

Zuni, Acoma and Isleta:

Three Pueblo cultures of New Mexico which are deeply rooted in naked eye observations of astronomical phenomena that provide the pivotal dates around which their lives are structured.

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This unit includes learning about secret ceremonial rituals and unsolved mysteries of ancient inhabitants of the southwest deserts. It is the stuff of which Indiana Jones could write a tale and experience an adventure of a lifetime!

Unit Goals

The primary goal of this instructional unit is to teach students to be mindful of earth's routine astronomical cycles, and the role these cycles play in their lives. These cycles include sunrise and sunset, the phases of the moon, and the solstices and the equinoxes and their relationship to seasonal change. Students will be expected to define the major concepts such as solstice and equinox. They will make their own naked-eye observations to determine the date of at least one solstice. They will also be expected to draw the phases of the moon over a month's period and to name the phases, and its direction through the ecliptic. Observations of constellations and the annual movement of the sun through the zodiac are also possibilities for student activities.

A second goal of the unit is to teach the students to be mindful of Earth as the home of mankind, to revel in their own existence on earth and to contemplate their unique perspective and special nature in the universe. It is expected that the student shall be able to describe the importance of the sun to the earth, and thus to himself, through various means of expression such as a written paper, a play or a demonstration.

A third goal is to prepare the student to imagine him/her self as an observer from a point not on earth's surface, to imagine earth and man as a small part of a greater universe. This "spaceship earth perspective" will be viewed as an opportunity to make the student aware of Earth as mankind's only home and his individual responsibilities for the stewardship of earth. The student is expected to be able to describe the differences between being on earth and being on an orbiting space station. These differences may be expressed orally, written or enacted out.

A final goal will be to go beyond research and fact gathering and inspire the student to use his mind to explore his imagination for the future as well as the motivations and aspirations of his inner self. The student should be able to use his imagination to construct a future that he is a part of, a future that expresses his own personal aspirations, backed up by realistic goals and real expectations.

Student Learning Objectives

Learning objectives are an expected part of each student activity, but in addition I would like to suggest a partial list of student objectives *for the unit*. After studying this curriculum unit, the student should be able to:

1. Define the major concepts of archaeoastronomy.
2. Compare and contrast archaeoastronomy with modern astronomy.
3. Observe and record naked-eye observations of sunrise on the horizon to determine the location of the sun at the winter solstice (or the summer solstice in summer school).
4. Observe and record the phases of the moon over a period of one month.
5. Explain the importance of astronomy to prehistoric cultures.
6. Suggest how ancient rituals might be used to improve the quality of life in contemporary culture.
7. Define a personal "place" by selecting an observation place. This site may be an observation point for astronomical phenomena, or to "bring it home" the site might be a street corner where the student sits and records "life" going by. Either choice will demand focus and thus becomes a potential exercise in concentration and meditation. I prefer the latter choice — to personalize the experience.
8. Make a list of their activities day by day, and another list of their activities by night, and prepare a statement of the effect of day and night on their own life.
9. Make a list of their summer activities, and contrast it to a list of winter activities.
10. Evaluate mankind's use of fossil fuels to "turn away the darkness," and the ultimate consequences on his/her behavior.
11. Describe the motion of the Earth on its axis and its effect on Earth's inhabitants.
12. Describe the motion of the Moon around the Earth, the reasons for the moon's phases, and other effects of the moon on the earth, such as tides.
13. Use a diagram to show the causes of the several different kinds of eclipses.
14. Explain the reasons for the seasons.
15. Make a chart to show that the sun is the source of all energy on Earth. This activity might be broken down into several parts. They could include a list of where the sun's energy is stored on Earth, how those different storage "sinks" are different from each other, how their differences affect utilization by mankind, the effect of releasing that stored energy on the Earth's biosphere, and many related topics.
16. Research specific topics on the Internet that either contain content about ancient cultures or astronomy.
17. Visit a particular Internet location and outline it, including major concepts and links to other locations. Outline the content of at least three of those links.
18. Prepare a flow chart describing a web-site on archaeoastronomy and all of its links. A location address must be given for each link, as well a brief description of its contents. A student might pursue the links for 3-4 levels.

Any unit integrating both culture and astronomy lends itself to a million learning objectives! Customize the list to your own classroom, your own educational background, and the interests of your students. The objectives are best constructed in a format so that they lead directly to learning assessment.

Introduction

Seminar topic

The seminar in which I enrolled for the summer of 1999 is archaeoastronomy or cultural astronomy of the southwest. This seminar provided opportunities to explore connections between the ancient and present pueblo cultures of the Southwest with their integration of observed astronomical events into specific religious and cultural aspects of their lives.

I plan to integrate the content of this seminar into my own teaching of science, particularly my interest in the International Space Station as a focus of instructional units for several content areas — specifically biology, physical science, physics, astronomy and chemistry. The International Space Station, or any orbiting platform around Earth, is an entirely different experience for a man or woman living there than a familiar spot on earth.

The reference points on an orbiting space station are more elusive. The "sense of place" is less defined. It is therefore very different from the Pueblos which we are about to explore, that are literally fashioned from the earth where they are located. Without the specifics of place, such as the horizon, or the particular angle of the sun, there are no references around which to build a calendar. Orientation and planning are more complicated, and require defined points of reference that are very different from earthly locations. The contrast of these two perspectives, one grounded on Earth and anchored by a sense of place, the other neither grounded nor stationary and anchored only by a sense of self-suggest some fascinating explorations of the psychology of mankind.

Pueblo cultures emphasize the importance of synchronizing a person's life with his or her environment — and the necessity of keeping close to the earth's cycles for health and well being. The rising of the sun each day is a matter of celebration for all Pueblo inhabitants. Seasonal variations determine the cycles of sowing and reaping that are vital to any civilization. Our modern technological society is ultimately ruled by these same astronomical events. Lights to cut away the darkness and planes and trains to seek an endless day do not alter the fundamental importance of sunrise and the effects of the seasons. The fundamental importance of earth's turning on its axis and its orbit around the sun may not be apparent to many people in our present society, but these are the cycles that influence the very existence of all life on earth.

Key Concepts: An Essential Vocabulary for Understanding Archaeoastronomy

The physical settings in the Southwest deserts of New Mexico and Arizona are a long way from the green swards of New Haven, Connecticut. The special nature of the southwest is born from its low precipitation, its extremes of heat and cold, its low-lying deserts and its cool, alpine mountains, and the unique perceptions that are made possible by the low humidity and clear skies.

Far *horizons* are visible and obvious and a part of everyone's daily perceptions. When the sun rises, the first light pierces the early morning with a blinding shaft of light. There is nothing timid about the southwestern sun! It shines clear and bright and hot and cannot be ignored, even in winter months. Shadows are sharp. When the sun sets, it sets with ceremony, painting the

clouds with colors of celebration and rest forthcoming. When the moon rises, it rises to light the night. It is clear and bright and floods the landscape with a light that still maintains the clarity of the sunlight from which it is reflected.

It is hot in the sun, and cool in the shade. Sun-parched earth is naked with sparse plant growth. Infrequent rivers bring water from melting snows to confined arteries in parched lowlands. Before damming, the rivers' annual flooding was both life-giving and destructive.

This is a land where local building materials for walls of homes are fashioned from earth and straw into adobe building blocks. Vigas and latillas for construction of the roofs of buildings are fashioned from trees hauled down from the mountains. In the southwest, there is no escaping the nature of the *region*. It burns deep into your soul.

It is different in the southwest than it is in the eastern United States, or in the midwestern part of the country. It is also very different from the west coast, whose climate is moderated by the Pacific ocean. The southwest is unique enough that it is necessary to learn a new vocabulary to understand the native peoples who have lived here for millennia, and the present day descendants of those peoples that still occupy ancestral homes. It is what the eye sees that is so different, and thus this section will start with a selection on naked-eye observations that are so much a part of the daily lives of the inhabitants of the Southwest. The selection is followed by explanations of the unique vocabulary that is necessary to gain some insight into the Pueblo cultures that are the focus of this unit.

The motions of astronomical objects you can see by eye follow distinctive patterns and cycles in the sky over both short and long periods of time. If you watch the sky often for a year, you can observe just by eye the behavior of the stars, planets, sun and moon. The sun rises and sets; the seasons flow. The moon's illumination changes nightly; different constellations appear as the seasons change. Planets move majestically and sometimes oddly among the stars. Careful study allows you to detect the pattern and timing of these movements and events. (Zeilik, 1992)

It is these patterns that were observed by ancient peoples and which became integrated into the entire culture of the peoples, into their daily rituals, their monthly ceremonies, their planting and harvesting times, and their personal prayers for a fruitful and long life.

Many of the following concepts are unique to the Southwest, and many more are unique to science (not even being in the dictionary) and thus may be difficult for students to understand. Visuals of the southwestern United States may help a great deal in understanding those concepts that are unique to the Southwest.

Archaeoastronomy

The term derives from a prefix of Greek and Latin derivation "archaeo" meaning ancient, earlier, or primitive. Some related words are archaeology (the study of ancient cultures), archaeopteryx (an extinct bird genus), archaeozoic (a division of the Precambrian era), archaeoceti (ancient whales) and archaeogeology (the geology of the most ancient periods). Thus archaeoastronomy is the study of ancient astronomy. Although the word is not found in many contemporary dictionaries, its meaning is easy to deduce from so many other words with "archaeo" as the prefix. Archaeoastronomy, as a science, is in its infancy. An editorial in the

Journal *Archaeoastronomy* by Michael Zeilik explores the assertion that to become an accepted scientific discipline, archaeoastronomy must be done in the appropriate cultural context, *sans* ethnocentrism, and its purpose is to provide insight into prehistoric life. (Zeilik, 1983)

Anticipatory Observations

Naked-eye observations are made for the purpose of predicting accurate dates of astronomical phenomena, particularly of the solstices. Anticipatory observations have come to be one focus of study of the astronomy of the Pueblo people. It was these observations that "were the central focus of the Sun Priest's work, the special knowledge of his office," in contrast to the approximate time of the solstice, which was general public knowledge. (Zeilik, 1983)

Anticipatory observations are made prior to an astronomical event, usually about two weeks in advance. Usually these observations are associated with the solstices. The sun priest was ultimately responsible for the anticipatory observations necessary to predict the exact day of the solstices. It took the Pekwin (sun priest of the Zuni) eight years "to time the turning of the sun exactly," which may be interpreted more as a way of conveying a sense of the ritual importance of the training, rather than an amount of time actually needed for the instruction. The difficulty with this accuracy in predictions stems from the fact that near the solstices, the sun "stands still" (the translation of the word "solstice") on the horizon. Because it is not moving, it is difficult to tell by naked-eye observations the exact day of the solstice, unless there has been previous planning and learning about the phenomenon. By starting about two weeks in advance, the sun-watcher could do a daily countdown (notches on a stick or knots on a rope) to make the most accurate prediction. This knowledge is sacred and is taught and handed down from Sun Priest to Sun Priest. (Zeilik, Anticipation in Ceremony)

Calendrical Sites and Observations

Calendrical observations may be made at sun-watching stations or sunports and are used to predict in advance the dates of the summer and winter solstice. These sites are chosen but not always marked. Calendrical observations for the sun were made using a horizon calendar. The second technique involved the casting of light and shadow through windows or portals against a wall with markers. (Zeilik, 1986).

Eclipses

The Tewa Pueblos of the Rio Grande generally perceived eclipses of the sun as evidence of an imbalance in the world. This imbalance could lead to danger and death for the pueblo. A solar eclipse would occasion a prayer to the Sun that illustrates the concerns of the people:

Let the earth be covered with all things beautiful.

All trees, plants, flowers. Let the deer, antelope,

Mountain sheep and turkey roam over the earth

That we may have food in plenty for our children.

Let the eagle soar over the earth that we may have

Feathers to offer our gods. Refresh our

Mother earth with rains that she may be happy. (Williams, p. 85)

Equinox, Spring and Fall

Although observed, the equinoxes were less important than the solstices to most Pueblo cultures, perhaps because at equinox the sun does not turn around to mark a reversal of the sun's direction on the horizon, but simply appears to move either north or south rather quickly. Generally, the equinoxes are not celebrated by the pueblos. At each equinox, the Sun rises on the horizon due East and sets due West.

Estufa

In Spanish, the word "estufa" is translated as stove, heater, foot-heater, secondly as a greenhouse, hothouse, conservatory, and third as a drying chamber or sweating-room. However, when referring to the pueblos, it may refer to a Kiva, or large ceremonial house. I no longer have access to the original documents where this was used, but more research needs to be done to clarify the use of this term, and to what, exactly, it refers.

Ethnoastronomy

This term also will not be found in many contemporary dictionaries. The prefix "ethno" is of Greek origin, and means race, or people. Thus ethnology is the science that analyzes and compares human cultures. Other words with "ethno" as a prefix are ethnocentrism, the belief in the superiority of one's own ethnic group; ethnohistory, the scientific study of the development of human cultures; ethnomusicology, the comparative study of music of different cultures, etc. Thus, we may deduce that ethnoastronomy is the scientific study of the astronomy of a particular culture or peoples.

Heliacal Risings and Settings

Heliacal risings and settings are the first and last times a star or star pattern appears in the east with sunrise or sets in the west with sunset. This phenomenon has to do with the apparent motion of the sun through fixed patterns of stars in the sky called the zodiac. This following of non-circumpolar star groups throughout the year was of some interest to Pueblo cultures. The Pleiades, in the constellation Taurus, is a good example of an open cluster of stars, easy to pick out in a winter sky free of light and pollution. The Zuni call this cluster the Seed Stars and relate them to the growing season, perhaps because they first appear in the early morning sky during the height of summer when seeds are forming. (Williamson, p. 71) The Zuni observed a total of 26 stars and constellations. (Miller, 1997)

Horizon Calendar

Connected with an observation site, this term refers to specific marks or features of a horizon, which are used both for anticipatory observations and marking specific astronomic events such as solstices. The marks on the horizon are determined by the location of the first gleam of the sun as it rises above the horizon.

Horizon Markers

Horizon features are a feature or features that are used to establish the sun's seasonal position along the horizon. Sun shrines may mark the sun's key positions on the horizon. When horizon markers are not apparent, light and shadow (through windows or ports) may be used as an alternative observation method.

Lunar Observations

Some pueblos paid close attention to the phases of the moon to schedule festivals. One notable festival is Shalako at Zuni. The use of the moon to schedule ceremonies, combined with an already accurate seasonal calendar based on solar observations, necessitates an elasticity in the calendars solved usually by adjusting the number of months in a year to allow for a continuity of the normal ceremonial and spring planting times. (Zeilik, 1986)

Naked eye observations or astronomy

This term refers to observations of behaviors of the sun, moon, stars, and other heavenly bodies that are made only with the naked eye, without aids such as telescopes, binoculars or cameras.

Planetary Observations

In naked eye observations, planets look like bright stars, even though they are non-luminous. They appear to move among the stellar background. The word planet is derived from the Greek meaning "wanderer." Little is known about Native American observations of the planets, perhaps because most early ethnographers had little knowledge about the motions of the planets and *did not know what to ask*. The Zuni use observations of Mercury and Venus (or perhaps Saturn, Jupiter or Mars), the "morning stars", to time the beginning and ending of several ceremonies. (Williamson, p. 83)

Predictions and Accuracy

The Pueblos depend on accurate predictions of major astronomical events such as solstices. Preparation activities take place in the weeks before the event, and there are ceremonies during and after the event as well. Accuracy is so important that, although it is the responsibility of the head priest, the calculations are verified by the other "caciques." An error of plus or minus one day has been deduced, by contemporary researchers, as the degree of accuracy of these predictions in prehistoric times. Precise observations with an experienced priest result in the actual day of the solstice being predicted.

Pueblo

A permanent village or community of any of the Pueblo peoples, Native Americans living in New Mexico and Arizona, including the Hopi, Zuni, Taos, Isleta and others. This word is of Spanish origin, meaning small town or village. The word is also translated as "people".

Sacred Number Four

The sacredness of the number four to the Pueblo people has its origins in the four directions on the horizon of the summer and winter solstices and the "turning" points during sunrise and

sunset on these dates. The number four is directly tied to astronomical observations. The number four or multiples of four are integrated into many ritual observances, including timing of anticipatory observations, and many aspects of ceremonies. Three additional directions, up, down, and "center" are also sacred in cultural rituals and ceremonies.

Solstices, summer and winter

The time at which the day or the night is the longest; in the Northern Hemisphere, the summer solstice (around June 21) is the time of the longest day and the winter solstice (around December 21) the time of the shortest day. (Zeilik, 1993). At the summer solstice, the sun rises north of East, its northernmost point on the horizon. At the winter solstice, the sun rises south of east at its most southerly position on the horizon in its annual cycle. This annual cycle is caused by the tilt of the earth at an angle of 23.5 degrees from the ecliptic, the plane of the Earth's orbit around the Sun. It is this tilt that is responsible for the change of seasons and the change in the relative length of day and night throughout the year. (Glenn, 1987) Both the winter and Summer Solstice in the Pueblo calendar are part of a one-year seasonal cycle with the winter solstice as the beginning of the new year. (Zeilik, 1967)

Sun Priest

Also called the "cacique of the Sun" (Zeilik, 1986). This term refers to a religious office invested with the responsibility for watching the sun. The task of acquiring the knowledge of predicting solstices through anticipatory observations is passed down from sun priest to sun priest. The sun priest also keeps track of the basic planting calendar from April to June. In Zuni, the sun priest is called *Pekwin*. At Acoma Pueblo the sun priest is called the *Cacique*.

Sun watching stations

These are locations usually within or near the pueblo where the sun watcher makes the anticipatory and the confirmatory observations. Observation times are most likely to be at sunrise, rather than at sunset. These stations are typically not marked by rock art.

Sun shrine

A shrine is a site at which offerings are made. In the pueblo cultures, offerings may be prayer sticks, corn meal, feathers, turquoise and other precious objects.

Sun portals

Current field research supports the hypothesis that portals, openings cut into the walls of pueblos, were used to supplement or confirm information about both summer and winter solstice predictions. These portals, or small windows, allowed light from the sun to fall on a particular point within a room. As the light beam tracks across the wall, marking the tracks of the sunbeam's progress at regular intervals made anticipatory observations possible of both winter and summer solstices. Some portals provided observational points for the equinoxes, as well.

Now that we have a basic vocabulary to work with, the three different Pueblos will be introduced to the reader.

Pueblo Cultures of the Acoma, Isleta, and Zuni: Perspectives from Earth- where the sun rises and the stars twinkle

The sciences of archaeoastronomy and ethnoastronomy cannot be understood out of context of the cultures of which they are a part. In this unit, some basic information on three Pueblo cultures will be presented to better understand how this ancient astronomy came about, and how deeply it was integrated into the lives of the Pueblo people. The individual Pueblos share much in the way of culture, yet each is unique because of their histories, ceremonies, and location. The culture and traditions of each Pueblo are deeply rooted to the physical sites from which they were built, and the techniques for determining ceremonial dates is a direct consequence of the physical nature of the horizons which define the Pueblo world.

Acoma Pueblo

Location

Acoma pueblo is located in west central New Mexico, fifty-five miles west-southwest of Albuquerque. It is known as the "Sky City", and is believed to be the oldest continuously inhabited place in the United States (since the 10th century). Its inhabitants live in terraced dwellings made of stone and adobe atop a precipitous sandstone butte 357 feet above the surrounding plains. On the plains they engage in farming, ranching and pottery making. Most inhabitants now live in the city of Acomita, to the north and near Interstate 40, the old Route 66 through New Mexico. The reservation is contiguous with Laguna reservation to the East

Pueblo culture and Ceremonies

Acoma culture has one noteworthy feature — an *integration* of function and form. It's society is a close-knit, organic unity of kinship and social life. Its beautiful ceremonies are not only spiritual in nature but are also very pleasant social occasions that bind the community together with a common spirit and shared responsibilities. (White p.140) As with most Pueblos, their social culture is structured around clan groups. In Acoma, there are 14 clans: Eagle, Sun, Bear, Yellow Corn, Parrot, Red Corn, Oak, Road Runner, Antelope, Water, Sky, Pumpkin, Turkey, and Tansy Mustard (White, p. 35). The naming of the clan groups suggests how deeply the physical world is embedded in the Pueblo culture. (White, p.35)

The Cacique, the person who symbolizes the entire Pueblo, is the most important, most honored and most respected individual in the Pueblo. He works *for* the people. But his authority is manifested more by counseling than commanding, and he is more priest than chief. His primary duties are to "watch the sun," and he determines the times of the solstices, which is his most important ceremonial function.

The Sun is a Great Spirit, the greatest of all supernaturals in the Pueblo culture. The sun is called "father," and like at other pueblos, is often prayed to with offerings of corn meal or pollen. The twin war gods, the morning and evening stars, Masewi and Oyoyewi, are patron gods of the warrior society, and symbolize courage, strength and virtue. The K'obictaiya are the spirits who live in the east, at sunrise. They are very powerful and beneficent spirits, and are impersonated by masked men at the winter solstice ceremonies. (White, p. 64)

The Summer Solstice

About the middle of June the Cacique begins to watch the sun rise. He stands at a certain spot in front of the Catholic Church and notes the point at which the sun first appears over a great mesa in the east. (The sun moves north toward the summer solstice.) When the sun has almost reached its northernmost point the Cacique proclaims that the day of its turning south will fall on a certain day, specifying a time a few days subsequent to his announcement. (White, p. 84)

Prayer sticks are offered to the sun and an altar is set up in the Mauharots (the head estufa or house) and there is a limited ceremony of prayers and songs and sometimes dancing.

The Winter Solstice

The Cacique watches the sun, as he did for the summer solstice. He sets the date for the solstice eight days in advance. Everyone in the village is notified. This signals a period of time during which rituals are performed to cleanse the body and purify the soul, a time marked by abstinence of certain foods and sexual intercourse. Ceremonies require major preparations. New moccasins are made; seeds and plants of all kinds are collected for use in the ceremonies and rabbits are caught and kept alive for ritual games and offerings. The ceremonies include many dances — masked men impersonating the spirits, and a ceremony at sunrise of the solstice performed at a specific site on the mesa above which the sun rises, called the Sun's House. Dates for important ceremonies are almost always set eight days in advance, eight being a multiple of the sacred number four. (White p. 87).

Isleta Pueblo

Location

Isleta Pueblo is located less than 12 miles south of Albuquerque, the largest city in New Mexico. The Village itself occupies both sides of the Rio Grande, and the Reservation extends both east and west of the river. The western boundaries of Isleta Reservation are contiguous with the eastern boundaries of Laguna Reservation to the west, and Canoncito Navajo Reservation to the north. In reading about a history of Isleta in 1929 by Parson, I was intrigued by the many connections that this pueblo has had to surrounding pueblos, including several Pueblos which are no longer occupied. The name "Isleta" means "Little Island" is Spanish, but Isleta Pueblo occupies an area of 211,002 acres and a population of more than three thousand. It has been a refuge for peoples from the abandoned pueblos of Quarai and Tajiique, in the mountains to the east, when those pueblos were abandoned because of Apache depredations and incursions of the Spanish. (Parsons, 1929) When the Isleta people returned to their home after the Pueblo Revolt, they brought with them Hopi mates and children. Isleta also has history connecting it with the pueblos of Zuni and Sandia, mainly with Isleta as a refuge from European introduced diseases that were decimating the Indian populations. There have also been intermarriages between men and women of these pueblos, including Laguna. In some ways, it seems to have been a central refuge for many surrounding pueblos, having ties to the Mexican south as well. Because of conflicts between the heterogeneous societies that now co-exist within the pueblo, Isleta today is comprised of two small communities, Oraibi and Chicale, and the

main pueblo, Isleta.

The source of all ceremonial life in the Pueblo is the town chief, the *Cacique*. He was considered so essential to the town at the time Parsons was writing, that he was not permitted to leave the town. His land was planted and harvested for him, and he could do nothing but ritual work. He held a particularly intimate relationship with the sun.

Everyone in the pueblo sprinkles corn meal or pollen (they are used interchangeably) to the sun at sunrise. In other ceremonies, it is also sprinkled to the moon and stars, in all directions or in the direction of the spirit that is being addressed.

Several common Pueblo concepts such as the "Sun's house," a fixed point on the horizon marking the solstices, as well as observations of the moon for timing ceremonies, are lacking in Isleta traditions. Rather there is a correlation of ceremonies with the "Augustan calendar." Thus, December 1-20 is the time of the Winter solstice ceremonies and June 1-20 the Summer solstice ceremonies. There is no mention of horizon markers in the accounts of Parsons; rather the ceremonies are centered around a shaft of sunlight that enters through a hole in a ceremonial room and shines on the floor. A ritual "pulling down the sun" accompanied by singing initiates several days of ceremonies including many offerings and storytelling.

Zuni Pueblo

Location

Zuni Pueblo is located in west central New Mexico, on the Arizona border. The Zuni Reservation is bordered on the east by the Ramah Navajo Reservation, and on the northeast by the Cibola National Forest which encompasses the Zuni Mountains. The city of Gallup, New Mexico is about 30 miles to the north of Zuni Pueblo. Interestingly, when the Spaniards first encountered the pueblo in the 16th century, they were living in Hawikuh and five or six other towns. Collectively these came to be called the Seven Cities of Cibola, which became the focus of the golden empire sought vainly by Coronado and other explorers. After the Spanish defeat of the Pueblo rebellion in the late 17th century, the Zuni were crowded into one multi-story masonry pueblo. (Encyclopedia Britannica, 12:941)

The Nature and Function of Prayer in Zuni Culture

Because of their very special nature, I have chosen a selection of prayers of the Zuni culture to try to illustrate how the pueblo people perceived natural events such as sunrise and sunset. Zuni Prayers express the essence of the perceptions of the Zuni people to real world events such as the solstices, sunrise and sunset. Prayers are sacred and powerful in themselves, and are considered a source of great power. Zuni prayers deal with external events and conditions rather than with inner states. Their content is mostly limited to two fields: natural phenomena, such as sunrise, sunset, dawn, night, the change of seasons, the phases of the moon, rainstorms, etc. and ritual acts, especially the making of prayer sticks, setting up of altars, and transfer of authority. (Bunzel, p. 618)

The form and content of each prayer is constant, although there is some degree of individual variation. Prayers are formally learned or acquired by legitimate means from someone who has

the right to use them, and they must be paid for (Bunzel, p.493), a process which helps to ensure the accuracy and meaningfulness of this oral tradition.

Nearly all prayers are requests with accompanying offerings. The prayers are constructed in three sections: a statement of the occasion, a description of the offering, and the request. Also included are regular blessings for long life, old age, rain, seeds, fecundity, riches, power, and "strong spirit". Prayers are never used for strictly personal requests. Unlike western religions, Zunis do not humble themselves before the supernatural, they bargain with it.

Prayer at Sunrise
Now this day,
My sun father,
Now that you have come out standing
to your sacred place,
That from which we draw the water of
life,
Prayer meal,
Here I give to you.
Your long life,
Your old age,
Your waters,
Your seeds,
Your riches,
Your power,
Your strong spirit,
All these to me may you grant.
(Bunzel, 1929)

The Pekwin Sets the Date for the Summer Solstice

"Before the summer solstice the Pekwin makes daily observations of the sunset from a shrine east of the village. When the sun sets behind a certain point in the mesa he begins to count days with offerings of prayer sticks. There are six such offerings... At dawn of the morning following the last offering he announces from the highest housetop in Zuni that the summer solstice will take place after eight days (Bunzel, 1929)

Now that those who hold our roads,
Dawn ancients,
Youths,
Matrons,
Maidens,
Over their sacred place,
Have raised their curtain.
Here, on the corn priests' housetop
I stand up.
My fathers,
My sun father,

We have made your days.
Divine ones,
Remember your days.
When this many days, eight days, are past,
On the ninth day.
All together
We shall reach your appointed time.
This many days anxiously waiting
You shall pass these days.
I think it is this many days, eight days,
And then on the ninth day.
You will grant that all of us finish our roads
(Bunzel, 1929)

Ideas and Strategies for developing the proposed curriculum into a meaningful learning experience for students

There are nuts and bolts required to use every instructional unit in a real classroom setting. Students may need to be prepared by reviewing basic scientific concepts. The material must be at the appropriate reading level, concepts must be understandable to the students, and there should be an assessment of the general appropriateness of the topic as well as its method of presentation.

Assessment of skill levels

Students may receive an initial assessment of basic skills in reading and comprehension, writing and presentation, and then in the higher skills of analysis and evaluation. These assessments will determine the course of instruction, as well as whether some sections need to be altered or deleted. There should be no hesitation on the part of the instructor to slow down and spend quality time on comprehension or topics of special interest to the students, even if these detours do not allow completion of the unit. Good assessment and close monitoring of the unit ensure student success. In depth coverage of parts of the unit is preferable to a meaningless race to cover all the material.

Analyzing the Student Population

The student population of the district in which I am employed is largely minority, many of whom are bilingual or ESL students. The interests of many of these students are often centered on their social life. Their lives both in and out of school are greatly influenced by close ties to friends and neighborhood social activities. These relationships and activities often consume their energies to the neglect of thinking about their futures and a life beyond the confines of their immediate friends, families and neighborhoods. Too often their educational aspirations are limited to a high school diploma or GED. These students have both the ability and often the desire to pursue higher education but are too often held back by peer pressure and family obligations.

Linking the proposed topic to the students

There is the already stated interest in developing a closer link between the students and the world they live in. These topics may or may not be a part of their own cultural backgrounds, but they are part of the New Mexico culture in which they live. Understanding their own home place provides the tools necessary for understanding the larger community of mankind with its incredible diversity of culture and aspirations.

Making education effective

This topic is included as an opportunity to introduce the necessity of making student success possible by reducing the ratio of students to teachers, and the need to disperse students into smaller learning centers which eliminate the problems so often encountered in large middle and high schools. Please obtain a copy of the book *The Power of Their Ideas* by Deborah Meier, from which I will excerpt some important observations.

This is a book worth reading. It presents solutions that have been effective in one Harlem school from 1974 to the present for increasing students success. The author sees these strategies as applicable to schools across America. Small schools, rather than large schools is not a new concept, but Ms. Meier has found that about 300 students is a manageable size to create a climate of trust, good communication and caring among both staff and students. She states that experts at team building find a group works best between 15 and 20. "By this standard, both class size and staff size should top at around 20."

With this criteria, her school has reduced the number of children a teacher sees each day from 160 to only 40. In this setting, a real opportunity exists to know the students and their families individually, which opens the door to student success, lower dropout rates, higher test scores and a generally more manageable school. More time is spent in educating and learning and time spent on discipline is minimized. Meier has many other innovative ideas in her book, but these are particularly notable.

"Labs for Learning"

In our educational community of Albuquerque Public Schools, there are already an increasing number of dispersed learning centers, including alternative schools, continuation schools and computer based programs such as NOVANET with facilitating instructors. Dispersed learning centers, facilities to accommodate an instructor and 15 or 20 students, open longer hours (from 7am to 10pm) and Saturdays, with flexible rules for student time in class, are part of this observer's vision of the future of educational facilities. Small learning centers or labs located *within* the communities they serve, open at hours to accommodate the students. Criteria for graduation will be defined, as it is presently, by the district or the school center. Students will have access to view their transcripts (a real incentive technique as many students do not know what they need to graduate). They will be able to access most required courses through computer based facilities, and access to the learning centers during hours which accommodate their schedules. The instructors in these facilities will by necessity have wider roles as facilitators for a range of subject areas, or there may be traveling educators to work with students in specific content areas.

These learning centers will be linked to a "hub" campus of about 300 students, which also

serves as the home base for a reduced administrative staff, but credits may be earned at all extension learning centers for most basic academic subjects. This hub may include facilities for specialized content instruction, such as science labs and courses requiring other special equipment or instructional materials.

School to Careers

Quality of life is most often linked to career choices in our society. The ideas in this unit can expose students to the idea that they are capable of developing the skills to go on to a challenging career. Challenging careers expand a person's awareness of both the greater physical world and the world of the mind. Challenging careers present the opportunity to experience a more cosmopolitan view of life, society, culture and the very real potential contributions a student is capable of making to a better world.

Linking the topic to real world events.

Whenever possible, lessons should be introduced by some real event. An archeological dig, or an article from the local newspaper about local cultural events, such as Pueblo ceremonies, can be used, with some searching, to introduce topics. Using contemporary Internet technology, a link can be found to just about any topic. I like to go to a major Internet international news location, such as ABC.com, CNN.com or TheTimes.com. If there is not an article in the daily section, a search of the archives will usually yield many related articles.

Cultural links

I suggest a search for some cultural link, possibly historical, which might link the topic to goals for self-improvement. It is desirable to establish, in explicit phrases, the link of the curriculum to the students—both individually, culturally, and career-wise. One example might be a person of the student's color, or culture, or interest, that is currently engaged in astronomical research, or archeology, or who has a strong amateur interest in the subject. Another might be a "storyteller" from the local Indian community, or perhaps any role model or adult who is interested in education. There are many choices in most communities. Having someone else in the classroom for a time is a big relief for the students, and the instructor as well!

A Contract with the Student

A written contract with the student, detailing the goals of the curriculum, the conceived benefits of the studies and finally, a signed commitment detailing expectations for both time devoted to the unit and the quality of work expected might be one strategy to use for student success. The contract could include explicit expectations and a statement demanding commitment to excellence. I have been told by some teachers that these work—sometimes. But if the unit isn't interesting, then I suspect that a contract, signed or not, will not inspire participation.

Student Learning Objectives

"Bring it home." Student objectives must be explicit and very understandable. Answer the questions that are inevitable: "What good is this stuff to me, anyhow?" "Of what use is this stuff to me, now or in the future?" "When would I ever use this?" Explanations for the importance of

learning certain content is difficult, but just the exploration of the topic through discussion or activities may contribute to the student's desire to learn. This phrase "Bring it home" can be part of the next section on "Habits of Mind".

Habits of Mind — CPESS (Central Park East Secondary School)

I recently read a very stimulating book on education, and I would like to use this opportunity to introduce the reader to a means of focussing the student's learning on essentials that are selected to enable the student to *find unity across disciplines*. The author is Deborah Meier, the book *The Power of Their Ideas*. These "Habits of Mind" as she labels them are as follows:

1. The question of evidence, or "How do we know what we know?"
2. The question of viewpoint in all its multiplicity, or "Who's speaking?"
3. The search for connections and patterns, or "What causes that?"
4. Supposition, or "How might things have been different?"
5. Why any of it matters, or "Who cares?"

These habits, Meier points out, are typical thinking strategies employed by professionals in many disciplines — law, journalism, science, and education. Meier emphasizes that these habits need to be practiced in depth to become habitual. "Young people need to be immersed in their use," and "instructors must demand evidence in the form of performance at real, worthwhile tasks." (Meier, 1995) Now, there's a challenge!

Extension Activities and Integration of Curriculum

Because of the very nature of science, there are extension activities in all the content areas. There is no science without language, no science without math, no science without history, and no science without culture or art. Science, of all the content areas can be integrated easily into all the content areas, and should certainly be linked very closely with the math department, or combined with it.

Portfolio Assessment- not just a folder

"Students should be expected to demonstrate their abilities directly—to "show" what they know and can do. Multiple-choice tests are not a substitute for the real performance." (Meier, 1995) Meier's school has taken an already established alternative strategy for assessment and integrated it into the last phase of her home educational institution.

This time for the student is called the "Senior Institute", when each student takes on the task of completing fourteen portfolios full of work, including seven major presentations in such areas as math, science, literature, history, the arts, community service and apprenticeship, and autobiography." The presentations are made to a graduation committee composed of several faculty members, an adult of the student's choice, and another student. These presentations are the record of the student's success at CPESS (Central Park East Secondary School), and the *basis for earning the diploma*. This model was *too good* to miss inserting into this paper, which will be disseminated to many schools in the Albuquerque Public Schools district.

Challenges in developing this instructional unit

One challenging aspect of this unit development is finding connections to the astronomy and culture of the past, and its significance to the present and to the future. To develop an integrated unit centered around the development of the International Space Station, for instance, to tie the past to the present and the present to the future, with possibilities of discussion of esoteric questions of origin and evolution to more practical explorations of career opportunities.

Originally, I planned to construct a unit which explored two perspectives. The first — a view from earthbound ancient cultures using naked-eye observations. The second — a view from the more contemporary construction, the International Space Station. I see many possibilities within this path of learning, including the contrast of the past to the future, the limited vision of two eyes compared to the Hubble Telescope, and the essence of a pueblo built out of the earth to the space station fabricated from refined materials. Such opportunities! My final decision was to only suggest the possibilities for a separate unit on the International Space Station, and to leave that for another year!

But now that I have had the opportunity to read Meier's book, perhaps the real challenge is not within this unit itself, but in finding ways to get the students to the unit! With dispersed learning labs that have access both to very structured learning courses as well as Internet access, this curriculum unit, and all the others are available to all students for content assimilation. Just reading the extensive "rationale" demanded in units on the YTI site will certainly be more interesting than reading out of a text! There will always be a "misuse" of the Internet facilities by some students (and instructors), but the wealth of activities, curricula and information must become a part of the student's learning resources. Truly integrating the World Wide Web into the curriculum is a challenge all teachers face in the next millenium. Students may have access to these sources. They need not be the special province of the instructor, plucked out of some mysterious sourcebook.

Two Suggested Student Activities

These simple activities require minimal materials, engage the students in personal observation and recording, and are excellent starting points from which they can learn many neat things about the world they live in.

Student Activity #1: Observing and Recording Sunrise or Sunset

Objective: Each student will create a horizon profile on which to record the position of sunrise or sunset over a period of time.

Materials: Paper, pencil, and ruler.

Procedure:

1. Construct a scale at the bottom of the length of the paper to measure angular distances. This scale will also make the horizon sketch more accurate. I suggest that this scale be 1"=1 fist. (Angular measurements may be estimated with a hand extended at arm's length. A closed fist will be approximately equal to 10 degrees of arc for an adult,

proportional for a child)

2. Sketch about 24 inches of the horizon (on the paper, about 240 degrees of arc of the horizon), using the fist as the unit of measure.
3. Include all "features" such as trees, building profiles, light poles, mountains or hills, etc.
4. Label each feature.
5. Record the position of the first beam of sunrise or the final ray of sunset
6. Note the date and the time on each observation.
7. **Note:** Do this at least for several weeks before and after the winter solstice (Dec 21), or better, for the entire school year. The act of observing and recording phenomenon in the natural world is just as important to today's populations, for personal development, as it was from prehistoric times to Darwin. Perhaps more so.

Student Activity #2: Observing and Recording the Phases of the Moon

Objective: Each student will construct a chart to record the phases of the moon on a daily basis for at least a month.

Materials: Paper, pencil, and ruler.

Procedure:

1. Construct a chart with the following items:

- A border around all sides of 2 centimeters width.
- Fill in the center with a month of calendar days, in typical calendar format.

2. In the border:

- Create a legend to explain the phases of the moon, including associated terms such as full, new, waxing, waning and crescent.
- Define "moon". Include the word origin.
- Find at least three important moon facts; i.e. distance from earth, diameter, and the effect of the moon on tides.

3. Record in the date box the phase of the moon by direct observation each night/day.

4. Sketch visible features of the moon. Encourage use of binoculars, if available.

5. Note: Use all this data gathered by direct observation to hypothesize about the direction and shape of the orbit of the moon around the earth.

the reasons for the changes in phases why the observed features of the moon do not change and so many more!

Additional Student Activity Sources

The following is a list of several noted publications of student activities in physics and astronomy.

Andrew Fraknoi, ed. *The Universe at Your Fingertips: An Astronomy Activity and Resource Notebook*. The Astronomical Society of the Pacific. Project Astro, 1999.

Handwerker, M. *Ready to Use Earth & Astronomical Science Activities for grades 5-12*. The Center for Applied Research in Education, West Nyack, NY, 1999. *This volume is one of a series of the "Secondary Science Curriculum Activities Library" and provides 15 uniformly formatted teaching units which include a weekly agenda, content notes for lecture and discussion, a fact sheet, home suggestions and lesson plans.* www.phdirect.com.

Zeilik, Michael. *Interactive Lesson guide for Astronomy: Cooperative Learning Activities*. The Learning Zone, Inc. Santa Fe, NM, 1998. TLZinc@aol.com.

This includes activities for naked-eye observations as well more in-depth activities investigating phenomena of physics and astronomy such as Kepler's Laws, Doppler Shift and Stellar Parallax. The activities are self-contained and for the most part require simple mathematical calculations.

Bibliography

Bunzel, Ruth. *Zuni Ritual Poetry*. Forty-seventh annual report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. United States Government Printing Office. Washington, D.C., 1929.

Bunzel, Ruth. *Zuni Origin Myths*. Forty-seventh annual report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, pp.467-1086. United States Government Printing Office. Washington, D.C., 1929.

Meier, Deborah. *The Power of Their Ideas: Lessons for America from a Small School in Harlem*. Beacon Press, Boston, 1995.

Parsons, Elsie Clews. *Isleta, New Mexico*. Pp. 193-466.

Forty-seventh annual report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution. United States Government Printing Office. Washington, D.C., 1929.

White, Leslie A. *The Acoma Indians*. Forty-seventh annual report of the Bureau of American Ethnology to the Secretary of the Smithsonian Institution, pp. 17-192. United States Government Printing Office. Washington, D.C, 1929.

Wood, L. *Education Outreach: The Sidereal Times*. Newsletter of the Albuquerque Astronomical Society. P. O. Box 50581, Albuquerque New Mexico 87181-0581, 1999.

Zeilik, M. *Conceptual Astronomy: A journey of ideas*. John Wiley & Sons, Inc. New York, 1993.

Zeilik, Michael. *Anticipation in Ceremony: The Readiness is All in Astronomy and Ceremony in the Prehistoric Southwest*. . Papers of the Maxwell Museum of anthropology. John Carlson and James Judge, eds.

Zeilik, Michael. *Keeping the sacred and planting calendar: archaeoastronomy in the Pueblo*

Southwest. World Archeoastronomy, ed. Aveni, A. Cambridge University Press, 1986.

Zeilik, Michael. *One Approach to Archaeoastronomy: An Astronomer's View*. Journal for the Center for Archaeoastronomy, 1983.

Additional Teacher Resources-Articles and books

Carlson, John W. and W. James Judge, Eds. *Astronomy and Ceremony in the Prehistoric Southwest* (Papers of the Maxwell Museum of Anthropology, Number 2). Albuquerque: Maxwell Museum of Anthropology, University of New Mexico, 1993.

Clark, Ann N. *Sun Journey: A Story of Zuni Pueblo*. Ancient City Press, 1988.

Farrer, Claire R. *Living Life's Circle*. Albuquerque: University of New Mexico Press, 1991.

Glenn, William. *The Modern Astronomy of Ancient Observatories: A Practical Survey*. The Science Teacher, April 1987.

Friffin-Pierce, Trudy. *Earth Is My Mother, Sky Is My Father: Space, Time and Astronomy in Navajo Sandpainting*. Albuquerque: University of New Mexico Press, 1992.

Lipe, W. D. *Anasazi/Pueblo Culture Period in the Northern Southwest (Pecos Classification)*. Crow Canyon Archaeological Center.

Malville, J. McKim and Claudia Putnam. *Prehistoric Astronomy in the Southwest* (revised edition). Johnson Books, 1993.

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

Williamson, Ray A. *American Indian Astronomy: An Overview*. Stars Above, Earth Below: American Indians and Nature, Bol, M., ed. Carnegie Museum of Natural History.

Williamson, Ray A. *Living the Sky: The Cosmos of the American Indian*. New York: Houghton Mifflin, 1984.

Williamson, Ray A. and Claire R. Farrer, eds. *Earth and Sky: Visions of the Cosmos in Native American Folklore*. Albuquerque: University of New Mexico Press, 1992.

Williamson, Ray A. *Archaeoastronomy in the Americas*. Ballena Press, 1981.

Zeilik, Michael. *Astronomy, The Evolving Universe*. John Wiley & Sons, Inc. New York, 1991.

Zeilik, Michael. *Archaeoastronomy at Chaco Canyon: The Historic-Prehistoric Connection*. In Ned Light On Chaco Canyon, School of American Research Press, Noble, David, ed., 1983.

Zeilik, Michael. *Conceptual Astronomy*. John Wiley & Sons, Inc. New York, 1992.

Zeilik, Michael. *Sun Shrines and Sun Symbols in the U. S. Southwest*. Archaeoastronomy: Journal for the History of Astronomy, no. 9, Hoskin, M. A., ed., 1985.

Zeilik, Michael. *The Ethnoastronomy of the Historic Pueblos, I: Calendrical Sun Watching*.

Archaeoastronomy, no. 8 (JHA, xvi (1985))

Zeilik, Michael. *The Ethnoastronomy of the Historic Pueblos, II: Moon Watching*. Journal of the History of Astronomy, Hoskin, M., ed., 1986.

Teacher Resources- Web Sites

The following web locations contain content as well as student activities. I like to assign activities where the students explore web sites with tasks which include everything from writing down the location address, and explaining what the symbols mean, to scavenger hunts for specific information, to research reports. There are now many online interactive activities that the students may do with proper supervision.

<http://www.wam.umd.edu/~tlaloc/archastro/> Home Page of the Center for Archaeoastronomy, founded in 1978 at the University of Maryland "to advance research, education and public awareness of archaeoastronomy. This location includes an introduction to the topic, links to related sites, as well as essays from the Center's Newsletter.

http://www.exploratorium.edu/learning_studio/cool/astronomy.html This is the web location of the highly acclaimed Exploratorium in San Francisco.

<http://cse.ssl.berkeley.edu/> The Home Page for the Center for Science Education at UC Berkeley. Includes links to lesson plans, internet-interactive units and more.

www.usno.navy.mil The U.S. Naval Observatory performs an essential scientific role for the Navy, for the Department of Defense and for the United States. Its mission is to determine the positions and motions of celestial objects, to provide astronomical data, to measure the Earth's rotation and to maintain the Master Clock for the United States.

<http://www.nativeweb.org> I have included this location for its collection of contemporary poems and stories by Native Americans, which often express the same integrated philosophy of living that was typical of ancient cultures.

<http://www.indianpueblo.org> The Indian Pueblo Home Page in Albuquerque, New Mexico. Information about each Pueblo, as well as a yearly calendar of Indian Dances and Events at the Pueblos.

http://ccwf.cc.utexas.edu/~vbeatty/exhibit_archive/sun/calendar.html This location includes a history of astronomy, archaeoastronomy and Ethnoastronomy, and well as links to related sites.

<http://arcturus.pomona.edu/sw/Navajo.griffith.essay2.html> An essay by Matthew Green "The Sacred Sky of the Navajo and Pueblo". This essay has several parts, including The Southwest Environment, Astronomy and Religion of the Southwest Peoples, and more.

<http://www-hpcc.astro.washington.edu/scied/astro/astroarchaeo.html> This is a mirror page maintained by Wolfgang Dick at the University of Bonn. There are many links to archaeoastronomy, Ethnoastronomy, book sources, course information and links to others university departments dealing with this subject.

[Http://www.swanet.org/](http://www.swanet.org/) Home Page for Southwestern Archaeology. This is described as the "type site" for scientists who practice archaeology in the American Southwest. Links to many locations, much information about Anasazi Culture and Chaco, and links to sites by State.

<http://www.ets.uidaho.edu/chaco/> This site has links to information on many of the Anasazi Great Houses, including maps.