

Ideas for Integrating Astronomy into Other Subject Areas

Social Sciences

Compare constellations from different cultures:

What was important to each culture is reflected in the pictures they imagined in the sky. For example, the Inuit imagined a blubber container and lamp stand near each other in the northern sky; the blubber was the fuel for the lamp.

Would the students expect the ancient Egyptians to have visualized a blubber container in the sky? Why not? What constellations would they expect the Egyptians to have imagined? Did the Egyptians in fact have constellations that the students suggested?

Take one recognizable group of stars (Orion, Ursa Major/the Big Dipper, and Leo are all excellent choices), and have students compare how various cultures connected the dots to make different pictures in the sky.

Discuss why constellations were created:

1) To act as a basic calendar for harvesting and planting. For example, the Navajo see the stars the Greeks called Orion as First Slim One. First Slim One is a star figure associated with agriculture and is known as the keeper of months. When this figure was first seen setting at twilight, in early May, it signaled the time to begin planting crops.

When nearby Dilyehe [the Pleiades] is seen rising just before dawn in late June, the time for planting is over. A curved line of stars beside First Slim One is often seen as a digging stick, a tool used by many Native Americans to prepare the ground for planting seeds. The reference to 'slim' in the name of this star figure may be related to the fact that it is visible at night during the lean winter months of the year, when most plants are dormant and food for the people is scarce.

Have the students research other constellations (from any culture) that were used as basic agricultural calendars.

2) Constellation legends also frequently served as morality tales, to help communicate what was considered good and bad behavior. For example, the Wasco tribe of the Pacific Northwestern area of the USA, saw the stars of Orion as a canoe race between Chinook Wind and Cold Wind. Share the following legend with students, and ask them what it tells them

about the Wasco's values.

Once there was an old grandfather who always caught many salmon in Big River. His grandson Chinook Wind was very proud of him. They always had plenty to eat and some to give away to more unfortunate fishermen's families. This began to change, however, when Chinook Wind left to visit relatives in a faraway camp. That was when Cold Wind decided he should take over.

Cold Wind wanted salmon, too. But because he was lazy, he always came to Big River too late for good fishing. He decided simply to take a salmon from Old Grandfather.

Every day, Cold Wind got up later and later. Every day he went down to fish too late to catch anything. Every day he stole a salmon from Old Grandfather.

One day, Chinook Wind returned from his journey. When he heard how Cold Wind had been taking salmon from Old Grandfather, he grew angry and decided to teach him a lesson. Chinook Wind hid in Old Grandfather's tipi and waited patiently until he came home from fishing. That day Old Grandfather returned whistling merrily, for he had caught more fish than usual.

As usual, Cold Wind came roaring up to the tipi demanding salmon. This time, however, Chinook Wind boldly stepped out. And so the two wrestled. Chinook Wind fought hard and won the match. Because Chinook Wind won, Cold Wind can never again take salmon away from Old Grandfather. To this day Chinook Wind is stronger than Cold Wind.

If you look closely at the sky, you can see Chinook Wind and his brothers in their canoe close to Old Grandfather's salmon. Cold Wind and his brothers are in a canoe far behind. Cold Wind can never get Old Grandfather's last salmon.

Language Arts

Create a constellation:

As discussed in the last section, the sky has inspired stories for thousands of years. Have students create their own constellations, and then write legends to explain how those constellations ended up in the sky.

Chemistry

Stellar evolution/nuclear fusion:

Discuss how stars change over the course of their “lifetimes,” as lighter elements fuse into heavier elements. Suggestions:

- Show images of at least one star in each stage
- Use the periodic table to point out each element as you discuss it
- Present a lesson on spectroscopy, and allow students to observe the spectra of different gases
- Use the Hertzsprung-Russell diagram to discuss the relationship between a star's spectral type and its absolute magnitude

Background resources:

http://imagine.gsfc.nasa.gov/docs/science/known_12/stars.html
<http://education.gsfc.nasa.gov/ess/Units/Unit5/U5L06A.html>
http://en.wikipedia.org/wiki/Stellar_evolution
<http://www.astronomytoday.com/cosmology/evol.html>
<http://www.umich.edu/~gs265/star.htm>

Math

Have students calculate their weight on different planets:

Discuss the difference between mass and weight. Point out their mass would not change if they traveled to another planet, but their weight would because of different gravitational forces on the other planet.

To calculate their weights on other planets, students should multiply their weight on Earth by:

Mercury	0.378
Venus	0.907
Earth's moon	0.166
Mars	0.377
Jupiter	2.364
Saturn	1.064
Uranus	0.889
Neptune	1.125

Have students calculate their age on other planets:

Discuss what a “year” means (one orbit around the sun). Is a year the same length on every planet in the solar system? No, the length of a year varies, since planets are different distances from the sun.

To calculate their age on different planets, students should multiply their Earth age by:

Mercury	4.15
Venus	1.63
Mars	0.53
Jupiter	0.084
Saturn	0.034
Uranus	0.012
Neptune	0.006

Parallax:

Parallax was used to calculate the distances to stars and to determine the length of an AU (astronomical unit).

A simple way to introduce the concept of parallax:

- Have each student hold up one finger two to three inches in front of his or her nose.
- Instruct students to close one eye at a time while holding the finger still.
- What do the students notice?
- Repeat the activity for something on the far side of the room.
- What do the students notice?

For information on the use of parallax to determine the length of one AU, see Digitalis' "How Do We Know?" lesson for high school students (14-18 years old):

<http://DigitalisEducation.com/curricula.html>

Ptolemy's model of the solar system:

Ptolemy was a Roman astronomer, mathematician, and geographer who lived in Egypt from about 87 to 150 CE. He was a supporter of the geocentric model of the solar system—that is, Earth in the middle instead of the sun in the middle. In order to make his model accurately predict the movements of the planets, Ptolemy had to create a complicated system using epicycles, equants, and more.

You can download a PDF of the Ptolemaic system from Digitalis' lesson plans webpage:

<http://DigitalisEducation.com/curricula.html>

History

Discuss past, present, and future comet visits, planetary conjunctions, eclipses, transits, meteor showers, etc. (Dates and viewing locations for these events are easy to find with simple web searches.)

Discuss the role of important scientists/mathematicians in astronomy history as well as in world history: Aristotle, Ptolemy, Nicholas Copernicus, Johannes Kepler, Galileo Galilei, Sir Isaac Newton, Henrietta Leavitt, the brother and sister team of William and Caroline Herschel, Edwin Hubble, etc.

Some information about these topics can be found in Digitalis' "How Do We Know?" lesson for high school students (14-18 years old):

<http://DigitalisEducation.com/curricula.html>

See also:

http://en.wikipedia.org/wiki/History_of_astronomy

http://en.wikipedia.org/wiki/Isaac_Newton

http://en.wikipedia.org/wiki/Galileo_Galilei

http://en.wikipedia.org/wiki/Henrietta_Leavitt
<http://en.wikipedia.org/wiki/Ptolemy>
<http://en.wikipedia.org/wiki/Copernicus>
http://en.wikipedia.org/wiki/Johannes_kepler
http://en.wikipedia.org/wiki/William_Herschel
http://en.wikipedia.org/wiki/Caroline_Herschel

Discuss the space race of the 1950's and 1960's, in particular the surprise successful of the Russian satellite Sputnik:

<http://en.wikipedia.org/wiki/Sputnik>
http://en.wikipedia.org/wiki/Space_Race

Physics

Electromagnetic Spectrum:

Everything we know about space we know from studying light. Discuss the electromagnetic spectrum and how astronomers use each wavelength of light to learn about the universe. This topic is covered in detail in Digitalis' "How Do We Know?" lesson for high school students (14-18 years old):

<http://DigitalisEducation.com/curricula.html>

Egg Drop:

How do you design a vehicle that can land on the surface of Mars at great speed without sustaining damage to its cargo? Discuss the various robots that have been successfully sent to Mars, focusing on how NASA engineered the landing craft.

Background information for the missions:

Mars Pathfinder Mission: http://www.nasa.gov/mission_pages/mars-pathfinder/index.html

Mars Exploration Rovers: http://www.nasa.gov/mission_pages/mer/index.html

Phoenix Mars Lander: http://www.nasa.gov/mission_pages/phoenix/main/index.html

After studying how NASA designed their landers, have students work in teams to design and create a vessel that will enable an egg to drop from a significant height (the school roof, for example) without breaking. Have students begin collecting materials from their homes at least one week before they begin building their landers. This activity can be messy, but it is always a lot of fun!

Newton's Laws of Motion and Universal Gravitation/Einstein's Theory of Relativity:

Activities and discussions about these topics can be found in Digitalis' "How Do We Know?" lesson for high school students (14-18 years old):

<http://DigitalisEducation.com/curricula.html>

Impact craters:

Show an image of the moon, and discuss the cratering visible on the surface. Introduce vocabulary such as ejecta, rays, and central uplifts. Have the students experiment with making their own craters using one or both of the following lesson plans:

<http://www.astrosociety.org/education/publications/tnl/23/crater2.html>

http://www.spacegrant.hawaii.edu/class_acts/CratersTe.html

Earth Science/Geology

Major surface features:

View Earth (from the moon or from a point high above the earth). If necessary, jump day by day until the earth is full. Fast forward time to demonstrate Earth's rotation, and discuss the following:

- Prominent geologic features (Lake Titicaca, Andes Mountains, Rocky Mountains, Himalayan Mountains, Nile River, etc.)

Geography

Continents/oceans/major rivers/etc.:

View Earth (from the moon or from a point high above the earth). Zoom in until surface can be distinguished. If necessary, jump day by day until the earth is full. Fast forward time to demonstrate Earth's rotation, and discuss the following:

- Names of continents
- Names of oceans
- Major geographic features—mountain ranges, lakes, rivers, etc.

Night Earth:

Jump forward day by day until the earth is new, which will show you city lights from NASA's "Visible Earth" image on the side of the earth facing you. Discuss the following:

- Bright areas tend to be areas with dense populations
- Difference in the lights over North Korea and South Korea—what do the students think is the cause of this disparity?
- The visibility of the Trans-Siberian Railway
- The visibility of the US Highway system
- The lights clustered along the Nile River—Why is that an area of dense population?

For more information or to download the Earth at Night two-dimensional image, visit:

<http://www.nightearth.com/>

http://visibleearth.nasa.gov/view_rec.php?id=1438

Planetary surface comparisons:

Compare and contrast the surfaces of Mars and Earth. What features do the two planets have in common? How are they different?

Biology

Invent an alien:

Have students work in teams. Each team will research a planet, then invent an alien that could live in those conditions. Brainstorm with students the factors that they will need to consider, such as:

- Does the planet have an atmosphere? If so, what is the atmosphere's composition?
- How close to the sun does the planet orbit?
- How do the atmosphere (if any) and distance from the sun affect the typical temperature range on that planet?
- How strong is the force of gravity on the planet?
- How/what will the alien eat?
- How will the alien move?

See the “Invent an Alien” activity for more information:

<http://www.astrosociety.org/education/publications/tnl/01/halley2.html#activity>

Manned Missions to Mars:

The students may have heard past discussions of manned missions to Mars. Why have we used robots in the past? What would astronauts have to bring with them on the trip?