regions share threads of common history. The ECHO partners include: the Alaska Native Heritage Center and the North Slope Borough in Alaska; the Bishop Museum in Hawai`i; the Mississippi Choctaw; and the New Bedford Oceanarium, New Bedford Whaling Museum, and Peabody Essex Museum in Massachusetts. Each of these partners has its own distinct mission, but all are stewards of the arts and knowledge of their regions. They gather cultural stories, drawings, paintings, sculpture, artifacts, music, poetry, and literature. They assemble historical and scientific facts, figures, and documents. Their collections reflect the connections that the oceans have created between the regions and the connections between the natural environment and culture.

Hawai`i, Massachusetts, Alaska, and the Moon and the Tides

Understanding about the moon and tides has universal importance. Students around the globe need to understand about the cycles and constancy of these natural phenomena-regardless of whether they live next to the ocean or in an inland location. There are numerous examples of the importance of these cycles to all people:

- Research has found connections between the phases of the moon and movements in the earth's crust, earthquakes and volcanic eruptions. These appear to be caused by the gravitational pull of the moon when

it is in perigee-particularly close to the earth and aligned with the earth and sun in full moon position.

- The gravitational pull associated with the phases of the full and new moon can cause measurable changes in water levels-not only in oceans, but also in large rivers, lakes, bays, and estuaries.
- The water surges associated with increased water levels at the full or new moon allow fish and other aquatic creatures to lay their eggs in timed intervals above the water line. In turn, these eggs have the opportunity to incubate, away from aquatic predators, until the next full or new moon, when they hatch.
- The migration of birds and other wildlife is often associated with periods of the full moon.
- The majority of scientists assert that the temperatures of the earth and ocean are rising. The environmental changes brought on by sea level changes associated with global warming are exacerbated during full or new moon high tides.

These are only a few examples of why the study of the science of the moon and tides is critical for all students, regardless of their locale.

This *Moon and Tide: Multiple Perspectives* curriculum unit is unique, in that it explores these natural phenomena, from both a scientific and cultural perspective. The curriculum has its roots in the *Cycles and Hawaiian Traditions* curriculum developed by Hui Malama o Mo'omomi and the Pacific American Foundation. The *Cycles and Hawaiian Traditions* curriculum integrates scientific and cultural knowledge about the moon and tides. The New Bedford ECHO Partners at the University of Massachusetts Dartmouth were given permission to create a unit that would incorporate learning experiences from this Hawaiian curriculum, with the goal of supporting teachers and students in broadening their perspectives about how people from different locales make meaning.

Another curriculum, *Tlingit Moon and Tide Teacher Resource: Elementary Level*, which was developed at the University of Alaska by Dolly Garza, similarly examines the moon and tides from both native and scientific ways of knowing. It contains learning activities about the cycles of the moon and tides in the lives of the Tlingit people of Southeast Alaska. Additional information about this curriculum is available on pages 41-42 and on the web at http://www.uaf.edu/seagrant/bookstore/pubs/SG-ED-33.html. or http://www.ankn.uaf.edu/curriculum/Tlingit/Salmon/graphics/moonandtides.pdf.

Multiple Perspectives

Human beings are inherently curious. They want to understand why and how things are as they are. Over time and across civilizations, humans have sought to make sense of their social and physical environments. Their meaning-making has been immersed in and shaped by the cultures in which they live. Each group has constructed its own reality, truth, right and wrong. Some have used narrative to understand. Others have turned to science to make sense of complex phenomena. This curriculum combines both narrative and scientific views through an exploration of the moon and tides. In addition, it teaches students about the complexity of culture and encourages them to discover the connections between culture, the natural environment, and social systems.

Narrative: The Power of Story

Throughout time and across cultures, people have created stories that entertain, teach, and connect them with others.

> "Stories are the threads which bind nations, cultures, and families together. Just as there is no culture without stories, no childhood or education is complete without the magic of shared stories. Stories allow all children, regardless of age, culture, or ability, instant access to a larger world, in terms of time and space, than the one in which they live." (Cabral and Manduca, 1997)

Stories, such as *Star Wars* and *Lord of the Rings*, both entertain and provide a contemporary vehicle for exploring good and evil. Ancient stories, such as the myth of Pandora, served a similar purpose. Others were created to explain natural phenomena. For example, the ancient Romans accounted for the seasons with the myth of Demeter, the goddess of agriculture, whose daughter, Persephone, was kidnapped by the god of the underworld. Demeter was so grief-stricken that she wouldn't allow anything to grow. A deal was struck and Persephone was allowed to live with her mother for half the year. When Persephone was with Demeter, the weather was warm, and the crops grew and were harvested. But when Persephone was in the underworld, nothing grew and it was winter.

Other ancient cultures created myths, or stories, to explain natural phenomena. The Japanese told the tale of Amateras-Ohmikami, the sun

goddess. When she hid, there was night and when she came out of hiding, there was daylight. In South Africa, the story was told about the Moon, who sent a rabbit to the earth to deliver a message of hope. The rabbit relayed the message incorrectly and told a story that filled everyone with grief. The Moon was furious and hit the rabbit with a stick. The rabbit was so angry that he scratched the Moon with his claws, and to this day, the Moon wears the scars of the rabbit's retribution.

Hawaiian Cultural Stories

The cultural stories of Hawai`i are particularly important to the Hawaiian people because they are sacred oral texts that were almost lost when, during the 19th century, armies, politicians, and missionaries convinced the people of Hawai`i to turn away from their cultures and beliefs. Political and social initiatives are underway to reclaim the languages, beliefs, histories, values, traditions, and cultural stories of the Hawaiian Native People. These stories, which tell of ancient beliefs, are considered sacred facts that explain the interrelations of the gods, nature, and humans. They have deep spiritual significance. Some of these stories are included in this curriculum unit.

Science

Cultural stories describe profound human truths and an indigenous view of the world. Western science involves objective truth, experiments, and testing. Both have long histories. As early as 585 BC, Thales of Miletus was observing stars and studying eclipses. In 240 BC, Eratosthenes calculated the size of the earth. In 120 AD, Ptolemy was able to determine the movement of the stars, planets, and moon around the earth. In the 1400's, Copernicus theorized that the sun was at the center of the universe. And in 1609, Galileo first used a telescope, drew a representation of the moon, and provided evidence to support Copernicus' theory that the earth revolved around the sun.

Culture: At the Center

As humans, we ask, and attempt to answer, complex questions. Both our questions and answers are shaped by our prior knowledge, beliefs, traditions, values, and cultural backgrounds. This curriculum unit aims to support

students and teachers in understanding the complexity of culture and its relationship to the natural environment, social systems, art, and literature.

Backward Design

This curriculum was developed using the backward design approach, a research-based curriculum development process designed by Jay McTighe and Grant Wiggins (Understanding by Design, 2004). The backward design approach consists of three stages:

1. **Identify the Desired Results**: What should students know, understand, and be able to do? What are the enduring understandings, essential questions, and specific knowledge and skills that will be studied?
2. **Determine Acceptable Evidence**: How will we know that students understand the big ideas and content standards?
3. **Plan the Learning Experiences:** What will need to be taught? How will it be taught? What will be the sequence of learning? What guidelines will shape the planning?

The Unit: *The Moon and Tide: Multiple Perspectives*

Desired Results: Enduring Understandings

- The environment can be understood from both scientific and cultural perspectives.
- Everyone has a culture that shapes how we see the world, ourselves, and others.
- Stories help us understand our own and other cultures.
- Understanding involves generating ideas and questions, posing problems, gathering evidence from multiple sources, and using scientific processes.
- There are predictable and observable patterns and cycles in nature that impact the earth.

Desired Results: Essential Questions

Each learning experience supports students in exploring one or more of the following essential questions:

- What are some aspects of culture?
- What are the critical and recurring questions about nature that have confronted people in the past and present?
- How and why does the appearance of the moon change over the course of a month?
- What are the different cycles of the tides and how are they related to the phases of the moon?
- How and when can we use our knowledge of the phases of the moon and the cycles of the tides?
- Do myths and cultural stories reflect culture or shape it?
- How and why do beliefs change?
- How do cultural explanations of natural phenomena differ from scientific explanations? How are they similar?
- What makes a good recipe for a cultural story?
- What are natural cycles and how are they essential to life?
- What skills and processes do scientists use to investigate a question?

Desired Results: Specific Knowledge and Skills

During recent decades, content standards have been developed to guide teaching and learning. This curriculum unit focuses on two content areas: science and English language arts. National and state standards for each content area are available on the internet at the Education World website: http://www.education-world.com/standards/state/index.shtml

State standards for the ECHO partners in Hawai`i and Massachusetts are available in the Appendix.

Acceptable Evidence of Learning

Students will choose to demonstrate their learning through one or more of the following performances or a student/teacher developed performance:

- **Student groups will prepare a presentation that explains a natural phenomenon from both a scientific and cultural perspective:**
  - Create and present a myth or story that incorporates accurate information about the moon, tides, and creatures whose life cycles are shaped by the moon and tides. The myth or story should reflect your culture.
  - Conduct research, identify a story about the moon and/or tides, explain what the story reveals about a particular culture, and describe its scientific accuracy. Present your findings to the class.
  - Research a question you have about nature. Identify how other cultures have addressed that question over time. How has science addressed the question? Present your findings to the class.

- **Student groups will prepare a presentation that explains tides and currents, demonstrates the influence of the sun and the moon on the tides, explains spring and neap tides, and tidal magnitude (perigee, apogee, perihelion, and aphelion). The presentations may be physical models, visual media, dramatic presentations, or a publication.**

  - Develop a dramatic presentation that accurately depicts the phases of the moon and cycles of the tides and their impact on a particular creature in its habitat. Your presentation must be scientifically accurate.
  - Develop a presentation that displays data you have gathered about the moon, tides, and cycles of the seasons. In your presentation, show ways that your life is affected by these cycles. Your presentation should include graphs, charts, photographs, and artifacts that you have gathered and/or created.

- Create a mural or other artifact that represents and identifies various marine species and depicts how their life cycles and habitats are shaped by constancy and change in their environments.

Learning Experiences

The development of the unit and learning experiences in this curriculum unit was guided by the following *Understanding by Design* (UbD) principles:

- **W** The students know **where** they are going and **why**. They also know **what** is expected and required and how they will be evaluated.
- **H** Students are **hooked** or engaged in working with the enduring understandings and essential questions.
- **E** Students have opportunities to **explore** enduring understandings and essential questions and receive instruction they need for the required assessments.
- **R** Students have opportunities to **rethink**, **revise**, and **refine** their work based on feedback.
- **E** Students have opportunities to **evaluate** their own work and set learning goals.
- **T** Instruction is **tailored** to the needs of individual students using**:**
    - Differentiated instruction
    - Content area literacy strategies
    - Cooperative learning
    - Opportunities for oral language
- **O** **Organized** and sequenced

Sequence of Learning Experiences (LE's)

- LE One: Learning Experience One: Where Are We Going?
- LE Two: Understanding Culture
- LE Three: Culture, Families, and Communities
- LE Four: Myths and Cultural Stories
- LE Five: What I Know About the Moon
- LE Six: The Phases of the Moon
- LE Seven: The Moon, Sun, and Earth
- LE Eight: The Moon and the Tides
- LE Nine: A Closer Look at the Moon's Relation to the Tides

Assessment and Evaluation

Each learning experience has been planned to give students the knowledge and skills necessary to meet the final assessment requirements. The teacher should allow time, throughout the unit, for students to form groups, plan, and research information for the final performances. The teacher should also work with students, throughout the unit, to develop criteria and rubrics for successful completion of the performances. Models and directions for creating rubrics can be found at

http://school.discovery.com/schrockguide/assess.html#rubrics

Learning Experience One

Where Are We Going? Why?

Overview: This learning experience introduces students to the curriculum unit so they know *where* they are headed and *why*. The learning experience also introduces students to the performance tasks.

Materials:

- Chart Paper
- Colored Markers
- Dialectical Journal

Activity One: Carousel Brainstorm

Teacher Notes

** Set a purpose for learning*
** Discussion-based activity that promotes active learning and oral language and discussion skills*
** Expectations for learning are revealed*
** Students see how their learning will be assessed*

- Explain to students that they are about to begin a new unit. You should tell students that you are beginning the unit by showing them the "final exam." Their task is to guess what they will be learning in the unit. To do this, they will be working in groups. Be sure to remind students about the rules of group work (taking turns, talking quietly, etc.).
- Carousel Brainstorm:
    - Select four of the possible performance tasks from the template (see Lesson One Notes to Teacher). Write each of the four performance tasks on a separate piece of chart paper. Hang the chart paper around the room.
    - Divide students into four groups. Give each group a different color marker.
    - Assign each group to one of the charts. Ask students in each group to read the performance task and identify what they will need to know and be able to do to complete the task. Give them an example. (If your task asks you to write a short story, you then have to know the parts of a story.)
    - Give each group a few moments to come up with and write as many items as possible. You will have to monitor the work and time. They may need five or more minutes to complete the task.

- Ask each group to move in a clockwise direction to the next chart. They should read the performance task and the items that the previous group listed. They will then add to the list.
- After about five minutes, they should move to the next chart and repeat the process.
- They will move through the charts until they end up where they began. Give them a few moments to read what other groups have written on their original chart.
- Process the activity with the group. Ask a student from the first group to read the list. On the board or on another piece of chart paper, write their list. Continue with the second chart, third, and fourth charts. Add only new information to the chart you are developing
- After gathering all their items, add objectives they haven't included. Use language that they will understand, rather than scientific words.

Activity Two: Dialectical Journal (see Handout One below).

Teacher Notes

** Students process their learning and activate their prior knowledge.*

** The teacher assesses students' prior knowledge.*

The Dialectical Journal is a writing-to-learn tool that provides an opportunity for students to process what they have learned and activate their prior knowledge. Ask students to select 5 or 6 of the objectives from your final chart and write them in the first column. They should complete the second column of the chart before the end of class or for homework. The teacher can review students' Dialectical Journals and use the information to plan teaching and learning that is aligned with students' current levels of knowledge of the objectives.

Notes to Teacher: Final Unit Performance Tasks

- Create and present a myth or story that incorporates accurate information about the moon, tides, and creatures whose life cycles are shaped by them. The myth or story should reflect your culture.

- Conduct research and identify a story about the moon and/or tides. Explain what the story reveals about a particular culture, and describe its scientific accuracy. Present your findings to the class.

- Develop a dramatic presentation that accurately depicts the phases of the moon and cycles of the tides and their impact on a particular creature in its habitat. Your presentation must be scientifically accurate.

- Develop a presentation that displays data you have gathered about the moon, tides, and cycles of the seasons. In your presentation, show ways that your life is affected by these cycles. Your presentation should include graphs, charts, photographs, and artifacts that you have gathered and/or created.

- Develop a presentation that depicts what would happen to you and the natural environment if there suddenly were no gravity.

- Create a mural or other artifact that represents and identifies various marine species and depicts how their life cycles and habitats are shaped by the cycles, or phases of the moon and tides.

- Research a question you have about nature. Identify how other cultures have addressed that question over time. How has science addressed the question? Present your findings to the class.

Learning Experience One

Dialectical Journal: Handout One

What will we learn?	What do I already know about this?

Learning Experience Two

Understanding Culture

Overview: This learning experience was developed by the Unites States of America's Peace Corps as a tool for preparing volunteers for assignments in various countries and is available on the web at (http://www.peacecorps.gov/WWS/bridges/lesson4/index.html). hidden. Students will be introduced to the following ideas about culture (*Beyond Culture* by Hall, 1981):

- Culture is like an iceberg. Some aspects are visible, and others are beneath the surface. Invisible aspects influence and cause the visible ones.
- Culture is like the air we breathe.
- Culture is learned.
- Culture is a living, interlocking system(s)--touch one part, the rest moves.
- Culture is shared; it is created and maintained through *relationship*.
- Culture differentiates one group from another.

In this lesson, students will distinguish between the visible and invisible aspects of culture. They will explain how the invisible aspects of culture influence the visible ones.

Understandings

- Everyone has a culture that shapes how we see the world, ourselves, and others.

Essential Question

- What are some aspects of culture?

Materials:

- Chart Paper and Markers
- Handouts One, Two, and Three

Activity One: The Cultural Iceberg

Teacher Notes

** Structured Cooperative Learning Activity*

**Promotes active learning and oral language and discussion skills*

**Inclusive Activity: All students can participate including English Language Learners and struggling readers*
**Builds on students' cultural knowledge*

- Place students in groups of 4-6.
- Draw an iceberg on chart paper. Tell students that culture is like an iceberg. Only a little of an iceberg can be seen above water; most of the iceberg is invisible to the eye and hidden beneath water.
- Distribute Handouts One and Two to students. Handout One is a list of cultural characteristics. Handout Two is a drawing of an iceberg.
- Each group should select a recorder and a reporter. The recorder will take notes. The reporter will "report out" to the class.
- Direct students to work in their groups to identify those features from the list that they can see in the behavior of people and those that are invisible. They will record the features on the blank iceberg chart on Handout Two indicating those that are visible and those that are invisible (above or below the waterline respectively on your iceberg drawing).
- Process with students. Ask one group's reporter to share the information on his/her group's iceberg. Record the information on the iceberg you drew on chart paper. Allow time for comments, disagreements, and discussion from other groups. Through discussion, students come to understand that there is a relationship between those aspects of culture that we can see and those that are hidden. In most cases, the invisible aspects of culture influence or cause the visible ones. For example, holiday traditions may reflect religious beliefs.

If you have access to the Internet, you can show students Gary Weaver's *Cultural Iceberg http://www.hsp.org/files/culturaliceberg2.pdf*

Activity Two: Revealing Photographs

Teacher Notes

** Structured Cooperative Learning Activity*

**Promotes active learning and oral language and discussion skills*

**Students process what they have learned through the 3-2-1 Summarizer*

- Place students in groups of 4-6.
- Ask students to select a new recorder and new reporter.
- Distribute Handout Three on which there are photographs of people from different cultures. Assign one or two photographs to each group.
- Ask each group to examine their photograph(s) and answer the following questions. Discuss the answers with students.
    - What do you see in the photograph?
    - What visible (above the waterline) cultural characteristics do you see?
    - What invisible characteristics (below the waterline) might be causing the visible ones?
- 3-2-1 Summarizer. Ask students to write in their journals:
    - 3 questions they have about their own cultures
    - 2 values they think are important in their own cultures
    - 1 thing they've learned about culture

Activity Three: Homework

Teacher Notes

Connects with students' cultures, families, and communities

- In Activity Two, students did a 3-2-1 Summarizer. They came up with three questions they have about their own cultures.
- Ask students to identify three family members who are willing to answer those questions. Students will interview those 3 family members.
- Students will take notes and then write up their findings. (You can use their drafts as a means of reviewing punctuation – such as quotation marks.)
- Process with students at the beginning of the next class.

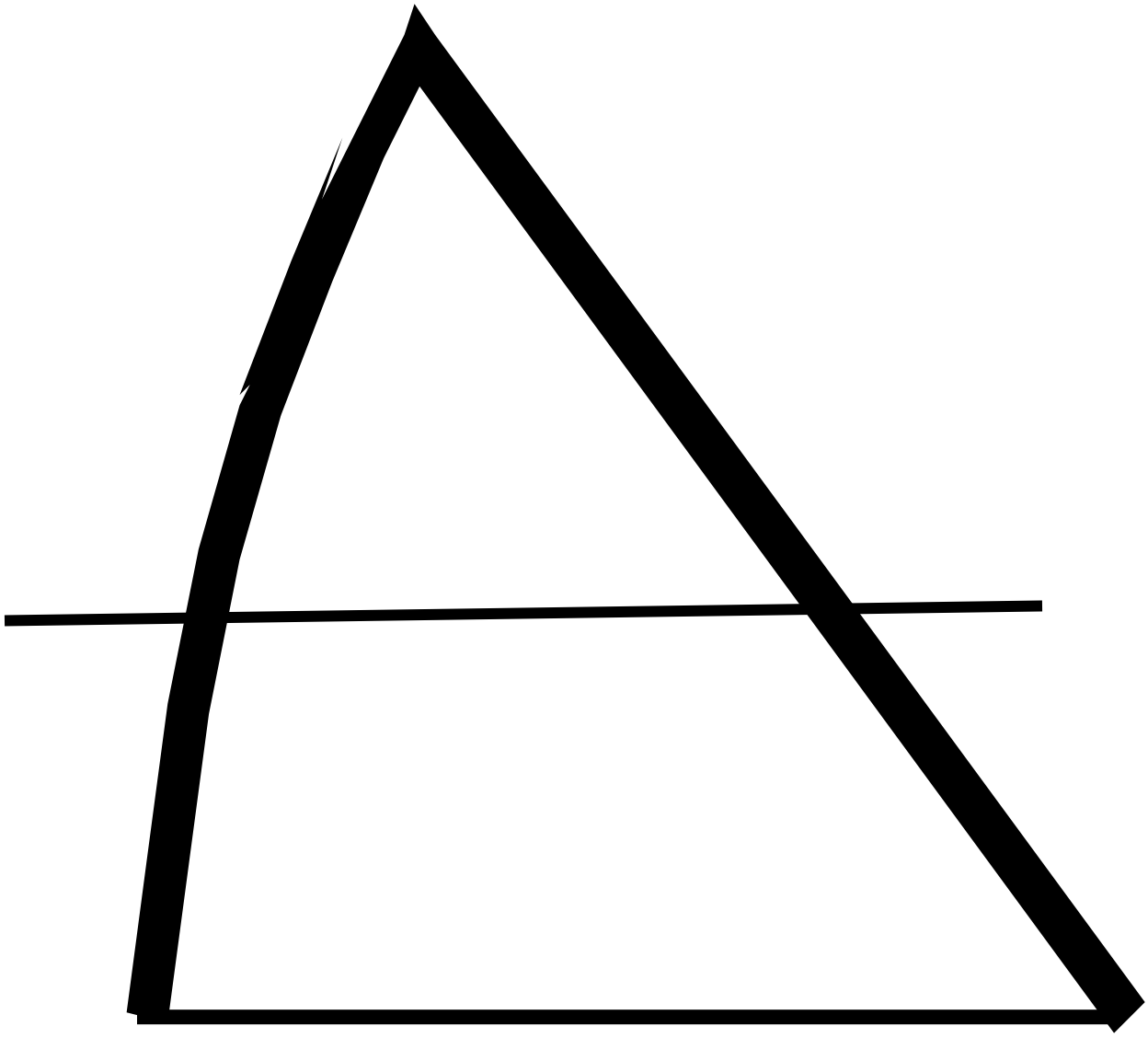
Learning Experience Two

Handout One

The following is a list of cultural features or characteristics. Your job is to identify those features from the list that you can see in people and those that are invisible. You will record the features on the blank iceberg on Handout Two. Place those that are visible above the waterline and those that are invisible below the waterline.

- facial expressions
- religious beliefs
- religious practices
- paintings
- literature
- ideas about friendship
- ideas about leadership
- gestures
- holiday customs
- ideas about fairness
- non-verbal communication
- foods
- eating habits
- the importance of work
- ideas about beauty
- music
- styles of dress
- view of the world
- concept of personal space
- rules of social behavior
- ways of speaking

Handout Two: The Cultural Iceberg



Handout Three

Learning Experience Three

Culture, Families, and Communities

Overview: This learning experience encourages students to bring their families and communities into the classroom as they relate the ways in which they practice cultural behavior. In the learning experience the students can recognize the importance of values as a means of solving problems and discussing situations. This learning experience was adapted from the *Cycles and Hawaiian Traditions* curriculum developed by Hui Malama o Mo`omomi and the Pacific American Foundation. Students will continue to explore the following ideas about culture (*Beyond Culture* by Hall, 1981):

- Culture is like the air we breathe.
- Culture is learned.
- Culture is a living, interlocking system(s)--touch one part, the rest moves.
- Culture is shared; it is created and maintained through *relationship*.
- Culture differentiates one group from another.
- Culture can be described as an iceberg.
- There are many facets of culture - visible and invisible.

Understanding

- Everyone has a culture that shapes how we see the world, ourselves, and others.

Essential Questions

- What are some aspects of culture?
- How do myths and cultural stories reflect culture?

Evaluation

- The teacher and students generate rules for informal discussion and create a rubric for self-evaluation. Students self-evaluate using the rubric.

Materials:

- Chart paper and markers
- Students will need to bring a picture of themselves and pictures of people who are important to them in their lives.
- 8” X 10” poster paper or oak tag
- Handouts

Activity One: Creating a Discussion Rubric

Teacher Notes

** Structured Cooperative Learning Activity*

**Promotes active learning and oral language and discussion skills*

**Student-generated rubric for discussion promote "buy in"*

- Inform students that they will be engaging in a great deal of discussion about their families and cultural values in this learning experience. Before beginning, they will have the opportunity to establish some ground rules for their discussion.
- Brainstorm with the class: What rules do you think are important for informal group discussions? Record every response on chart paper.
- Lead a discussion with the goal of having students identify five rules they will follow for the group activities.
- Place students in groups of 4-6.
- Distribute Handout One. Students will select a discussion director. Ask students to fill in the rubric together for each of the categories. They will come up with descriptors for each category/rule. An example might be that "Students Take Turns in Discussions."
  - Excellent might be "Every speaker got to state his/her ideas."
  - Good might be "One speaker was interrupted."
  - Needs some work might be "More than one speaker was interrupted."
- Process with students. On chart paper, create a class rubric based on the ones that students developed in their small groups.

Activity Two: What's Important?

Teacher Notes

** Structured Cooperative Learning Activity based on Harvey Daniels' Literature Circles*

**Promotes active learning and oral language and discussion skills*

**Students process what they have learned through the 3-2-1 Summarizer*

- In the previous learning experience, students were asked to identify two values that are important to them and their family and community members. (This was done in the 3-2-1 Summarizer.) Students will use this information for Activity Two.
- Place students in groups of 4-6. Students select a Discussion Director, Recorder, and Reporter. Each group will develop a list of the values that are important to them.
    - The Discussion Director and Recorder create a list of all the values their group members contribute (two from each student). All group members will copy the list.
    - Each group member will prioritize his/her list.
    - The Discussion Director and Recorder will then make a list of the most frequently appearing values based on each student's list. What are the "top five?"
- Process with the class. What are the most frequently identified values identified by each group? Write these on chart paper or a white board. Discuss with students. What are the five most frequently occurring values? Why are there common values? Why is this important? Students should understand that the values they have chosen reflect their cultures.

Activity Three: Picture Boards

Teacher Notes

**Hands-On Activity*

**Connects with students' cultures, families, and communities.*

- In this activity, students will examine their values.
- Students affix a picture of themselves to the center of a piece of poster board. They should then arrange the pictures they brought with them around their own picture and affix them. Identify the people in the pictures by writing their names carefully beneath each picture.
- Select one of the values you have written on chart paper. Students will define and give examples of that value.
- Ask for a volunteer to hold up his/her poster. Show the picture of one person in the poster and tell a story about how that person practiced the chosen value. Encourage other students to share their stories.
- Do the same for all five values.

Activity Four: Think-Pair-Share

Teacher Notes

**Writing to Learn"*

Discussion-based

Students process their learning.

**Connects with students' cultures, families and communities.*

- Ask students to write in their reflective journals. What have they learned about culture and cultural values?
  - Pair students up and give them as much time as necessary to share their ideas.
  - Process. Check for understanding to be certain that students are **beginning** to understand that:

    - Culture is learned.
    - Culture is a living, interlocking system(s)--touch one part, the rest moves.
    - Culture is shared; it is created and maintained through *relationship*.
    - Culture differentiates one group from another.
    - There are many facets of culture - visible and invisible (iceberg).

Learning Experience Three

Handout One: Rules for Informal Discussions

Rule	Excellent	Good	Needs Some Work

Learning Experience Four: Cultural Stories

Overview: In this learning experience, students will learn that people from different cultures create stories that capture their beliefs, values and traditions. These narratives, which are often deeply symbolic, preserve and cherish the wisdom of a culture. They typically use supernatural explanations for natural phenomena and may also explain issues like creation and death.

Students will learn about the characteristics of Roman and Greek myths by reading "Demeter and Persephone." They will then read narratives from other cultures and identify the characteristics of those cultural stories. Finally, they will read "The Legend of Hina" and learn about the sacred aspects of Hawaiian cultural stories.

Understandings

- Stories help us understand our own and other cultures.
- Culture has many aspects.
- The environment can be understood from both scientific and cultural perspectives.

Essential Questions

- What are critical and recurring questions about nature that have confronted people in the past and in the present?
- How do myths and cultural stories reflect culture?
- What are the characteristics of a cultural story or myth?

Evaluation

Students will write a myth or cultural story. Their writing will be evaluated according to criteria in the rubric included with this lesson.

Materials:

- Chart Paper and Markers
- Handouts One, Two, Three and Four

Activity One: Exploring a natural phenomenon from scientific and cultural perspectives

Teacher Notes

**Activate and assess students' prior knowledge*

**Promotes active learning and oral language and discussion skills*

**Students process what they have learned through the 3-2-1 Summarizer*

- Brainstorm: Ask students why we have seasons. Place their responses on chart paper. Review students' responses. Their responses will probably be based on information they've learned in science. This will allow you to assess prior knowledge and set the stage for the next part of the activity.
- Place students in groups of 4-6. Ask them to imagine that they do not have any scientific information about the seasons. They simply know that the weather and amount of daylight and darkness changes over time. Ask students to brainstorm ideas for a story they would tell to explain why we have seasons, using their cultural knowledge. Encourage divergent and creative thinking.
- Each group will come up with an explanation or story they will share with the class. Each group's explanation or story should be recorded on chart paper. A reporter from each group will discuss the explanation.
- Process with the class. What common characteristics do the explanations share? List on chart paper or the board.
- Distribute Handout One: The Characteristics of Myths and Cultural Stories. Compare and contrast the characteristics of students' explanations with those on Handout One. Discuss and explain the characteristics.

Activity Two: "The Myth of Demeter"

Teacher Notes

**Reading aloud gives all students access to the text.*

** Review characteristics of myths. Check for understanding.*

- Read the "Myth of Demeter" on Handout Two with students.
- Be certain that students understand that this story was based on the beliefs about gods and goddesses held by ancient people. The "Myth of Demeter" explains why there are seasons (Handout 2).
- Help students understand that people from all cultures create stories that capture their beliefs and traditions. These narratives preserve and cherish the wisdom of a culture. They typically use supernatural explanations for natural phenomena and may explain issues like creation and death.
- After reading the "Myth of Demeter," review the information in Handout One. Duplicate Handout One on chart paper, or the board. Discuss each characteristic in relation to the story.

Activity Three: Identifying Characteristics

Teacher Notes

**Differentiate instruction and homogeneous grouping for reading*

**Discussion-based activity*

**Structured cooperative learning activity*

**Check for understanding*

**Writing to learn*

**Summarize learning*

- Handout Two contains myths and stories from diverse cultures. (These stories vary with regard to level of difficulty.)
- Place students in homogeneous groups and assign each group to read one of the stories. Students should read stories that are at an appropriate level of difficulty for their reading level (not too easy and not too difficult). Students will read the narratives independently.
- Each group will select a Recorder, and a Reporter.
- The groups will discuss their myth/cultural story. They will:
  - Identify the characteristics of myths/cultural stories they found in their reading. (The Recorder will take notes about this discussion using Handout One.)
  - The Reporter will report on their discussion to the class.

- Process with the class. Since students have read different texts, the teacher, should provide a very brief summary of each text before the process discussion. Check for understanding, to be certain that students understand the characteristics.
- Journal Writing: Direct students to write what they have learned about myths/cultural stories in their journals. An example of one summarizer you might use is included in Handout Four.

Activity Four: "The Legend of Hina"

Teacher Notes

**Read the story aloud to/with students. This assures that all students have access to the text.*

** Students learn more about culture in general and Hawaiian culture and history specifically.*

** Students learn that Native Hawaiian People have used cultural narratives as well as science to make sense of natural phenomena.*

- Read "The Legend of Hina" with students (Handout 3). Before reading, explain to students that the story preserves and reflects values of the ancient Hawaiian people. It also is part of a body of cultural stories that are held to be sacred facts that explain the interrelations of the gods, nature and humans. Hawaiian cultural stories have deep spiritual significance. The same is true of Alaskan cultural stories. Some Native Alaskan people believed the man in the moon to be the keeper of the souls of men and animals. To help students further understand this significance, you might ask them about sacred writings in other cultures (e.g. the Bible, the Koran, and the Torah).
- Before reading "The Legend of Hina," you should read the Notes for Teachers related to the story. Provide this information to students. For additional information see: http://carbon.cudenver.edu/public/fwc/Issue5/Hawai`i-1.html and http://www.alternative-Hawai`i.com/hacul/history1.htm.)
- Today, the Hawaiian people are working to reclaim their language and culture. The "Legend of Hina" is part of that culture and is very important to the Hawaiian people.
- Explain that people from all cultures create stories that capture their beliefs and traditions. These narratives, which are often deeply symbolic, preserve and cherish the wisdom of a culture. They typically use supernatural explanations for natural phenomena and may also explain issues like creation and death.
- Be sure to discuss how "The Legend of Hina" represents the Native Hawaiian cultural understanding of the phases of the moon.
- Refer students to Handout Four, which includes links to moon stories from other cultures.

Activity Five: Writing Cultural Stories

Teacher Notes

**Writing- to-learn*

**Learning to write*

- Students will write their own myth or cultural story.
- The children's author, Jane Yolen, provides guidelines: http://teacher.scholastic.com/writewit/mff/mythswshop_index.htm.).
- An adaptation of her suggestions is provided in Handout 5. Review these guidelines before students begin writing.
- Students write a draft then meet with peers to ensure that their stories include some or all of the characteristics of myths and cultural stories.
- Students revise their drafts and submit to the teacher.
- The purpose of this writing activity is for you, the teacher, to evaluate how well students have learned the characteristics of myths and cultural stories. You should develop a rubric that includes the information in Handout One and any other writing component that you have taught and want to evaluate.

Activity Six: What Have You Learned about Myths and Cultural Stories?

Teacher Notes

**Students process their learning*

**Teachers check for understanding*

- In this activity, students think about what they have learned about myths and cultural stories.
- Distribute Handout 6. Ask students to complete each box, indicating what they have learned.
- Collect and read students' responses. Check for understanding? Do students' responses capture the desired learning? Are there misconceptions? Are there students who need additional teaching and learning? How will you meet their needs?

Notes for Teachers

The Purposes of Cultural Stories and Myths:

1. To explain natural phenomena or an occurrence;
2. To explain the creation of the world;
3. To teach people moral lessons;
4. To explain some historical event;
5. To explain some ancient religious practices; and
6. To reveal the common hopes and fears of mankind.

The characteristics of cultural stories:

1. Cultural stories reflect peoples' attempts to explain or understand the universe.

2. There are god-like characters in the cultural stories or myths.

3. The god-like characters are super human in nature.

4. The god-like characters often experience human emotions.

5. There are often magical and seemingly unbelievable events.

6. The god-like characters sometimes appear in disguises.

7. A transformation, or change, may occur.

Learning Experience Four

Handout One: The Characteristic of Cultural Stories

Characteristics of Cultural Stories or Myths:	The Myth of Demeter	Group Story	Student's Story
*Explain a historical event or natural phenomenon. * Explain a religious belief or practice. *Explain the creation of the world. * Teach a lesson. * Reveal peoples' hopes and/or fears.			
The story includes gods, goddesses, or mystical animals.			
The gods, goddesses, or mystical animals possess super powers.			
The gods, goddesses, or mystical animals experience human emotions.			
There is magic in the story.			
Gods, goddesses, or mystical animals sometimes appear in disguised form.			
A transformation or change may occur.			

Handout Two
Stories and Myths

The Myth of Demeter

Persephone was the goddess of the underworld in Greek mythology. She was the daughter of Zeus and Demeter, goddess of the harvest. Persephone was such a beautiful young woman that everyone loved her. Even Hades, the god of the underworld, wanted her for himself. One day, when she was collecting flowers on the plain of Enna, the earth suddenly opened and Hades rose up from the gap and abducted her. None but Zeus, and the all-seeing sun, Helios, had noticed it.

Broken-hearted, Demeter wandered the earth, looking for her daughter until Helios revealed what had happened. Demeter was so angry that she withdrew herself in loneliness, and the earth ceased to be fertile. Knowing this could not continue, Zeus sent Hermes, the messenger of the gods, down to Hades to make him release Persephone. Hades grudgingly agreed, but before she went back he gave Persephone a pomegranate. When she later ate of it, it bound her to the underworld forever and she had to stay there one-third of the year. The other months she stayed with her mother. When Persephone was in Hades, Demeter refused to let anything grow and winter began. This myth is a symbol of the budding and dying of nature.

"Persephone." Encyclopedia Mythica from *Encyclopedia Mythica Online.* http://www.pantheon.org/articles/p/persephone.html. [Accessed September 10, 2005].

The Story of Annigan

You will find the story of Annigan and his sister, Malina, on the web at (**http://www.windows.ucar.edu/tour/link=/mythology/anningan_moon.html&edu=mid**. Anningan is the moon god of some of the Inuit people who live in Greenland. Malina is the sun goddess. The story explains why the moon and sum rise and set at different times.

From the Puyallup Tribes in the Northwest

This story tells the tale of the great chief, Tyee Sahale, his sons, Klickitat and Wyeast, and the beautiful Loowit. The story explains the origins of Mount Helen, Mount Hood, and Mount Adams, is from the Puyallup Tribe of the Pacific Northwest. It can be found on the web at **http://volcano.und.edu/vwdocs/msh/llc/hr/hrho/nam.html**.

The Story of Apollo and Daphne
From Bullfinch's Mythology

Daphne was Apollo's first love. It was not brought about by accident, but by the malice of Cupid. Apollo saw the boy playing with his bow and arrows; and being himself elated with his recent victory over Python, he said to him, "What have you to do with warlike weapons, saucy boy? Leave them for hands worthy of them, Behold the conquest I have won by means of them over the vast serpent who stretched his poisonous body over acres of the plain! Be content with your torch, child, and kindle up your flames, as you call them, where you will, but presume not to meddle with my weapons." Venus's boy heard these words, and rejoined, "Your arrows may strike all things else, Apollo, but mine shall strike you." So saying, he took his stand on a rock of Parnassus, and drew from his quiver two arrows of different workmanship, one to excite love, the other to repel it. The former was of gold and sharp-pointed, the latter blunt and tipped with lead. With the leaden shaft he struck the nymph Daphne, the daughter of the river god Peneus, and with the golden one Apollo, through the heart. Forthwith the god was seized with love for the maiden, and she abhorred the thought of loving. Her delight was in woodland sports and in the spoils of the chase. Lovers sought her, but she spurned them all, ranging the woods, and taking no thought of Cupid. Her father often said to her, "Daughter, you owe me a son-in-law; you owe me grandchildren." She, hating the thought of marriage as a crime, with her beautiful face tinged all over with blushes, threw her arms around her father's neck, and said, "Dearest father, grant me this favor, that I may always remain unmarried, like Diana." He consented, but at the same time said, "Your own face will forbid it."

Apollo loved her, and longed to obtain her; and he who gives oracles to all the world was not wise enough to look into his own fortunes. He saw her hair flung loose over her shoulders, and said, "If so charming, in disorder, what would it be if arranged?" He saw her eyes bright as stars; he saw her lips, and was not satisfied with only seeing them. He admired her hands and arms, naked to the shoulder, and whatever was hidden from view he imagined more beautiful still. He followed her; she fled, swifter than the wind, and delayed not a moment at his entreaties. "Stay," said he, "daughter of Peneus; I am not a foe. Do not fly me as a lamb flies the wolf, or a dove the hawk. It is for love I pursue you. You make me miserable, for fear you should fall and hurt yourself on these stones, and I should be the cause. Pray run slower and I will follow slower. I am no clown, no rude peasant. Jupiter is my father, and I am lord of Delphos and Tenedos, and know all things, present and future. I am the god of song and the lyre. My arrows fly true to the mark; but, alas, an arrow more fatal than mine has pierced my heart! I am the god of medicine, and know the virtues of all healing plants. Alas! I suffer a malady that no balm can cure!"

The nymph continued her flight, and left his plea half uttered. And even as she fled she charmed him. The wind blew her garments, and her unbound hair streamed loose behind her. The god grew impatient to find his wooing thrown away, and, sped by Cupid, gained upon her in the race. It was like a hound pursuing a hare, with open jaws ready to seize, while the feebler animal darts forward, slipping from the very grasp. So flew Apollo and Daphne- he on the wings of love, and she on those of fear. The pursuer is the more rapid, however, and gains upon her, and his panting breath blows upon her hair. Her strength begins to fail, and, ready to sink, she calls upon her father, the river god: "Help me, Peneus. Open the earth to enclose me, or change my form, which has brought me into this danger!" Scarcely had she spoken, when a stiffness seized all her limbs; her bosom began to be enclosed in a tender bark; her hair became leaves; her arms became branches; her foot stuck fast in the ground, as a root; her face became a tree-top, retaining nothing of its former self but its beauty, Apollo stood amazed. He touched the stem, and felt the flesh tremble under the new bark. He embraced the branches, and lavished kisses on the wood. The branches shrank from his lips. "Since you cannot be my wife," said he, "you shall assuredly be my tree. I will wear you for my crown; I will decorate with you my harp and my quiver; and when the great Roman conquerors lead up the triumphal pomp to the Capitol, you shall be woven into wreaths for their brows. And, as eternal youth is mine, you also shall be always green, and your leaf will know no decay." The nymph, now changed into a Laurel tree, bowed its head in grateful acknowledgment.

The Story of Pandora (Bullfinch)

The first woman was named Pandora. She was made in heaven, every god contributing something to perfect her. Venus gave her beauty, Mercury persuasion, Apollo music. Thus equipped, she was conveyed to earth, and presented to Epimetheus, who gladly accepted her, though cautioned by his brother to beware of Jupiter and his gifts. Epimetheus had in his house a jar, in which were kept certain noxious articles, for which, in fitting man for his new abode, he had had no occasion. Pandora was seized with an eager curiosity to know what this jar contained; and one day she slipped off the cover and looked in. Forthwith there escaped a multitude of plagues for hapless man, such as gout, rheumatism, and colic for his body, and envy, spite, and revenge for his mind,-- and scattered themselves far and wide. Pandora hastened to replace the lid; but, alas! The whole contents of the jar had escaped except one thing which lay at the bottom. That was hope. So we see at this day, whatever evils are abroad, hope never entirely leaves us; and while we have that, no amount of other ills can make us completely wretched.

Coyote Steals the Sun and Moon – Hopi

This Hopi story of Coyote and Eagle was told to explain the seasons. It can be located on *Living Myths Online* at http://www.livingmyths.com/Nativesum.htm.

Learning Experience Four

Handout Three: "The Legend of Hina"

Deep beneath the blue Hawaiian sea is a kingdom called Lalohana. In this kingdom under the ocean lived a beautiful young goddess. Her long Hawaiian name was Hina'aikamalama, but everyone just called her Hina. She lived there with her brothers who traveled here and there, but her brother, Kipapa, was supposed to stay with her and take care of her.

Kipapa had other things he wanted to do besides taking care of his sister, and one day he left her and their home under the sea and he didn't come back. Hina was lonely, but she had a wonderful 'umeki, or calabash, hidden away that was full of good things to eat such as sweet potatoes and fish. So even though she didn't starve, she grew more and more lonely there in Lalohana all by herself.

Now, Hina knew there was a world above her ocean home. She had heard tales of the people who lived there, and sometimes she saw the bottoms of their canoes and the white swish of bubbles that marked their paddles as they cut through the water over her home. She enjoyed playing games and tricks with these people, so when they lowered their fish hooks to catch a tasty aku, she'd laugh and take the nehu bait to feed the little fishes that lived around her home.

Finally, Konikonia, the chief of the fishermen, sent his men to find the sharks that stole their bait and left them with no fish to feed the village. The men returned and said that they found no sharks anywhere around those fishing grounds. So Konikonia sent for his kahuna and asked him what he should do. Hina did not fool the priest, and he told the chief the reason the fishermen could catch no fish.

Chief Konikonia began to wish to meet Hina even more than he wished for his fishermen to catch fish. He thought and thought of some way he might meet the beautiful young goddess, and finally he again called the wise kahuna to his hale to ask for advice. Again the kahuna did not let him down, and Konikonia called his men to help him with his plan to meet Hina.

Here is what he did. He ordered the carving of many, many ki'i, or small men, complete with mother-of-pearl eyes and human hair. He told his men to dive to the entrance of Hina's home at night and to place a ki'i on a string every few feet all the way up to the surface of the sea. From the surface of the sea, the ki'i continued all the way to the beach and on to the entrance of Konikonia's court. When all the ki'i were in place, the kahuna told the chief to blow his conch shell to awaken the sleeping young goddess.

When Hina heard the sound of the conch, she awoke and noticed the ki'i. She was charmed by the ki'i, and she swam along collecting the small carvings as she went up to the surface of the sea. She could not resist getting them all, and when she held the last ki'i, she was right at the entrance of Konikonia's court. She was so tired from her journey

and from the excitement of her adventure that she decided to take a little nap before she returned to her home far under the sea.

When at last she opened her eyes again, she found herself looking at ten brown toes, and she slowly looked up, up and right into the eyes of the chief himself! Konikonia hurried to comfort her, and he asked her to be his honored guest at his court. After sometime passed, Hina realized she loved the mortal chief, and they were married with much happiness and feasting and dancing throughout the village.

The young bride enjoyed her new life, but one day she found herself feeling a little sad and homesick. Konikonia asked if there were anything he could do to make her lips smile and her eyes sparkle the way he lived to see them. Hina thought and thought, and finally she requested that he send his men to drive into her kingdom to find and bring her special `umeki to her .Her wish was granted, and when she opened the lid of her beloved calabash, out floated many pieces of sweet potatoes and fish that became the moon and the stars into the night sky. She told Konikonia that as long as the moon stayed high in the sky, all was well.

Time passed happily for everyone in the village until one evening when Hina noticed the moon resting upon the sea. She knew this meant her brothers were searching for her and would come to return her to Lalohana. She also knew her brothers would come in the form of pao'o fish that travel on the tips of tsunami waves bringing great destruction to those who live on the land.

When Hina explained this sign to her husband, he commanded all his people to find safety in the mountains. Sure enough, the tidal waves hit the village and flooded the land and destroyed crops and homes, but the people of the village were safe, and later they returned to rebuild their village.

As for Hina'aikamalama, she escaped the waves and her brothers by leaping into the heavens. There she shines in the night sky in the form of the moon and the stars, watching out for the people in the Hawaiian Islands.

Adapted (by Hui Malama o Mo`omomi and the Pacific American Foundation) from: *Moonstruck* by Carol Silva, Aloha Airlines magazine. Jan/Feb 2003.

Learning Experience Four

Handout Four: Other Moon Stories

By now, you know that humans observed the phases of the moon long before scholars could explain them. As we have learned, cultures created their own explanations for these natural phenomena. You can find cultural stories about the moon in a curriculum developed by Kristi Kerns, Rebecca Williams, Hillary Henke and Beth Madison in Collaboration with Dan Flannigan and Kent Roberts of the Colville, WA School District http://education.wsu.edu/literacy/528/Preservice/Spring_2000/Kerns/Cultural_Diversity.html. The stories are:

- "The Moon Man" (Australia)
- "Handprints" (India)
- "Weaver and Cat" (Iroquois, North America)

Learning Experience Four

Handout Five: Writing Your Own Myth or Cultural Story

1. Select an event, natural phenomenon, religious belief or practice, a lesson you want to teach, or a story you want to tell about your hopes and fears.

2. Remember to think about the present as well as the past. Consider the times in which you live right now, the cultures of your family and the communities in which you live and work (school, friends, clubs, etc.). Your myth or cultural story does not have to reflect the past.

3. Gather as much information as you can about your topic. Talk to family, friends, and community members. Go to the library. Do research on the internet. Don't forget music, art, and artifacts.

4. Record all the information you gather including readings, artifacts, internet articles, and information from family and community members.

5. As you gather your research, collect words related to your topic. Use the thesaurus or dictionary to find related words that may help you think more deeply about your topic.

6. Brainstorm ideas for your myth or cultural story. Your ideas can be magical, mystical, or fantastic.

7. Use the information in Handout One to help with your brainstorming:

- Will you include super heroes or mystical creatures?
- What super powers will they possess?
- Will there be magic and/or disguises?
- Will there be some kind of transformation? (Will one of your characters be turned into a tree or mountain or???)

8. Write a first draft of your myth or cultural story.

9. Meet with a partner. Use Handout One to evaluate whether your story includes some or all of the characteristics of myths and cultural stories.

10. Revise.

Learning Experience Four

Handout Six: What Have You Learned?

Next to each of the letters below, write two or three sentences that summarize your learning about the characteristics of myths and cultural stories. Your first sentence should begin with the letter.

S	
T	
O	
R	
Y	

Notes on the Legend of Hina and Hawaiian Culture

This information is taken from the *Cycles and Hawaiian Traditions* curriculum developed by Hui Malama o Mo`omomi and the Pacific American Foundation.

Mahina, the moon, was very important to the survival of Hawaiians. To the Hawaiian people, the moon was not an astral object that was projected into the sky millions of years ago as the result of a catastrophic event. The moon, Mahina, was family. Personified, she was the goddess Hina. She gave the cycle of birth, life, death and rebirth each month-without fail. By her very nature of predictability, she was a reliable source of information that insured survival for generations upon generations. Just as lunar patterns and cycles were distinguished by nightly observations, so were correlating patterns and cycles noted in the sky, on the land and among living things on earth. Planting and fishing patterns were developed in alignment with lunar patterns that gave optimum yields. The times for resting fishing grounds or gardens were just as important and also widely known, because of the moon. Hawaiian knowledge of the moon names, functions and rhythms was a common knowledge, shared with all, because the moon was a benevolent provider of time-proven, life-giving resources and knowledge. As such, great reverence was given to the moon and chants were offered in her honor.

Hawaiian culture embraces the moon as a provider, personified as Hina, who is born, grows, dies and comes back again in birth. The moon's characteristics determine an ancient Hawaiian pattern of activity for fishing and farming practices. Students should understand the heritage of moon knowledge and the feelings of respect Hawaiian people have had for the moon and her important role for generations.

You can find additional stories and myths from many different cultures at the following websites:

- *http://teacher.scholastic.com/writewit/mff/myths.htm*
- *http://www.planetfusion.co.uk/~pignut/moonmyth1.html*
- *http://www.livingmyths.com/Nativesum.htm*
- *http://btc.montana.edu/ceres/html/MoonQuest/Quemoonresource.html#myths*

Tlingit Moon & Tide Teacher Resource: Elementary Level

Designed by Dolly Garza for the University of Alaska Seagrant
Downloadable at
http://www.ankn.uaf.edu/curriculum/Tlingit/Salmon/graphics/moonandtides.pdf
Available for purchase ($10) at
http://www.uaf.edu/seagrant/bookstore/pubs/SG-ED-33.html.

This curriculum contains learning activities about the cycles of the moon and tides in the lives of the Tlingit people of Southeast Alaska. The curriculum consists of four sets of lesson plans: An introduction to Native science and Native ways of knowing (Traditional Ecological Knowledge, or TEK); the moon in Tlingit culture; the tides in Tlingit culture

and their relationship to intertidal resources in Southeast Alaska; and Tlingit cycles of food-gathering activities following the seasonal round. The curriculum includes traditional origin stories featuring the trickster/culture hero Raven, Tlingit language lessons and art projects as well as student activities that require scientific observation, data collection, and prediction.

Originally designed to be used in Tlingit communities of Southeast Alaska, the curriculum provides a wealth of information about the ecology of the region, presented in a cultural context that combines experience, spiritual connection, and stewardship with the scientific method. It offers a unique comparative perspective for children in all coastal communities

Learning Experience Five

What I Know about the Moon and Tides

Overview: In this learning experience, students' knowledge of the science of the moon and tides is activated and assessed. The teacher has the opportunity to identify gaps in students' understanding, provide necessary information, and set a purpose for learning.

Understanding

- Natural cycles are essential to life.

Essential Questions:

- How can the scientific process, scientific tools, data, and technology help us investigate, understand, and explain the earth?
- How do constants in the environment, including natural cycles, impact the earth?

Materials:

- Chart Paper and Markers
- T-N-L-H Handout

Activity: What do I Think I Know? What do I Need to Know? What Did I Learn? How Can I Learn More?

Teacher Notes

**This activity is adapted from the K-W-L developed by Donna Ogle (1988).*

**This activity is useful for activating and assessing students' prior knowledge (T), setting the purpose(s) for learning (N), determining what has been learned (L), and identifying methods and resources for additional learning (H).*

**Students use oral language and work together and build on each other's knowledge. This promotes language and other learning.*

- The T-N-L-H Template
  - Distribute copies of Handout One, the T-N-L-H Template. You will use this template to activate students' prior knowledge, determine what they already know about the moon and tides, surface any misconceptions, set specific purposes for learning.
  - You should duplicate the template on chart paper for this activity and place it on the wall. As students learn about the moon and tides they can add information, assess their prior and developing knowledge, identify additional information they need, and identify ways to locate that information.
  - Explain the T-N-L-H Chart to students:
    - T stands for helping students recall what they THINK THEY KNOW about the topic.
    - N stands for helping students determine what they NEED to learn to complete the performance tasks.
    - L - Stands for helping students identify what they LEARNED.
    - H - Stands for HOW students we can gather additional information about the topic.
    - Categories or Kinds of Information We Expect to Use.
  - Ask individual students to fill in as much of the template as they are able (except for the Categories or Kinds of Information Box). Tell students that the purpose of the activity is to determine what they already know about the moon and tides. Remind them that this may be a new topic for them and that they might not be able to complete much of the "Think I Know" column. Encourage them to think of as many questions as possible about the moon and tides for the "Want to Learn" column.

- Next, do the T-N-L-H as a group activity. This will allow students to construct meaning together, learn from each other, be engaged, and build on each other's knowledge. As a group activity, the T-N-L-H promotes the use of oral language (critical for English Language Learners) and provides opportunities for students to learn collaboratively.
- As a follow-up, students can complete the section of the template "Categories or Kinds of Information We Expect to Use." This will allow you to assess students' understanding of the T-N-L-H activity.

Moon and Tides T-N-L-H Template

What Do We Think We Know about the Moon and Tides?	What Do We Need to Learn to Complete the Performances?	What Did We Learn?	How Can We Learn More? What Resources are Available?
Categories or Kinds of Information We Expect to Use:			

The T-N-L-H teaching technique was developed in 1986 by Donna Ogle and adapted from the template in The Strategic Teaching and Reading Project Guidebook. *(NCREL, 1995, rev. ed.).*

Learning Experience Six

The Phases of the Moon

Overview: In this Learning Experience, students make observations of the moon and record their observations over a one month period. Based on their observations, students draw conclusions and make predictions about the patterns and changes in the moon over a month. The teacher can choose one of two activities. 1) The first, the Moon Journal, is a month-long activity in which students actually conduct daily observations of the moon, record the data, and reflect on their observations in a journal. This activity is included in the *Cycles and Hawaiian Traditions* curriculum developed by Hui Malama o Mo'omomi and the Pacific American Foundation. It is also widely used by teachers in middle and high school, as well as undergraduate and graduate programs-both for teaching about the moon and to promote written reflection. 2) The second activity, the Birthday Moon Calendar and Journal, takes two class periods and utilizes the Internet rather than actual observations.

- **Moon Journal Activity**: Students keep a moon journal. This lesson takes one month with a daily five minute data observation check. Other lessons can be done simultaneously while students are working on their moon journals.

- **Birthday Moon Calendar and Journal**: Students will create a calendar that depicts the phases of the moon in the month following their actual birth date. This lesson takes approximately two 50-minute class periods.

Understandings

- There are predictable and observable patterns and cycles in nature that impact the earth.
- Understanding involves generating ideas and questions, posing problems, gathering evidence from multiple sources, and using scientific processes.

Essential Questions:

- What are some critical and recurring questions about nature that have confronted people in the past and present?
- How and when can we use our knowledge of the phases of the moon and the cycles of the tides?
- What skills and processes do scientists use to investigate a question?

Evaluation

- Create a journal of the moon or a moon calendar

Activity One: Moon Journal

Materials:

- Journals or Notebooks
- Handout One: Journal of the Moon Directions

Teacher Notes

**This hands-on activity was developed by Eleanor Duckworth and is used widely as a tool for helping students learn about the phases of the moon.*

**Students gather data using observation skills, they use writing as a tool for learning.*

**Group learning and discussion provide opportunities for all students to learn content and Language.*

**The teacher and students process and summarize which allows the teacher to check that all students understand the expectations.*

- Distribute the journals and explain that students will keep a journal of the moon over a one-month period. Distribute Handout One, which provides the guidelines for the journal.
- Review the guidelines with students.
- Provide students with an example of what they are to do for their moon journal. On chart paper, draw a picture of the moon as it will appear to students at their first observation (that evening). You can get this information from an almanac, the local newspaper, or from an internet website such as *http://stardate.org/nightsky/moon/.* Ask students to write down a description of what they see in your drawing. Ask: "What do you see?" Record answers on chart paper. Ask: "What shape is the moon?" Write students' responses. Ask: "What questions do you have?" Record their questions on the chart paper. Remind students that they are to answer all the questions on the guidelines: "What did you see? What shape is the moon? Where is the moon located in the sky? What questions do you have? What are you learning about the phases of the moon?" You will share these ideas with your classmates.
- Examples of journal entries can be found on the Annenberg Website: *http://www.learner.org/channel/workshops/lala/moonjsample.html#observe*.
- After the first observation (at the next class), place students in groups of 4. Ask students to share their observations with each other in their small groups. Ask students to take notes as you will call on one person from each group to summarize what has been said. While students are discussing, you should check their individual journals and listen to their discussions - check for understanding.
- After the discussion, process the activity with the class. Go through each question, asking each student to summarize for the group. Record their responses. This will take time but will ensure that they all have a model for the expectations for the assignment.

Activity Two: Birthday Moon Calendar and Journal

Materials:

- Handout One: Moon Calendar
- Handout Two: Moon Calendar Directions

Teacher Notes

**This activity allows students to chart the phases of the moon in one or two days (rather than the month required by the Journal of the Moon.*

**Students write to learn.*

- The journal of the moon requires a month to complete. As an alternative, if your students have access to the internet, they can create a Birthday Moon Chart.
- Students should refer to *http://stardate.org/nightsky/moon/*. On this website, they can enter the month and year of their birth. They will find the phases of the moon displayed on a moon calendar. Another useful URL can be found at *http://tycho.usno.navy.mil/vphase.html*.
- Give students a blank moon calendar (Handout Two). Ask them to draw the moon on their birth date in the first box. Then, in their journals, they will answer the questions. "What do you see? What shape is the moon?"
- Ask students to complete the moon calendar (Handout Two). They should copy the visual representation of the moon on their calendar for 29 days.
- Ask students to observe the changes in the moons they are drawing and to record their observations in their journals. "What do you see? What shape is the moon? How is the moon changing? Is it growing larger or getting smaller?" At a minimum, they should reflect after copying three moons.
- After students have completed their birthday moon calendars and journal writing, place them in groups of four. Ask students to compare and contrast their calendars and to answer the following questions:
    - How does the moon change over time?
    - What are the different shapes you see in the moon?
    - Does the moon actually grow smaller or larger?

Notes to the Teacher

Notes on the Journal of the Moon Activity

The "Journal of the Moon" activity was developed by Eleanor Duckworth at the Harvard Graduate School of Education. Duckworth requires that her graduate students keep journals of the moon as they learn about constructivist approaches to teaching and learning. Complete directions and examples of moon journals can be found on the following Annenberg Website:

http://www.learner.org/channel/workshops/lala/moonjinstruct.html

Introduction

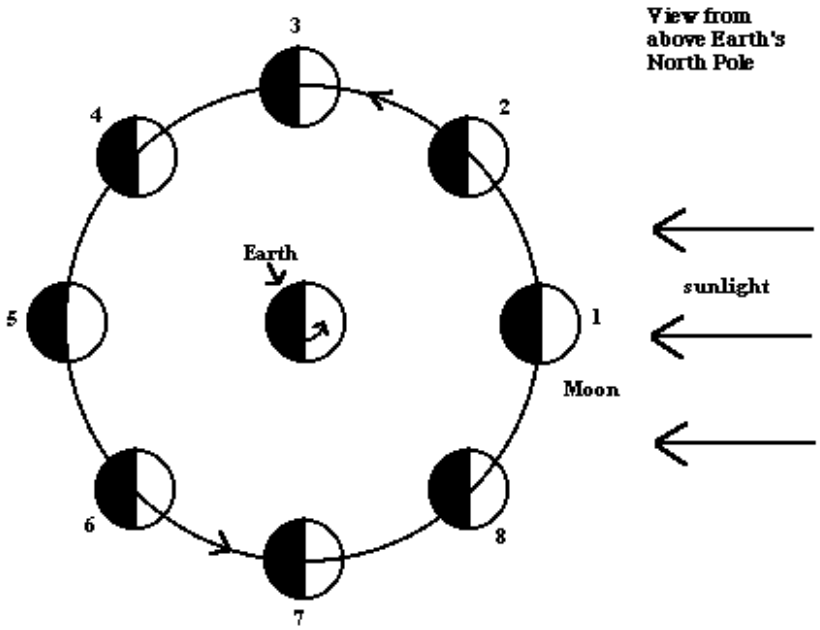
The natural environment is both constant and changing. The constancy can be seen in the cycles of the moon and tides, the seasons, and the life cycles of various living creatures. The changes that occur in the natural environment are the result of the cycles of nature along with the intervention of people and their technology. In this lesson, we look at one of the constants-the phases of the moon. We observe and gather data about the moon and use these data to predict the patterns and phases of the moon in the next month and the month after that. In subsequent learning experiences we will examine the relationship between the phases of the moon and the tides, and living creatures.

The Moon

As Earth's only natural satellite (a heavenly body orbiting another of larger size), the Moon has long been an object of fascination and confusion. Over the course of a 29-day cycle, the Moon shows us many different "faces". These different "faces" are called phases and they are the result of the way the Sun lights the Moon's surface as it orbits Earth. The Moon can only be seen as a result of the Sun's light reflecting off it. It does not produce any light of its own.

The moon orbits the earth. Look at the picture of the moon orbiting the earth. The direction of the sunlight will show which part of the earth and moon are bright. Look at when the earth is between the moon and sun. The sun's light is fully reflected on the surface of the moon facing the earth. That is when we see a full moon. Now look at when the moon is between the earth and the sun. That is when we see little or no moon because there is no light reflected on the side facing us.

Phases of the Moon as It Orbits Around Earth



Phases of the Moon as It Orbits Around Earth

http://images.google.com/imgres?imgurl=http://starchild.gsfc.nasa.gov/docs/StarChild/teachers/moonglow2.gif&imgrefurl=http://starchild.gsfc.nasa.gov/docs/StarChild/teachers/moonglow2.html&h=328&w=445&sz=5&hl=en&start=1&tbnid=pKnyT2f5q4mZlM:&tbnh=91&tbnw=124&prev=/images%3Fq%3Dphases%2Bof%2Bthe%2Bmoon%2Bas%2Bit%2Borbits%2Baround%2Bearth%26svnum%3D10%26hl%3Den%26lr%3D%26rls%3DGWYC,GWYC:2006-13,GWYC:en%26sa%3DN

Accessed June 30, 2006 from nasa.gov

Learning Experience Six

Handout One: Journal of the Moon Directions*

1. Choose a place that you will go to for your daily observations. You should choose a place where you face south and have a clear view of the eastern and western skies.
2. Choose a time to do your observations each day. Your teacher will use an almanac or the local newspaper to tell you the times that the moon rises and sets. Remember that if there are cloudy conditions, you may not be able to see the moon.
3. Begin your observations.
4. For each observation, you will use a page of your journal. Write down the date and time. Draw the moon as you see it. You should also write down a few ideas that you have. What did you see? What shape is the moon? Where is the moon located in the sky? What questions do you have? What are you learning about the phases of the moon? You will share these ideas with your classmates.
5. As you keep your journal, you should be thinking about the following questions:
    a. Does the moon change sizes?
    b. What are the phases of the moon?
    c. What do your observations tell you about the relationship of the earth, moon, and sun?

* Adapted from *http://www.learner.org/channel/workshops/lala/moonjinstruct.html*

Handout Two: Moon Calendar: Month _____

Your Birth Date						

Learning Experience Six

Handout Three: Moon Calendar Directions

1. Go to *http://stardate.org/nightsky/moon/*
2. Enter the month and year of your birth.
3. Locate the representation of the moon on the day of your birthday.
4. On your Moon Calendar, place the picture of your birthday moon in the first block. Also put the date.
5. In your Moon Journal, write your observations about the moon on your birthday. What do you see? What shape is the moon?
6. Copy the pictures of the moon for the next three days following your birthday.
7. In your Moon Journal, answer the following questions:
    a. What do you see?
    b. How is the moon changing?
    c. What shape is the moon?
8. Repeat this process for a full 29 days. Copy the picture of the moon for three days. Then answer the questions:
    a. What do you see?
    b. How is the moon changing?
    c. What shape is the moon?
9. After you have copied the moon for 29 days, look at your completed Moon Calendar and write answers to the following questions in your journal:
    a. What do you see over 29 days?
    b. How does the moon change as it moves through the cycle?
    c. What shapes does the moon take?
    d. What have you discovered about the phases of the moon?

Learning Experience Seven

The Moon, Sun, and Earth

Overview: This learning experience gives students a visual reference to the sun's reflection on the moon and helps explain, from a scientific perspective, why it looks the way it does in the sky. Scientific terms for the phases of the moon are introduced. This lesson was adapted from the curriculum by Hui Malama o Mo`omomi and the Pacific American Foundation.

Understandings

- Understanding involves generating ideas and questions, posing problems, gathering evidence from multiple sources, and using scientific processes.
- There are predictable and observable patterns and cycles in nature that impact the earth.

Essential Questions

- How and why does the appearance of the moon change over the course of a month?
- How and when can we use our knowledge of the phases of the moon and the cycles of the tides?
- What are natural cycles and how are they essential to life?
- What skills and processes do scientists use to investigate a question?

Evaluation

- Create a visual representation of the moon and name the phases

Activity One: Setting a Purpose for Learning

Teacher Notes
**Students understand where they are going and why (the lesson objectives)*

**Ongoing assessment as the teacher checks for understanding*

- The purpose of this activity is to give students the lesson objectives and to assess their prior knowledge.
- Reflective Journal: Ask students to write what they think they know about each of the following questions in their reflective journals. As students write their responses, circulate and check for understanding:
    - Why does the moon seem to change in shape each month?
    - Why is the moon bright on some nights and dark on others?
    - What does the moon look like when it is between the earth and the sun?

- What does the moon look like when the earth is between the moon and sun?
- Is there a "dark side of the moon?"
- What is the farside of the moon?

Activity Two: Reflection on the Moon

This activity provides students with a physical demonstration of the way light from the sun is reflected onto the moon's surface. This will help them visualize and conceptualize the movement, placement, and cycles of the heavenly bodies.

Materials:

- Two smooth spheres or balls of different sizes
- A flashlight or bright lamp
- Handout One

Teacher Notes

**Hands-on, active learning*

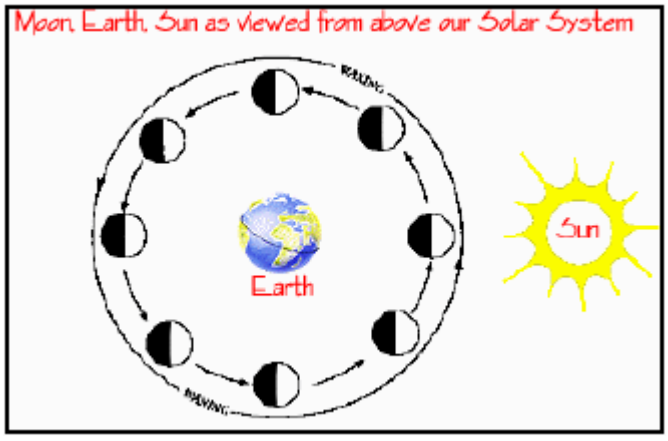
**Ongoing assessment as the teacher checks for understanding*

- Designate the light source as the sun, the larger of the two balls or spheres as the earth, and the smaller ball as the moon.
- Have students hold up the spheres and demonstrate the orbit of the moon around the earth at quarterly intervals. Observe the amount of sunlight reflected on the visible part of the moon. Remember to have the same side of the moon sphere face the sun at all times (The Moon orbits the Earth. As it does so, the Moon also rotates on its own axis-once per orbit. We, on Earth, only see one side of the Moon-the *nearside*. The side we never see is called the *farside*.)

Activity Three: NASA Lesson on the Moon's Phases (You can find the following activity at *http://www.nasaexplores.com/show_58_teacher_st.php?id=04081090515*

Materials:

- Lamp with at least a 60-watt bulb
- Large ball that reflects light
- One volunteer



Procedure: Over the course of a 29-day cycle, the Moon shows us many different "faces". These different "faces" are called phases and they are the result of the way the Sun lights the Moon's surface as the Moon orbits Earth. The Moon can only be seen as a result of the Sun's light reflecting off it. It does not produce any light of its own. This demonstration will illustrate why the Moon has so many different looks within that 29-day period known as the lunar cycle.

Teacher Notes

**Active, hands-on learning*

**Students learn about the moon's phases through physical movement*

**Teacher instruction: As students do this activity, the teacher provides ongoing instruction, questioning, checking for understanding*

** Ongoing discussion will allow students to explain their learning, surface misconceptions*

** At the end of each demonstration, students should explain orally or in writing*

- Put a lamp in the middle of the room. After the lamp has been turned on, darken all other lights. The lamp represents the Sun while the ball represents the Moon and the volunteer represents the Earth. Only the volunteer can see the intended results of this demonstration, so each student will have to take a turn in order to understand the phases of the Moon.
- Earth will face the Sun holding the Moon in the left hand. The Moon should be in front at arm's length and elevated slightly overhead. (Make sure the students understand that it is because of the Moon's slightly inclined orbit around Earth that we usually see a full Moon when the Earth is between the Sun and the Moon.)
- Notice that the lamp has lit up the side of the Moon away from Earth. No one on Earth can see the lit side at this point. This is a New Moon and it occurs when the Moon is between the Sun and Earth.
- While Earth is still facing toward the Sun, hold the left arm straight out to the side. People on Earth will now be able to see half of the Moon's lit side. Because the Moon has now revolved one-quarter of the way around Earth, this phase is referred to as a First-Quarter Moon. A First-Quarter Moon occurs approximately one week after a new Moon. Have the students carefully notice which half of the Moon is lit during a First-Quarter Moon.
- For the next phase, Earth's back should be to the Sun. The Moon should be held out straight in front of Earth, still slightly elevated. Earth can now see the full-lit face of the Moon. This phase is a Full Moon. The Moon has now completed half of its revolution around Earth.
- Before moving Earth into the next position place the Moon in the right hand. Now Earth should move the right arm into a position straight out to the side. Once again only half of the Moon is lit. Have the students carefully note which half is lit. This is the phase known as a Third-Quarter Moon. The Moon has now completed three-quarters of its revolution around Earth. This "face" appears approximately three weeks after a new Moon.
- To complete the demonstration, have Earth once again face the Sun. The Moon should be held straight out in front of Earth,

again showing the darkened side facing Earth. The lunar cycle now starts over again. The demonstration has concluded.

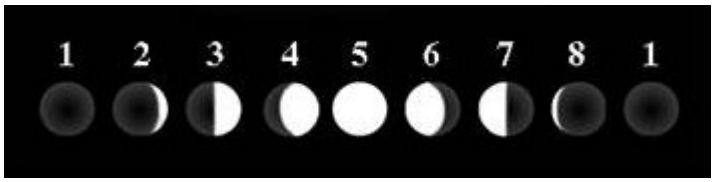
Notes for Teachers: The Phases of the Moon

The phases of the Moon are explained very clearly on the excellent website below:

http://home.hiwaay.net/~krcool/Astro/moon/moonphase/

The following is adapted for teachers who may not have internet access.

The Moon doesn't give off any light; it reflects the light of the Sun. As the Moon revolves around the Earth, it appears to change shape in the sky. This is caused by the different angles from which we see the Sun's reflection off the Moon's surface. The Moon's changes in shape are called the "phases" of the Moon. There are eight major phases that occur every 29.5 days. These phases always follow one another in the same order. The phases indicate both the extent to which the Moon is illuminated and the appearance of the illuminated part. These phases of the Moon are listed below.



(1) **New Moon** – The illuminated hemisphere is facing away from the Earth, and the part that faces us is all dark.

(2) **Waxing Crescent Moon** - As the Moon moves around the Earth, we get to see a little of the illuminated half. The Moon is growing or waxing. At first we get a sliver of it, which grows as days go by. This phase is called the crescent moon.

(3) **Quarter Moon** - A week after the new moon, when the Moon has completed about a quarter of its turn around the Earth, we can see half of the illuminated part.

(4) **Waxing Gibbous Moon** - During the next week, we see more and more of the illuminated part of the Moon, and it is now called waxing gibbous.

(5) **Full Moon** - Two weeks after the new moon, the illuminated hemisphere faces the earth and we can see the complete disk. If the Moon happens to align exactly with the Earth and Sun, then we get a lunar eclipse.

(6) **Waning Gibbous Moon** - From now on, until it becomes new again, the illuminated part of the Moon that we can see decreases, and we say it's waning. The first week after full, it is called waning gibbous.

(7) **Last Quarter Moon** - Three weeks after new, we again can see half of the illuminated part.

(8) **Waning Crescent Moon -** Finally, during the fourth week, the Moon is reduced to a thin sliver from us, sometimes called waning crescent. This is followed by the New Moon.

The Nearside and Farside of the Moon: The Moon orbits the Earth. As it does so, the Moon also rotates on its own axis-once per orbit. We, on Earth, only see one side of the Moon-the *nearside*. The side we never see is called the *farside*.

The Dark Side of the Moon: The phrase "dark side of the Moon" usually refers to the side of the Moon that we cannot see from the Earth. There is also a bright side of the Moon that is illuminated by the sun's reflection. The bright side (and therefore the dark side too) is not a fixed place, but appears to move as the Moon revolves around the Earth.

The rotation of the moon is synchronized with that of the earth. The side facing us is always facing us.

Learning Experience Eight

The Moon and the Tides

Overview : In this lesson, which is adapted from the *Cycles and Hawaiian Traditions* curriculum developed by Hui Malama o Mo`omomi and the Pacific American Foundation, students will recognize the gravitational effect of the moon on the Earth as they explore the reasons why we have tidal movements, and how those movements can be measured and predicted. A class mural of a beach landmark helps students visualize the ebbing and flooding of the tides.

Understandings

- The environment can be understood from both scientific and cultural perspectives.
- Understanding involves generating ideas and questions, posing problems, gathering evidence from multiple sources, and using scientific processes.
- There are predictable and observable patterns and cycles in nature that impact the earth.

Essential Questions

- How and when can we use our knowledge of the phases of the moon and the cycles of the tides?
- What are natural cycles and how are they essential to life?
- What skills and processes do scientists use to investigate a question?

Evaluation

Students first create a mural that captures the tidal zones and includes organisms that inhabit those zones. Then, the mural is expanded to include a record of the tides. They compare and contrast the tides as they relate to the moon's gravitational pull.

Materials:

- Chart Paper or White Board and Markers
- Handouts
- Local Tide Calendar
- Camera
- Large Colored Pins
- Class Mural: Paper Covered Bulletin Board
- Paint and Brushes
- Photos of Place at High and Low Tides
- Information:
- Check newspapers, television, or websites for local tide information

Activity One: Probable Passages

Teacher Notes

**Writing to learn*

**Students reveal what they already know*

**Teacher assesses students' understanding and differentiates instruction based on assessment*

- This activity provides an opportunity for the teacher and students to assess their current level of knowledge and make predictions about what they will be studying. They will revise their predictions at the end of the learning experience.
- Place the following questions on chart paper. Ask students to answer these questions, as best they can, in their Reflective Journals. Emphasize that the purpose of the activity is for you to learn what students already know.
    - What is gravity?
    - Does the sun or the moon have a stronger pull on the Earth? Why?
    - What causes high tide?
    - What causes low tide?
- Collect and review students' Reflective Journals.
- Students will read a selection (Handout One) on "The Moon and Tides." Before they read the selection, review their journal responses to assess their current level of knowledge. In addition, compare and contrast the information in the text with what students already know. What does the text assume that students know? What do students know? What misconceptions do they hold? What do you need to teach before students read the text? How will you teach it? See "**Notes to Teachers**" which contains links and information about the moon and tides from a variety of websites, including one by NOAA.

Activity Two: Observing the Tides

Teacher Notes

** Hands-on, active learning for students who live near the shoreline*

**If you do not live near the shoreline, use books or internet resources to complete this activity. For example, googling "shoreline habitat" and "Washington State" resulted in the following, either of which can be used as a substitute for the actual shoreline experience:*

http://brinnininfo.com/shoreline.htm and http://www.ecy.wa.gov/programs/sea/pugetsound/species/salmon.html

- Students can observe and chart the tides if they are close to the shoreline. Ideally, students should make daily visits to the beach (either the whole class at a time, or in staggered groups). Alternate ways of making tidal observations can be used if you and your students do not have access to the beach (see teacher notes). However, at least one trip to the beach would be best for establishing a visual point of reference for future classroom chartings.
- Establishing a place of reference:
  <u>If you want to choose a landmark from your own area: (A trip to the beach)</u>
  - Take a trip to a beach and look for one area that has distinguishing characteristics at low and high tides. Photograph a rock pile, beach walls, boat ramps, wooden pilings, the edges of a marsh or marsh vegetation, the edges of coral reefs, or even a pier at high and low tides. A landmark is a good spot by which you can measure the tides. If there is only sand, try photographing the area at high and low tides to show changes in the amount of exposed sandy area during low tide. This will be the subject of a class mural the students will create to show the ebbing and flooding of the tides.
  - Students should observe, photograph and do research about species that live in the various tidal zones.
  - You might try to find the high tide or "wrack line" of flotsam and jetsam and algae stain on the rocks. Above the wrack line might include insects in the sand, broken shell parts, crab or clam bodies, and land plants.
  - Look in the intertidal area (between high and low tide) for snails, crabs, barnacles, and other creatures such as seaweeds, mollusks, mussels that might be hiding under the rocks,
  - Look in the sub-tidal area for starfish or other small creatures in the pools. Look for eel grass in the intertidal and sub-tidal areas.
  - Photograph or draw the creatures.
  - Use a tide calendar or the daily paper to be sure you know the hour of the high and low tides for your pictures. Take several pictures of your landmark to get a good array to choose from. Keep a count of the photos so you can label each picture with the time it was taken. Also, try to wait for a lull or calm moment in which to get the most accurate sea level estimate.

Activity Three: Creating a Mural

Teacher Notes

**Hands-on, active learning*

**Includes observation, data gathering, and plotting*

**Explicit instruction by the teacher*

- **Paint the Mural that reflects the flowing and ebbing of the tide.** Identify, draw, and color organisms on that live in the various tidal zones on the mural. The mural will help your students visualize the wavy lines and positive or negative numbers in the tide calendar.
- Allow room on one side of the mural to mark tide levels relative to landmarks.
- **Labeling the Tidewater Zones:** From your photos labeled with the given hour and minute, estimate and mark these zone marks on your mural.
- **Explain** to students that people who study tides use a stick on which they mark the sea level at a given time. For safety's sake you will use photographs, which won't be completely accurate because the ocean is in constant flux, but will give students a satisfactory sea level indicator. Teachers will have to identify normal high, mid, low, and sub-tide zones for their areas. This varies by state and region. For example, in Hawai`i there are usually only a few feet between high and low tide, in Massachusetts there are several feet between the two.

    - Spray Zone (the area that remains above water except during the most extreme high tides
    - High Tide Zone
    - Mid Tide Zone
    - Low Tide Zone
    - Sub tide Zone (the area that remains underwater except during the most extreme low tides)

Activity Four: Using a Tide Calendar with the Mural

Teacher Notes

**Hands-on, active learning*

**Includes compare and contrast thinking and use of graphic organizers.*

** Students plot data*

**Explicit instruction on compare and contrast by the teacher*

- Staple a long piece of yarn or string from the top to the bottom of the mural at the farthest left hand side. At the top, label it with today's date.
- Look at today's date on the tide calendar.
- Choose the hours for which you would like to keep a daily record. Three or four selections are sufficient. Designate a push pin color to indicate the hour. (Example: Red –6AM, Blue 12 Noon, etc.)
- Students can record the tides on the mural. Do this activity for one week. Make comparisons and contrasts. Use a Venn Diagram or Double Bubble. Discuss findings.
- Question students: Look at the tide calendar. Given what you know about the moon's gravitational pull, what do you notice about the tides?

Activity Five: The Moon and the Tides

Teacher Notes

**Differentiated instruction*

**Check for understanding.*

** Students plot data*

**Explicit additional instruction when required*

- You have read students' answers to the questions in Activity One. Some students may have a lot of knowledge about the moon and tides; some may need a great deal of instruction.
- Differentiate instruction. Place students in homogeneous groups. Students who have a lot of knowledge about the moon and tides can read selections from the "Notes to Teachers." They can work together to answer the questions. Students who need more explicit instruction, should read "The Moon and Tides" (Handout One) with the teacher.
- Check for understanding. Students return to their Probable Passages (Activity One). They will rewrite their answers to the questions. The teacher will review their responses, check for understanding and provide additional instruction where necessary.

Notes for Teachers and Readings for Students

1. The images and information on the following website will help you understand the tides and how the Earth spins under the tidal bulge:

http://images.google.com/imgres?imgurl=http://physics.bgsu.edu/~layden/Anim/Tides/GIFs/tide00.gif&imgrefurl=http://physics.bgsu.edu/~layden/Anim/Tides/tX.htm&h=378&w=468&sz=5&tbnid=O4cjayO-xz4J:&tbnh=100&tbnw=125&hl=en&start=89&prev=/images%3Fq%3Dmoon%2Band%2Btides%26start%3D80%26svnum%3D10%26hl%3Den%26hs%3DkQ5%26lr%3D%26client%3Dfirefox-a%26rls%3Dorg.mozilla:en-US:official_s%26sa%3DN

2. You will find valuable information and lessons about the moon and tides on the following websites:
http://www.nos.noaa.gov/education/kits/tides/welcome.html.
http://www.nos.noaa.gov/education/kits/tides/lessons/tides_upsanddowns.pdf
http://www.physicalgeography.net/fundamentals/8r.html

This information will help you provide accurate and important information to students about the moon and tides.

The information that appears on the NOAA.GOV website (http://www.oceanservice.noaa.gov/education/kits/tides/tides01_intro.html) is provided below for teachers who do not have internet access. The following information has been copied directly from the NOAA.GOV website for teachers who do not have access to the internet.

3. What are Tides?

(For a visual representation, see the animated image under procedure 2 on: *http://www.teachnet-lab.org/ps101/bglasgold/lesson4tides.htm.*

Tides are one of the most reliable phenomena in the world. As the sun rises in the east and the stars come out at night, we are confident that the ocean waters will regularly rise and fall along our shores. Basically, tides are very long-period waves that move through the oceans in response to the forces exerted by the moon and sun. Tides originate in the oceans and progress toward the coastlines where they appear as the regular rise and fall of the sea surface. When the highest part, or crest, of the wave reaches a particular location, high tide occurs; low tide corresponds to the lowest part of the wave, or its trough. The difference in height between the high tide and the low tide is called the tidal range.

A horizontal movement of water often accompanies the rising and falling of the tide. This is called the tidal current. The incoming tide along the coast and into the bays and estuaries is called a flood current; the outgoing tide is called an ebb current. The strongest flood and ebb currents usually occur before or near the time of the high and low tides. The weakest currents occur between the flood and ebb currents and are called slack tides.

In the open ocean, tidal currents are relatively weak. Near estuary entrances, narrow straits and inlets, the speed of tidal currents can reach up to several kilometers per hour (Ross, D.A., 1995).

4. What Causes Tides?

Gravity is one major force that creates tides. In 1687, Sir Isaac Newton explained that ocean tides result from the gravitational attraction of the sun and moon on the oceans of the Earth (Sumich, J.L., 1996).

Newton's law of universal gravitation states that the gravitational attraction between two bodies is directly proportional to their masses, and inversely proportional to the square of the distance between the bodies (Sumich, J.L., 1996; Thurman, H.V., 1994). Therefore, the greater the mass of the objects and the closer they are to each other, the greater the gravitational attraction between them (Ross, D.A. 1995).

Tidal forces are based on the gravitational attractive force. With regard to tidal forces on the Earth, the distance between two objects usually is more critical than their masses. Tidal generating forces vary inversely as the cube of the distance from the tide generating object. Gravitational attractive forces only vary inversely to the square of the distance between the objects (Thurman, H.V., 1994). The effect of distance on tidal forces is seen in the relationship between the sun, the moon, and the Earth's waters.

Our sun is 27 million times larger than our moon. Based on its mass, the sun's gravitational attraction to the Earth is more than 177 times greater than that of the moon to the Earth. If tidal forces were based solely on comparative masses, the sun should have a tide-generating force that is 27 million times greater than that of the moon. However, the sun is 390 times further from the Earth than is the moon. Thus, its tide-generating force is about 59 million times less than the moon. Because of these conditions, the sun's tide-generating force is about half that of the moon (Thurman, H.V., 1994).

5. Gravity, Inertia, and Bulges

Gravity is only one of the major forces responsible for creating tides. Another is inertia, which is the force that acts to counterbalance gravity. It is the tendency of moving objects to continue moving in a straight line. Together, gravity and inertia are responsible for the creation of two major tidal bulges on the Earth (Ross, D.A., 1995).

The gravitational attraction between the Earth and the moon is strongest on the side of the Earth that happens to be facing the moon, simply because it is closer. This attraction causes the water on this "near side" of Earth to be pulled toward the moon. As gravitational force acts to draw the water closer to the moon, inertial force attempts to keep the water in place. But the gravitational force exceeds it and the water is pulled toward the moon, causing a "bulge" of water on the near side toward the moon (Ross, D.A., 1995).

On the opposite side of the Earth, or the "farside," the gravitational attraction of the moon is less because it is farther away. Here, the inertial force exceeds the gravitational force, and the water tries to keep going in a straight line, moving away from the Earth, also forming a bulge (Ross, D.A., 1995).

In this way the combination of gravity and inertia create two bulges of water. One forms where the Earth and moon are closest, and the other forms where they are furthest apart. Over the rest of the globe the two forces are in relative balance. Because water is fluid, the two bulges stay aligned with the moon as the Earth rotates (Ross, D.A., 1995).

The sun also plays a major role, affecting the size and position of the two tidal bulges. The interaction of the forces generated by the moon and the sun can be quite complex. As this is an introduction to the subject of tides and water levels we will focus most of our attention on the effects of the stronger celestial influence, the moon.

6. Changing Angles, Changing Tides

As indicated above, the Earth's two tidal bulges are aligned with the positions of the moon and the sun. Over time, the positions of these celestial bodies change relative to the Earth's equator. The changes in their relative positions have a direct effect on daily tidal heights and tidal current intensity.

As the moon revolves around the Earth, its angle increases and decreases in relation to the equator. This is known as its declination. The two tidal bulges track the changes in lunar declination, also increasing or decreasing their angles to the equator. Similarly, the sun's relative position to the equator changes over the course of a year as the Earth rotates around it. The sun's declination affects the seasons as well as the tides. During the vernal and autumnal equinoxes—March 21 and September 23, respectively—the sun is at its minimum declination because it is positioned directly above the equator. On June 21 and December 22—the summer and winter solstices, respectively—the sun is at its maximum declination, that is, its largest angle to the equator (Sumich, J.L., 1996).

7. Frequency of Tides: The Lunar Day

Most coastal areas, with some exceptions, experience two high tides and two low tides every lunar day (Ross, D.A., 1995). Almost everyone is familiar with the concept of a 24-hour solar day, which is the time that it takes for a specific site on the Earth to rotate from an exact point under the sun to the same point under the sun. Similarly, a lunar day is the time it takes for a specific site on the Earth to rotate from an exact point under the moon to the same point under the moon. Unlike a solar day, however, a lunar day is 24 hours and 50 minutes. The lunar day is 50 minutes longer than a solar day because the moon revolves around the Earth in the same direction that the Earth rotates around its axis. So, it takes the Earth an extra 50 minutes to "catch up" to the moon (Sumich, J.L., 1996; Thurman, H.V., 1994).

Because the Earth rotates through two tidal bulges every lunar day, coastal areas

experience two high and two low tides every 24 hours and 50 minutes. High tides occur 12 hours and 25 minutes apart. It takes six hours and 12.5 minutes for the water at the shore to go from high to low, or from low to high.

8. Tidal Variations - The Influence of Position and Distance

The moon is a major influence on the Earth's tides, but the sun also generates considerable tidal forces. Solar tides are about half as large as lunar tides and are expressed as a variation of lunar tidal patterns, not as a separate set of tides. When the sun, moon, and Earth are in alignment (at the time of the new or full moon), the solar tide has an additive effect on the lunar tide, creating extra-high high tides, and very low, low tides—both commonly called spring tides. One week later, when the sun and moon are at right angles to each other, the solar tide partially cancels out the lunar tide and produces moderate tides known as neap tides. During each lunar month, two sets of spring tides and two sets of neap tides occur (Sumich, J.L., 1996).

Just as the angles of the sun, moon and Earth affect tidal heights over the course of a lunar month, so do their distances to one another. Because the moon follows an elliptical path around the Earth, the distance between them varies by about 31,000 miles over the course of a month. Once a month, when the moon is closest to the Earth (at perigee), tide-generating forces are higher than usual, producing above-average ranges in the tides. About two weeks later, when the moon is farthest from the Earth (at apogee), the lunar tide-raising force is smaller, and the tidal ranges are less than average. A similar situation occurs between the Earth and the sun. When the Earth is closest to the sun (perihelion), which occurs about January 2 of each calendar year, the tidal ranges are enhanced. When the Earth is furthest from the sun (aphelion), around July 2, the tidal ranges are reduced (Sumich, J.L., 1996; Thurman, H.V., 1994).

9. Tidal Variations - The Influence of Position and Distance

If the Earth were a perfect sphere without large continents, all areas on the planet would experience two equally proportioned high and low tides every lunar day. The large continents on the planet, however, block the westward passage of the tidal bulges as the Earth rotates. Unable to move freely around the globe, these tides establish complex patterns within each ocean basin that often differ greatly from tidal patterns of adjacent ocean basins or other regions of the same ocean basin (Sumich, J.L., 1996).

Three basic tidal patterns occur along the Earth's major shorelines. In general, most areas have two high tides and two low tides each day. When the two highs and the two lows are about the same height, the pattern is called a semi-daily or semidiurnal tide. If the high and low tides differ in height, the pattern is called a mixed semidiurnal tide. Some areas, such as the Gulf of Mexico, have only one high and one low tide each day. This is called a diurnal tide. The U.S. West Coast tends to have mixed semidiurnal tides, whereas a semidiurnal pattern is more typical of the East Coast (Sumich, J.L., 1996; Thurman, H.V., 1994; Ross, D.A., 1995)

10. What Else Affects Tides?

The relative distances and positions of the sun, moon and Earth all affect the size and magnitude of the Earth's two tidal bulges. At a smaller scale, the magnitude of tides can be strongly influenced by the shape of the shoreline. When oceanic tidal bulges hit wide continental margins, the height of the tides can be magnified. Conversely, mid-oceanic islands not near continental margins typically experience very small tides of one meter or less (Thurman, H.V., 1994).

The shape of bays and estuaries also can magnify the intensity of tides. Funnel-shaped bays in particular can dramatically alter tidal magnitude. The Bay of Fundy in Nova Scotia is the classic example of this effect, and has the highest tides in the world—over 15 meters (Thurman, H.V., 1994). Narrow inlets and shallow water also tend to dissipate incoming tides. Inland bays such as Laguna Madre, Texas, and Pamlico Sound, North Carolina, have areas classified as non-tidal even though they have ocean inlets. In estuaries with strong tidal rivers, such as the Delaware River and Columbia River, powerful seasonal river flows in the spring can severely alter or mask the incoming tide.

Local wind and weather patterns also can affect tides. Strong offshore winds can move water away from coastlines, exaggerating low tide exposures. Onshore winds may act to pile up water onto the shoreline, virtually eliminating low tide exposures. High-pressure systems can depress sea levels, leading to clear sunny days with exceptionally low tides. Conversely, low-pressure systems that contribute to cloudy, rainy conditions typically are associated with tides than are much higher than predicted.

11. Monitoring the Tides

Predicting tides has always been important to people who look to the sea for their livelihood. Commercial and recreational fishermen use their knowledge of the tides and tidal currents to help them improve their catches. Depending on the species and water depth in a particular area, fish may concentrate during ebb or flood tidal currents. In some areas, strong tidal currents concentrate bait and smaller fish, attracting larger fish. In addition, knowledge of the tides has also been of interest to recreational beachgoers and surfers.

Navigating ships through shallow water ports, intra-coastal waterways and estuaries requires knowledge of the time and height of the tides as well as the speed and direction of the tidal currents. This was particularly critical to sailing ships because they had to take advantage of the tides and currents to maneuver correctly. Knowledge of tides and currents is still critical because today's vessels are much larger than the old sailing ships. The depths and widths of the channels in which they sail and the increased marine traffic leave very little room for error. Real-time water level, water current, and weather measurement systems now are being used in many major ports to provide mariners and port operators with the latest conditions.

Coastal zone engineering projects, including the construction of bridges, docks, etc., require engineers to monitor fluctuating tide levels. Projects involving the construction, demolition or movement of large structures must be scheduled far in advance if an area experiences wide fluctuations in water levels during its tidal cycle. Habitat restoration projects also require accurate knowledge of tide and current conditions.

Scientists are concerned with tides, water levels and tidal currents as well. Ecologists may focus on the tidal mixing of near-shore waters, where pollutants are removed and nutrients are re-circulated. Tidal currents also move floating animals and plants to and from breeding areas in estuaries to deeper waters. Oceanographers or atmospheric scientists may study tidal fluctuations to better understand the circulation of the ocean and its relationship to world climatic changes.

12. How Are Tides Measured? The Old Way

Since the early 1800s, NOAA and its predecessor organizations have been measuring, describing and predicting tides along the coasts of the United States. The longest continuous sea level records exist for the Presidio, in San Francisco, California. Records for the area date back to June 30, 1854. Today, the Center for Operational Oceanographic Products and Services (CO-OPS), which is part of NOAA's National Ocean Service (NOS), is responsible for recording and disseminating water level data.

In the past, most water level measuring systems used a recorder driven by a float in a "stilling" well. A stilling well calms the waters around the water level sensor. A typical stilling well consisted of a 12-inch wide pipe. Inside the stilling well, an 8-inch diameter float was hung by wire from the recording unit above.

Before computers were used, water level data was recorded on a continuously running pen and ink strip chart. These records were collected by observers once a month and mailed to headquarters for manual processing. In the 1960s, data were recorded onto mechanically punched paper tapes that were read into a computer for processing. Water levels were recorded at six-minute intervals. Observers maintained and adjusted the clocks, and calibrated the gauges with the tide readings. Tide stations were visited annually to maintain the tide houses and clean biological fouling from the underwater surfaces. During these annual visits, the components and support structures also were checked for stability.

Although these systems worked well, they had their limitations. Stations were subject to recording errors and marine fouling, and were constantly in need of maintenance. In addition, the measurement and data processing equipment could not provide users with information until weeks after the data was collected.

13. How Are Tides Measured: The New System

Advances in technology have helped solve many of the problems associated with the old tidal recording systems. Microprocessor-based technologies allow for customized data collection and have improved measurement accuracy. While older tidal measuring stations used mechanical floats and recorders, a new generation of monitoring stations uses advanced acoustics and electronics. Today's recorders send an audio signal down a half-inch-wide sounding tube and measure the time it takes for the reflected signal to travel back from the water's surface. The sounding tube is mounted inside a six-inch diameter protective well, which is similar to the old stilling well. In addition to measuring tidal heights more accurately, the new system also records 11 different oceanographic and meteorological parameters. These include wind speed and direction, water current speed and direction, air and water temperature, and barometric pressure.

Like the old recorders, the new measuring stations collect data every six minutes. However, whereas the old recording stations used mechanical timers to tell them when to take a reading, timing is controlled on the new stations by a Geostationary Operational Environmental Satellite (GOES). The stations also use these satellites to transmit their data hourly to NOAA headquarters. In the event of a storm, the stations can be programmed to transmit their data every six minutes. Field teams can quickly check and maintain the systems using laptop computers. In addition, all of the raw and processed data are available over the Internet.

14. Explaining Gravity: Adapted from *http://www.newi.ac.uk/buckleyc/forcesan.htm*

Author: Clive Buckley. School of Education and Humanities, North East Wales Institute of Higher Education.

The concept of gravity is not easy to understand or teach. Gravity is a force which every object exerts on every other object. When the object is small the force of gravity it has is also small. When the object is large, like the sun and the moon, the force is really important. There are several things to know about gravity:

- The force of gravity decreases with distance from the object.
- The rate at which it decreases increases rapidly with distance.
- The two factors that determine "how much gravity there is" are the masses of the two objects and the distance between them. (You have seen videos of astronauts on the moon. Astronauts on the moon weigh less than they do on Earth. That's because the moon is smaller than the Earth and so the force of gravity it exerts is smaller than that of the Earth.

15. Mass and Weight

Mass and weight are different. For an object to have weight there must be a force of gravity acting upon it. So the weight of an object is defined as the force exerted upon it by the gravity of the planet. Mass on the other hand is a measure of the matter contained by the object. So an astronaut weighs less on the moon but still has the same mass.

One other thing about the gravity of the Earth is that it acts equally on all objects. If you drop two objects, say a brick and a ball then they will fall at the same rate and hit the ground at the same time. **This doesn't happen when you use two objects that have very different shapes (**e.g. a stone and a piece of paper). The fall of the piece of paper is slowed down by air resistance. Where there is no air resistance (like on the moon) the two would fall at the same rate and hit the ground simultaneously.

Learning Experience Eight

Handout One: The Moon and Tides
Written by Kamalu Poepoe for the
Cycles and Hawaiian Traditions Curriculum
Hui Malama o Mo`omomi and the Pacific American Foundation

Sometimes when we go to the beach, we see a large bay filled with water, and other times we see the same areas filled with rocky tide pools, with the seawater edge far out into the bay. The water level on the shoreline is a changing cycle caused by tides.

Why do we have tides?

The Earth's gravity pulls everything toward the center of the Earth. It is what keeps the water in the ocean pulled to the planet, and not flying away into the air. There are other forces of gravity that pull on the ocean as well. The sun and moon have gravitational forces that pull water away from the Earth's surface. The moon has a stronger pull because it is much closer than the sun. The pulling creates a bulge where the water is attracted to one side (and its opposite side). This is high tide. As more of the ocean moves toward the bulge, a depression is created in the area water moves away from. There is less water in these areas now. This is low tide.

When the moon is between the sun and the Earth (at new moon), the sun's gravitational pull is in the same direction as that of the moon. During these days the high tides are higher and the low tides are lower than they'd be with just the moon's pull alone. This is called the spring tide. Tides are more extreme. On a tide chart, the lines are deeper and wavier.

When the moon is in its first quarter or its last quarter, the sun's gravitational pull is in perpendicular direction to that of the moon. The sun pulls water away from the areas of high tide to the areas of low tides, resulting in **lower high tides** and **higher low tides.** These are called neap tides. The tides are not as extreme. On a tide chart the tide lines are not as wavy and deep, but are more leveled out.

The Earth turns on its axis every 24hours, so a point on Earth will travel from an area of high tide, where there is gravitational force pulling water outward, through an area of low tide, where there is a water depression because the water is going to a high tide area. As the Earth continues to rotate, Mo'omomi once again will travel through an area of high tide, pulling opposite, and through another area of low tide. High tides and low tides occurring twice daily are called semidiurnal tides.

Learning Experience Nine

A Closer Look at the Moon's Relation to the Ocean Tides

Overview: In this lesson students will continue to explore the relationship between ocean tides and lunar movements. Students will plot high and low tides and lunar phases using actual tidal data for a one-week period. In so doing, students will learn that extremely high and low tides are related to specific times of the month. This learning activity has been adapted from one devised by John J. Crowley, former Executive Director of the Massachusetts Marine Educators' Association and marine science educator at Hingham, MA High School.

Understanding

- Understanding involves generating ideas and questions, posing problems, gathering evidence from multiple sources, and using scientific processes.
- There are predictable and observable patterns and cycles in nature that impact the earth.

Essential Questions

- What are the critical and recurring questions about nature that have confronted people in the past and present?
- What are the different cycles of the tides and how are they related to the phases of the moon?
- How and when can we use our knowledge of the phases of the moon and the cycles of the tides?
- What skills and processes do scientists use to investigate a question?

Evaluation

Students' learning will be demonstrated by their performance in creating the tide plotting chart and their ability to interpret and discuss the data on the chart.

Materials:

- Tide plotting charts
- A tide table for a week and a set of tide tables for a full year. (Use local data or data for Boston Harbor*. Keep in mind that if you use local data you may have to revise the learning experience.)
- Blue, yellow, and red markers
- Peelable labels for each student to draw lunar phases
- Handouts

* One full year of tidal information is available for Boston Harbor at the Massachusetts Marine Educators Website: http://www.massmarineeducators.org/curriculum/tides.shtml.

Activity One: Think-Aloud

In this learning activity, the teacher will use a Think-Aloud to teach students how to read a tide table and how to enter tide data on a tide plot chart.

Teacher Notes

** Hands-on and active learning*

** Think-Aloud: The teacher provides a model of the thinking behind the process of plotting tides.*

** Students gather data and create data displays*

** Students make inferences from the data.*

** Oral language development through discussion*

** Cooperative learning*

- Duplicate a tide table for one week (12/25-12/31) and distribute to students. Tide tables for Boston Harbor are available at *http://www.massmarineeducators.org/curriculum/tides.shtml*.
- Explain how to read the tables and the information they supply (AM and PM tide times and heights as well as sunrise and sunset).
- Distribute tide plot charts for one week. Have a copy of the tide plot chart on the overhead, or paper.
- **Think-Aloud**: Do the Think-Aloud for High Tide Data" to model how to read the tide table and plot the data on the tide plot chart. You will find this in the "Notes to Teachers Section" of this learning experience. You will be modeling how to think for students. Don't interact with students. Ask them to listen, watch, and take notes on what you say and do. Be sure to ask them NOT to interrupt your modeling. Advise them that you will be debriefing the activity with them. When you finish step K on the "Think-Aloud," you will process it with students. Ask them what you said and did. Take notes on chart paper. Then ask the students to write the directions for reading the high tide table and entering data on the tide plot in their journals (in their own words). Check for understanding. Put students in pairs and have them enter all the high tide data for 12/25 through 12/31. Check for understanding. **Be certain that all students use pencils and erasers to allow for corrections.**
  1. Do the "Think-Aloud for Low Tide Data" with students.
  2. Process with students. What did you say? What did they learn?
  3. Put students in pairs and have them enter all the low tide data for 12/25 through 12/31. Check for understanding.
  4. Identify students who are having difficulty with this task. These students will need additional support. How will you re-teach this so students understand?

Activity Two: Tide Charts

Teacher Notes

** Hands-on and active learning*

** Students gather data and create data displays*

** Students make inferences from the data.*

** Oral language development through discussion*

** Cooperative learning*

- Duplicate tide charts for as many weeks as necessary so that each student has data for a single week. We recommend that you use the tide charts for Boston Harbor since students are familiar with how to read them. (Tide information for over 3000 U.S. coastal points in a different format is available at *http:co-ops.nos.noss.gov/tides05/*. Click on a state. Locate the coastal point you want to use to get the data you need. You will have to teach students how to read the charts if you use the NOAA data.)
- Distribute an individual tide plot chart and a week of tide data to each student. **When you give out the tide data, go up and down rows so the students have data for weeks close to theirs to check later.**
- On receipt of the tide plot charts and tide data, students will fill in the month, day, and year at the top of the sheet.
- Students will plot all the tide points on their tide plots (exactly as they did with the teacher above).
- Students will begin this work in class and complete it at home. Be certain that you check at least a few points on students' tide plot charts before they work on them independently. Note the students who are struggling and those who are comfortable with the task. Remind students to use pencil to allow for corrections.
- When students bring in their completed tide plot charts, place them in heterogeneous groups of 3 or 4, based on your observations (see #5 above). Students should work together, checking the accuracy of the tide plot charts. The teacher should observe the various groups, checking for understanding.
- Individual students will connect the dots representing high tide points. Then, they will do the same for the low tide points.
- Caution students to stop at the last dot. They should not extend their high and low tide lines to the edge of the chart from the last dot.

Activity Three: Pulling the Data Together

Teacher Notes

** Discussion-based*

** Hands-on, active learning*

** The teacher provides explicit instruction and checks for understanding*

** Ongoing assessment*

- Students should fold the right side of their tide plot chart to the black edge line.
- The next step is for students to put all the individual charts together in chronological order. This will be fun for students as they will have to match their charts with those for the week prior to and the week following theirs. Expect a little chaos as they figure out how to do this. It will be a lot easier if, when you gave out the data, you went up and down the rows as directed above (see #2).
- Students then connect their final points on each side with the other charts and finish their data.
- Students will color their charts blue from the top of the graph down to the black line for high tides.
- Students will color their charts red from the bottom of the graph to the black low tide line.
- Students will tape their one week tide table to the bottom of their completed tide plot chart. (Pictures of the completed project are included in the Notes for Teachers.) Before students pass in their individual charts, they will determine the tidal range for each day by subtracting the lowest of the low tides for each day from the highest of the high tides for the day. The number that represents this information should be placed in the empty box between the 5- and 6- foot tide levels.
- Collect all work. Check the charts for accuracy. As you check, remove the right side margin from each chart with a paper cutter or scissors.
- Post the charts on the bulletin board in chronological order to develop a continuous tide chart. Students can now see that a very definite cyclical pattern develops over several weeks or months.

Activity Four: Adding the Moon to Your Chart

Teacher Notes

** Structured cooperative learning experience adapted from Harvey Daniel's Literature Circles*

** Hands on and active learning*

** Oral language and discussion*

** Ongoing assessment as the teacher checks for understanding, clarifies misconceptions, and provides explicit instruction when necessary*

- Distribute "peelable" yellow labels to students who will trace four dime-sized circles that represent the phases of the moon. Students use a dime so that there is uniformity in the size of the moon.
- Students should refer to the NOAA website http://co-ops.nos.noaa.gov/astronomical.html to identify the dates of the
    - New Moon- full circle shaded gray
    - First Quarter- half circle with opening to the right
    - Full Moon-full yellow circle
    - Last Quarter-half circle with opening to the right
- Students stick the four dime-sized moons in the correct time block on their individual chart
- Place students in groups of four. Ask them to answer the questions on Handout One. They will select a Discussion Director and Recorder. Because this is a cooperative activity, students are responsible for each others' learning. Once they've answered the questions as a group, they should make certain that each group member can answer the question. You will call on one person (not necessarily the Recorder or the Discussion Director) to answer questions and give one grade to the group. Circulate and encourage students to ask you to clarify or clear up misconceptions. Observe and check for understanding throughout the discussion.

Notes to Teachers Part One: Think-Aloud for High Tide Data

A. This is a tide table for the week of Sunday, December 25, 2005 through Saturday, December 31, 2005.

B. I'm going to look at the tide table to see when there are high and low tides on each day of that week. I'm also going to see how high and low the tides are.

C. I'm looking at December 25 in the morning. I'm circling the high tide at 5:58 AM and the tide height on 9 feet.

D. Next, I'm looking at the tide table for December 25 in the afternoon. I'm circling the high tide at 6:23 PM and the height of 8.3 feet.

E. What do I know so far? There are 2 high tides on December 25. There's one in the morning, and one in the evening.

F. What else do I know? There are 12 hours and 25 minutes between the two high tides. I also know that the morning high tide is a little higher than the one in the evening.

G. Now I'm going to take my tide plot chart. I find Sunday and put the date 12/25 on the line.

H. Next, I'm going to chart the times and heights of the high tides on December 25. Let me look at what I circled on the tide table. The first high tide is at 5:58 AM and it's 9 feet high. 5:58 AM is almost 6:00 AM. There's a broken line for 6:00 AM. I'll put a dot on that broken line at the 9 foot mark.

I. Now I'll chart the second high tide of December 25. The second high tide is at 6:23 PM and it's 8.3 feet high-a little lower than the one before. Let's see. There's a second broken line for 6:00 PM. 6:23 PM is pretty close to 6:00 PM. I'll put a dot a little above the 8 foot mark.

J. So what do I know so far about the tides on December 25? There are 2 high tides. The first is at 5:58 in the morning and the second is at 6:23 in the evening. I also know that there are 12 hours and 25 minutes between the two high tides. I wonder if it's always like that? I'll plot the next high tides to find out.

K. Well, I've learned that there are always 12 hours and 25 minutes between high tides. I've also learned that some high tides are higher than others. Now I'll do the low tides.

Notes to Teachers, Part Two: Think-Aloud for Low Tide Data

L. I'm looking at the tide table for December 25 in the afternoon. There's a low tide of 1.5 feet at 12:14 PM. I'll put a square around that.

M. Now I'll put the time and height of that one low tide on the tide plot. I know that the low tide is at 12:14 pm. There's solid line for noon (or 12:00 pm) so I'll put a little square on that line but way down-halfway between 1 and 2 feet. I still wonder why there's only one low tide on December 25. What happened to the other one?

N. So what do I know about all the tides on December 25? There are 2 high tides-one at 5:58 am and another, 12 hours and 25 minutes later at 6:23 pm.

O. What else do I know? There's only one low tide on December 25-at 12:14 pm. I wonder why? Let me think. The first high tide is at 5:58 in the morning. The first and only low tide is at 12:14 in the afternoon-6 hours and 16 minutes later.

P. What time is the second high tide? 6:23 pm. How many hours between those two? 6 hours and 9 minutes. So it looks like there might be a little over 6 hours between high and low tide.

Q. I wonder when the next low tide will be. I'll add 6 hours to 6:23 pm and predict that the next low tide will be at about 12:25 am-on December 26. Let me look at the tide chart to see if I'm right. I look at the first low tide for December 26. It's at 12:29. I'll put a square around it. I was right. It's at 12:29. It looks like there's about 6 hours between high and low tide.

Learning Experience Nine

Handout One

People who live along the ocean coasts often marvel at the changing tidal range on a daily basis. In an earlier lesson, you learned that the primary source of ocean tides is the gravity of the moon (lunar gravity). A secondary source is the gravity of the sun. The height of the tides depends on the distance between the earth and the moon on a given day. Because the moon and earth are not always the same distance apart, the tidal range changes daily. When the moon is closest to the earth (at perigee) the gravity or force of the moon is at its strongest. When the moon is farther away from the earth (apogee), the lunar gravity is somewhat weaker.

Your class has created tide plotting charts for several weeks or months. Study the charts and answer the following questions with your group.

1. Look at the charts. Describe what you see. Do you see any patterns? What are they? Be explicit.

2. What has caused the patterns that you see?

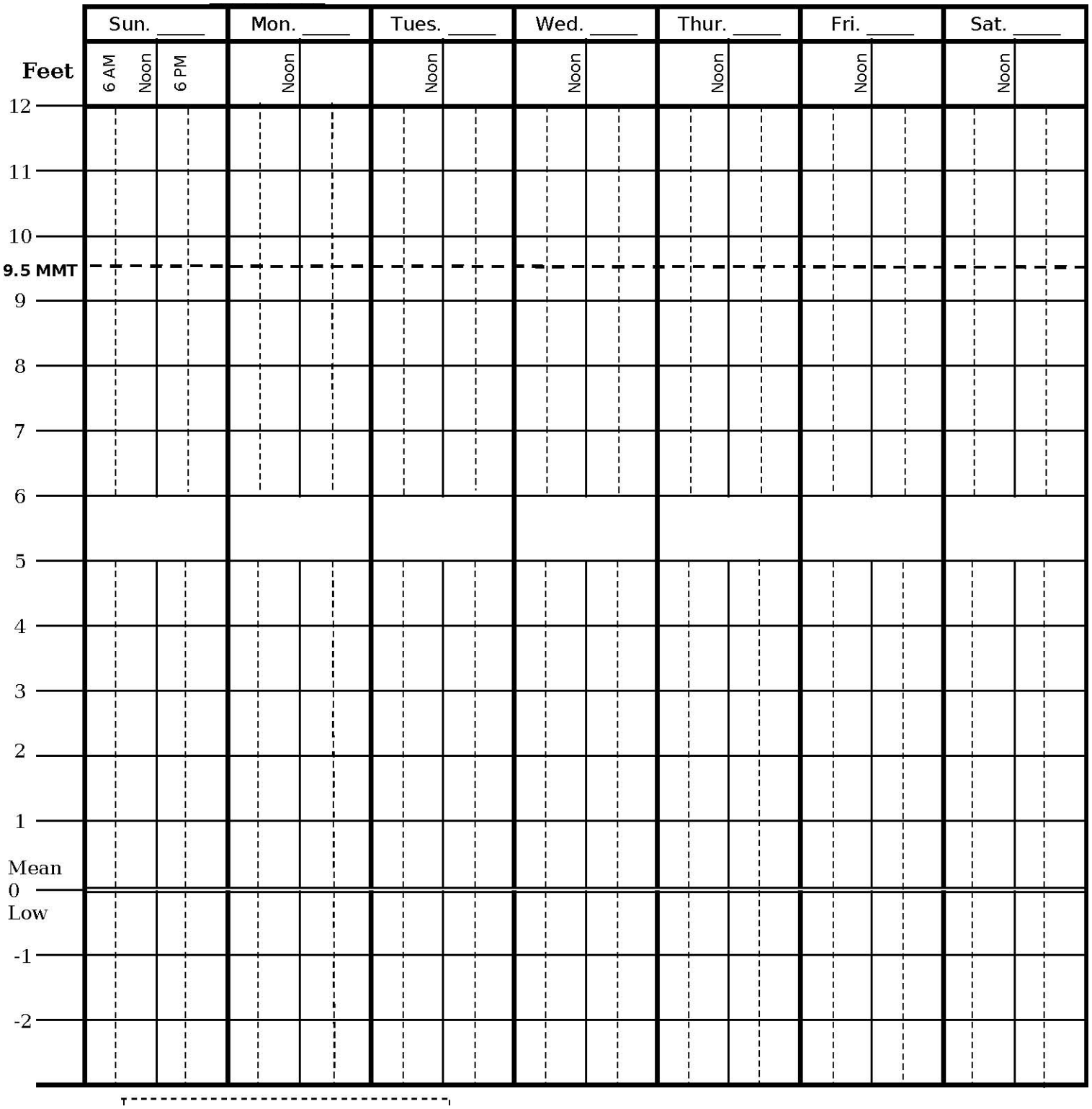
3. What role does the moon play in those patterns?

4. At what point in the month is the tidal range the greatest? What lunar phase is closest to this time of the month?

5. At what point in the month is the tidal range the smallest? What lunar phase is closest to this time of the month?

6. In an earlier lesson, you learned about the phases of the moon and how the gravity of the moon and sun causes the tides. Does the moon or sun have a stronger influence on the tides? Explain your answer.

TIDE PLOT CHART NAME _____MONTH _____
YEAR _____



Learning Experience Nine

Directions for Plotting the Tides

1. **Plot each high and low tide by the time and height above Mean Low water.**
2. **Show the lunar phases for each week on the top of the chart by day.**
3. **Calculate the maximum tide range for your week (high minus low for each day).**
4. **Place the answer on the chart in the block between 5 and 6 feet.**
5. **Using a black line, connect all the high tide points together.**
6. **Using a black line, connect all the low tide points together.**
7. **Color your chart blue from the top of the graph down to the black line.**
8. **Color your chart red from the bottom of the graph to the black line.**
9. **Attach your chart to the bottom of your tide-plotting chart.**

National Standards

National Science Education Standards

Content Standard A:

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Content Standard D:

- Earth in the solar system
- Earth and Space Science

Content Standard G:

- Science as a human endeavor
- Nature of science
- History of science

National Council of English Teachers Standards

1. Students read a wide range of print and non-print texts to build an understanding of texts, of themselves, and of the cultures of the United States and the world; to acquire new information; to respond to the needs and demands of society and the workplace; and for personal fulfillment. Among these texts are fiction and nonfiction, classic and contemporary works.

3. Students apply a wide range of strategies to comprehend, interpret, evaluate, and appreciate texts. They draw on their prior experience, their interactions with other readers and writers, their knowledge of word meaning and of other texts, their word identification strategies, and their understanding of textual features (e.g., sound-letter correspondence, sentence structure, context, graphics).

4. Students adjust their use of spoken, written, and visual language (e.g., conventions, style, vocabulary) to communicate effectively with a variety of audiences and for different purposes.

5. Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences for a variety of purposes.

7. Students conduct research on issues and interests by generating ideas and questions, and by posing problems. They gather, evaluate, and synthesize data from a variety of

sources (e.g., print and non-print texts, artifacts, people) to communicate their discoveries in ways that suit their purpose and audience.

8. Students use a variety of technological and information resources (e.g., libraries, databases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Hawai`i State Standards

Science:

Standard 1: The Scientific Process: SCIENTIFIC INVESTIGATION: Discover, invent, and investigate using the skills necessary to engage in the scientific process

Standard 2: The Scientific Process: NATURE OF SCIENCE: Understand that science, technology, and society are interrelated

Standard 7: Physical, Earth, and Space Sciences: FORCE AND MOTION: Understand the relationship between force, mass, and motion of objects; and know the major natural forces: gravitational, electric, and magnetic

Standard 8: Physical, Earth, and Space Sciences: EARTH AND SPACE SCIENCE: Understand the Earth and its processes, the solar system, and the universe and its contents

Language Arts:

Standard 1: Reading: CONVENTIONS AND SKILLS: Use knowledge of the conventions of language and texts to construct meaning for a range of literary and informational texts for a variety of purposes

Standard 2: Reading: READING COMPREHENSION: Use reading strategies to construct meaning from a variety of texts

Standard 3: Reading: LITERARY RESPONSE AND ANALYSIS: Respond to literary texts from a range of stances: personal, interpretive, critical

Standard 4: Writing: CONVENTIONS AND SKILLS: Use the writing process and conventions of language and research to construct meaning and communicate effectively for a variety of purposes and audiences using a range of forms

Standard 5: Writing: RHETORIC: Use rhetorical devices to craft writing appropriate to audience and purpose

Standard 6: Oral Communication: CONVENTIONS AND SKILLS: Apply knowledge of verbal and nonverbal language to communicate effectively in various situations: interpersonal, group, and public: for a variety of purposes

Standard 7: Oral Communication: RHETORIC: Adapt messages appropriately to address audience, purpose, and situation

Massachusetts Standards

Science:

Earth and Space Science

- Recognize that gravity is a force that pulls all things on or near the earth toward the center of the earth. Gravity plays a major role in the formation of the planets, stars, and solar system, and in determining their motions.
- Describe lunar and solar eclipses, the observed moon phases and tides. Relate them to the relative positions of the earth, moon and sun.
- Give examples of ways in which organisms interact and have different functions that enable them and the ecosystems to survive.
- Explain that living organisms meet some of their needs in their environments by using behaviors in response to information they receive from their environments.

Science Inquiry Skills

- Select and use appropriate tools and technology in order to make observations.
- Keep accurate records while conducting investigations.
- Recognize patterns in data and use data to create reasonable explanations for the results of an investigation.
- Make predictions based on observed patterns.
- Record data and communicate findings to others using graphs, charts, maps, models, and oral and written reports.
- Draw conclusions based on data or evidence presented in tables, graphs, charts, maps, and models. Make inferences based on patterns or trends in the data.
- Present and explain data and findings using multiple representations, including tables, graphs, mathematical and physical models, and demonstrations.

Language Arts:

Standard 1: Discussion

- Students will use agreed-upon rules for informal and formal discussions in small and large groups.

Standard 2: Questioning, Listening, and Contributing

- Students will pose questions, listen to the ideas of others, and contribute their own information or ideas in group discussions or interviews in order to acquire new knowledge.

Standard 3: Oral Presentation

- Students will make oral presentations that demonstrate appropriate consideration of audience, purpose, and the information to be conveyed.

Standard 9: Making Connections

- Students will deepen their understanding of a literary or non-literary work by relating it to its contemporary context or historical background.

Standard 10: Genre

- Students will identify, analyze, and apply knowledge of the characteristics of different genres.

Standard 11: Theme

- Students will identify, analyze, and apply knowledge of theme in a literary work and provide evidence from the text to support their understanding.

Standard 16: Myth, Traditional Narrative, and Classical Literature

- Students will identify, analyze, and apply knowledge of the themes, structure, and elements of myths, traditional narratives, and classical literature and provide evidence from the text to support their understanding.
    - Identify characteristics of myths and cultural stories.
    - Identify phenomena explained in myths and cultural stories.
    - Compare myths and cultural stories from different cultures.
    - Identify common structures (e.g. magic helper) and stylistic elements (simile, hyperbole) in myths and cultural stories.
    - Identify the exploits of a character in a cultural story or myth.
    - Identify, analyze, and apply knowledge of themes, structure, and elements of myths and cultural stories and provide evidence from the text to support their understanding.
    - Acquire knowledge of culturally significant characters and events in mythology.
    - Identify and analyze similarities and differences in stories from different cultures (for example, ideas of the afterlife, roles and characteristics of deities, types and purposes of myths and cultural stories.

Standard 24: Research

- Students will gather information from a variety of sources, analyze and evaluate the quality of the information they obtain, and use it to answer their own questions.
    - Gather relevant information for a research project through interviews. (For example, students generate questions about their family culture, interview family members, and present their information to the class.)
    - Integrate relevant information gathered from group discussions and interviews for reports.

Standard 25: Evaluating Writing and Presentations

- Students will develop and use appropriate rhetorical, logical, and stylistic criteria for assessing final versions of their compositions or research projects before presenting them to varied audiences.
    - Apply understanding of agreed-upon rules and individual roles in order to hold discussions and make decisions.
    - Give oral presentation for various purposes.