

STUDY GUIDE: LUMA

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The following is an overview of material, available for teachers, in conjunction with theatrical performances by Luma, produced by First Light Company.

BACKGROUND:

Luma is a show about light, performed 80% or more in the dark. It is presented in three suites: Natural, Artificial, and Metaphysical Light. Luma's creator, Marlin, was inspired to create the show after seeing natural wonders such as the lava flow on Hawaii's Big Island, and the night sky.

THE NIGHT SKY AS INSPIRATION:

Our **Sun** is perhaps the most prominent of all sources of natural light. Our eyes see the kind of radiation the sun is best at producing--visible light--but the sun also produces radiation our eyes can't see, such as ultraviolet rays.

Our **Moon** is closest to Earth--at 240,000 miles away. It's a source of **reflected** light and is represented in Luma's first suite, Natural Light. The moon has no atmosphere, water, weather, nor life forms, and its cratered surface changes very slowly.

We've all grown up being familiar with pictures of Earth, first available in the 1960's. Since then, our spacecrafts have managed to capture images of 8 of the 9 planets in our solar system. You may have created a model of our solar system in a science class, revealing what you know of Earth's size compared to the other planets.

The surface of **Venus** is so masked by perpetual clouds that radar beams had to be used to see what was below the dense layer of clouds.

Mars is visible as a "red planet" with only 38% of Earth's gravity and consequently, a very thin atmosphere.

Jupiter has a giant red spot--referred to as the "mother of all storms."

Saturn, which consists of the two lightest elements--hydrogen and helium, has rings which are not solid but are made up of icy particles.

For thousands of years on Earth, the dark has evoked fear and awe into the hearts of humans. The night brought the danger of wild animals and the wonder of the sky. Before technology and hard science, countless stories of the stars were passed down throughout many cultures to explain what people saw. We in the West are most familiar with myths from Greek culture. For example, **Orion** [who recognizes his belt?] was a mortal who bragged about being the best hunter there ever was. He was punished by a god from Mount Olympus who sent a scorpion to bite him. To keep the peace, as the story goes, Orion and Scorpio were placed on either side of the heavens. This story offered an explanation of why we never see Orion, a winter constellation, and Scorpio, a summer constellation, in the sky at the same time.

From the Hubble Space Telescope, the **Orion Nebula** has been captured on film. The nebula is visible to the naked eye in a dark sky, but with our modern cameras, we're able to learn more about how this star system--1,500 light years away--is being formed. Our technology allows us to begin to understand what we see without reliance on myth.

The death of stars is as spectacular as their formation. **Eta Carinae** is a star more than a hundred times the mass of our Sun and four billion times more luminous. This star was first observed in 1677, but in 1860 it was barely visible to the naked eye.

Supernova are massive natural sources of light likened to the artificial light of fireworks. Supernova refer to stars that become unstable at the end of their lives and explode, becoming extremely bright for a short period and producing new elements. [The Big Bang when it exploded created the two elements, hydrogen and helium.]

Comets are chunks of dirty snow and ice. The icy bodies of comets cannot melt because there is no pressure in space to allow for the existence of liquids, so the ice evaporates directly from solid to gas, forming a vapor cloud and tail.

Open clusters and globular clusters of stars are other inspirational images, as is our own Milky Way within galaxies such as **Andromeda**.

Most of the images we've ever seen rely on advanced technology. Yet much more than we think is visible to the naked eye in a sky free of **light pollution**. The U.S. alone is losing \$2 billion annually on wasted light.

And it's been getting worse. The satellite image of Los Angeles in 1908 and Los Angeles in 1988 are dramatically different. Much of the light one sees in the 1988 image is wasted: street lights, for example, light up the sky and actually reduce visibility at ground level.

It's unfortunate that, because of light pollution, many of you will never see the Milky Way's gas, dust clouds and stars as you can under a dark sky.

Mercury lighting creates the glare and splatter of light that you see around typical houses for "security." **Low-pressure sodium lights** offer a more efficient light with less glare and more useful light.

KINDS OF LIGHT:

Fire is a source of natural light. Can you name others?

[The moon...]

[Meteorites, when they come into our atmosphere...]

Some of Luma's props use natural sources of light, such as **flash paper**, sparkers (**magnesium against steel**), and **lighter fluid** on swinging torches.

Some animals make light naturally. Can you name any? Their light is used to attract mates and is called **bioluminescent**.

Science has imitated bioluminescence artificially. The space program designed “**cyalumes**” which contain two chemicals. When the cyalume is cracked, the chemicals mix and light is created. This kind of artificial light produces very little heat, but unlike jellyfish and lightning bugs, the light from cyalumes only lasts up to 12 hours or so.

Gas lamps provided light at night for many decades until Thomas Edison created the first electric light bulb. Does anyone know how the light bulb works? The invention of the light bulb meant that we could easily create “synthetic day” and has forever changed our relationship with the dark. **Incandescent bulbs** produce a lot of heat and are not very efficient because they require a lot of energy.

Can you think of other kinds of artificial light? Luma uses all of the following types of light:

LED’s...(light emitting diodes, used in common household items such as stereos, alarm clocks, microwaves, bicycle lights, what else...?)

Fiber optic light...(light bounces off the interior of a tube until it reaches the end.)

Electroluminescent wire...(screened phosphor carries the electrical charge through the entire wire *unlike* fiber optics where the light source is only at the base.) Electroluminescent light is also used in panels, such as in Indiglo Watches and camcorder mini-screens.

Diffused light...(incandescent light that is filtered through water, for example.)

Neon light...(an example of light from gas; the gas is stimulated by an electrical charge; when the electrons within the gas jump to a higher orbit, they throw off photons, thus creating light.) Neon is one of the Noble Gases, but “neon lighting” is misleading as Neon is often not the gas used for this kind of light. Do you know which gases are used instead?

Fluorescent light...(another example of light from gas.) Do you know which of the Noble Gases are used to create fluorescent lighting?

Black light...(a light which uses filters to highlight nothing but ultraviolet, or UV, light.) Luma colors objects with UV paint which contains artificial phosphors. Under black light, these painted objects “pop.” Tide detergent is a common household example of something with artificial phosphors.

What other kinds of artificial light are you aware of?

How about **Metaphysical Light**? Do you know what this means? Meta is the Greek word for “above” or “beyond.” How many of you have seen Star Wars? Do you remember when Obi Won Kenobi told Luke Skywalker about the Force? This is an example of Metaphysical Light, and the territory that Luma is pioneering.

There is a light or energy that represents the animating force within every living being. We sometimes call it the “twinkle” in your eye, or the “radiance” of your spirit. There is about 1.9 volts of energy generated within the human body. This is an electrical field that is measurable. When a person is sick, his or her energy is “low.” When healthy, the energy is “vibrant.”

How else has Metaphysical Light been represented or made visible?

Halos...

Auras...

Sixth Sense...

STUDENT ACTIVITY - For grades K – 5

CONSTELLATIONS

From [http://rip.physics.unk.edu/Astronomy/Constellations\(k-2\).html](http://rip.physics.unk.edu/Astronomy/Constellations(k-2).html)

Objective:

To introduce the concept of constellations

Activities:

- Class or group discussion about what a constellation is
- Showing drawings of a few constellations
- Having each child complete a dot-to-dot paper of two constellations

Materials:

For each student:

- worksheets (one copy of each included in this packet)
- Dot-to-dot worksheet (See next page)
- Make Your Own Constellation worksheet (See page 7)
- pencil, crayon or marker

For lesson:

- pictures of constellations (a few included in this packet; can also use a book or sky map that shows them). (See page 8)

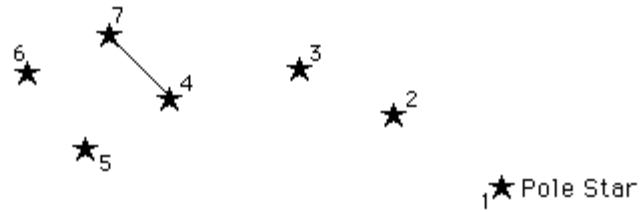
Procedure:

1. Explain that constellations are groups of stars that can be seen in the night sky. People draw imaginary lines between the stars to make pictures of animals, people or things. Each picture is a constellation. Some of the more famous constellations are The Big Dipper and Orion, the Hunter (or name the constellations you have pictures of). Show the children pictures or drawings of constellations.
2. You can continue by saying that there are many constellations in the sky, but you can't see all of them at once. Which constellations you will see depends on the time of year, time of night and where you are on the Earth.
3. The students can complete the dot-to-dot worksheet of The Little Dipper and Draco the Dragon, two constellations that can be found in our sky.
4. The students can complete the Make Your Own Constellation worksheet.

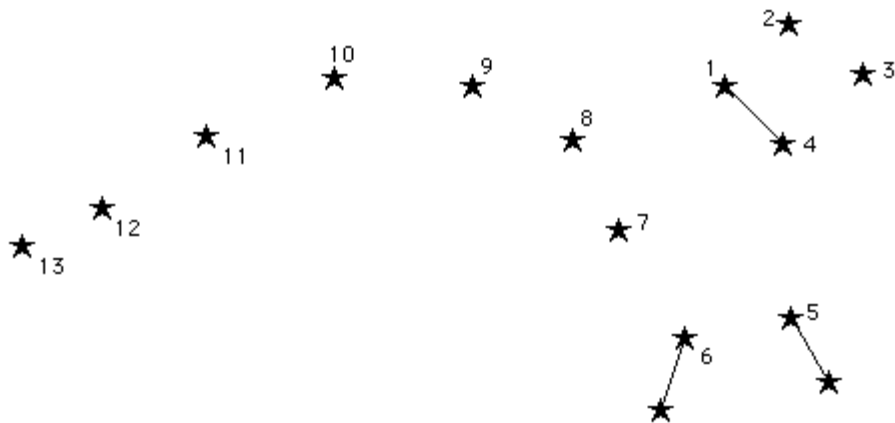
Name _____

Can you connect the stars in number order?

Make the Little Dipper.



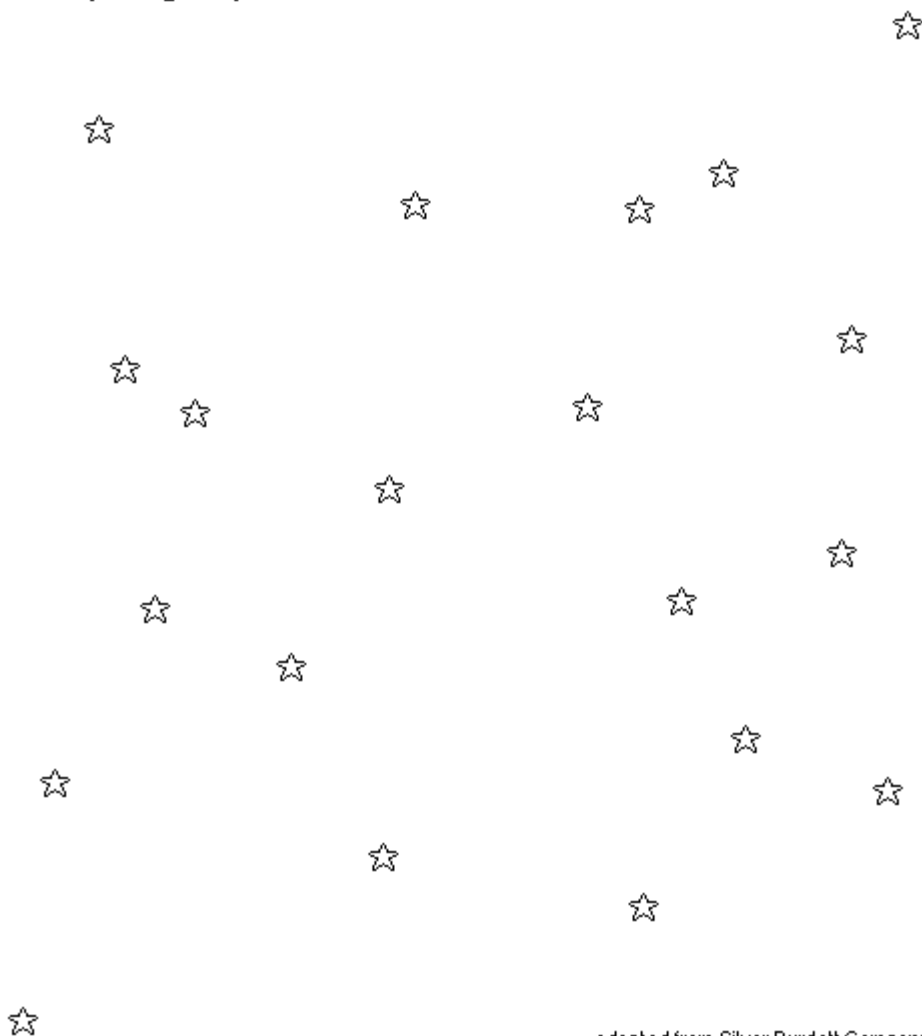
Make Draco, the Dragon.



adapted from Silver Burdett Company

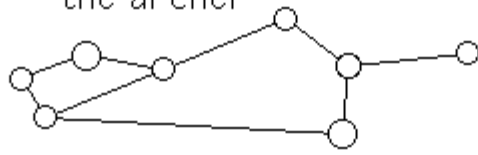
Name _____

You can make your own constellation.
Draw lines between some of these stars to make a picture.
What did you draw?
Can you give your constellation a name?

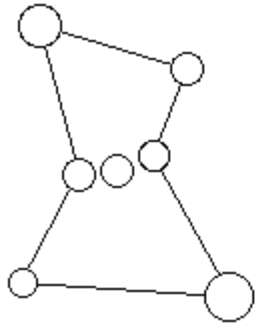


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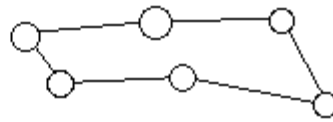
SAGITTARIUS
the archer



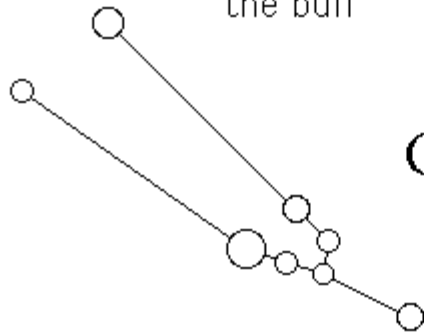
ORION
the hunter



LEPUS
the hare



TAURUS
the bull



CONSTELLATIONS

STUDENT ACTIVITY - For grades 6 – 8

Can be adapted for high school

From <http://school.discovery.com/lessonplans/programs/hubble/>

Objectives

Students will understand the following:

1. The Hubble Space Telescope lets us see farther into space than ever before.
2. The Hubble gives us images that are thousands of years old because light travels at a finite speed across vast distances of space.
3. The Hubble could be used to search the universe for other Earthlike planets, but such exploration is expensive.
4. There are arguments for and against spending money to look for other Earthlike planets that might be thousands of light-years away.

Materials

For this lesson, you will need:

- Computer with Internet access

Procedures

1. With the lights turned off, direct your students' attention to an electric light in the classroom. Then turn the light on.
2. Ask students how long it took for the light to reach their eyes. Make sure they understand that light takes time to travel across space. Light travels so quickly that over short distances it appears to take no time at all; however, scientifically speaking, the light did take a miniscule fraction of a second to reach their eyes.
3. Have students conjecture about how long it takes the light from a star to reach our eyes. Explain that light from Proxima Centauri, the nearest star beyond the sun, takes more than four years to reach Earth. Therefore, when we view Proxima Centauri, we are really seeing that star as it appeared more than four years ago. (In other words, Proxima Centauri is more than four light-years away.) Tell students that the Hubble telescope can view objects in space that are thousands of light-years away.
4. Encourage students to use the Internet to view images from space captured by the Hubble Space Telescope (see Links). Remind them that the images show objects in space as they appeared not in the present but in the distant past.
5. Introduce to your students the possibility of using the Hubble to search the universe for other Earthlike planets. After mentioning the considerable expense involved and the fact that any planets found are likely to be thousands of light-years away, lead the class in a brief discussion on the merits of such a search.
6. Divide the class into two fairly large groups to debate the issue you have raised and a smaller group to serve as a moderating panel. Assign each large group one side of the following resolution: Money should be spent to look for other Earthlike planets, even though they may be thousands of light-years away.

7. Allow time for the two debating groups to meet and come up with salient points to support the pro or con side of the resolution.
8. Hold a formal debate. Have the moderating panel keep notes on the debaters' points and decide which side presented the stronger arguments.

Adaptations

Adaptations for Older Students:

Encourage students to do research to find out how the Hubble Space Telescope “sees” and produces images from space. Have them write brief essays reporting their findings.

Discussion Questions

1. Discuss the idea that rocket and satellite technologies are the direct results of wars—World War II and the Cold War. Can such quick technological advances be made during times of peace or is competition essential to achievement? Can you think of any modern-day technologies that parallel rocket and satellite technologies?
2. Discuss the advantages and disadvantages of having over 10,000 scientists and engineers contribute to the building of the Hubble space telescope. Does quality control become a problem when so many people are involved?
3. Debate whether or not the information gathered by the Hubble has been worth all of the time, money, and effort involved. Could we do without this information? Why might some people be opposed to spending government money in this way?
4. Discuss the idea that while Hubble has confirmed many astronomical theories it has also revised and even overturned others. For example, some results show that some of the stars in the universe are older than the universe itself is thought to be. Does it seem reasonable that scientists who are experts in their field could be so wrong in some of their theories?
5. Discuss the significance of the “funny stars” in the Orion Nebula. Is it scientifically worthwhile to watch this particular area over a long period of time, or should Hubble be pointed in different directions?
6. Discuss the Origins program that is designed to search out other Earth-like planets around other stars similar to our sun and look for traces of life. Why is a program like this valuable? Who might oppose such a program?

Evaluation

You can evaluate your students on their debating skills using the following three-point rubric:

Three points: arguments logical, well organized, and supported by facts

Two points: arguments logical, sufficiently well organized, but lacking factual support

One point: arguments lacking in logic and organization, lacking factual support

Extensions

A Look at Celestial Time

Invite your students to pretend that another civilization is looking at Earth through a Hubble-type telescope from one thousand light-years away. Ask them to describe what Earth was like at the time the light they are seeing today was emitted. Challenge them to predict what Earth will be like when the light emitted from our planet today reaches the imaginary distant civilization one thousand years from now.

A Look at the Hubble

Have students use the Internet (see Links) to research the development and history of the Hubble Space Telescope. Challenge them to find out and report on the problems encountered by the early developers of the Hubble and how the great space telescope was “rescued.”

Suggested Readings

Hubble Vision: Astronomy with the Hubble Space Telescope

Carolyn Collins Petersen and John C. Brandt. Cambridge University Press, 1995.

This lavishly illustrated book traces the space telescope from its inception, including its problems, the people involved with it, and its eventual successes transmitting photos of the universe.

Origins: Our Place in Hubble’s Universe

John Gribbin and Simon Goodwin. Overlook Press, 1998.

Dozens of detailed photographs taken by the Hubble space telescope, the Anglo-Australian telescope, and the Cosmic Background Explorer satellite are accompanied by clearly written text which tells how the big bang gave us galaxies, stars, planets, and people.

Links

The Best of the Hubble Space Telescope

This gallery provides the latest and the best of images from space captured by the Hubble Space Telescope. A website with great visuals for bulletin boards and for making transparencies for your talks on astronomy.

Amazing Space

Amazing Space is a set of web-based activities primarily designed for classroom use, but made available for all to enjoy. Be sure to check out their “Solar System Trading Cards” activity and the “Student Astronaut Challenge.”

The Hubble Space Telescope: Design and Development

This clickable map of the Hubble Space Telescope will help your students to understand how the telescope works one part at a time.

Earth and Space Lesson Plans

Many interesting links to lesson plans that will help your students understand the difference between various kinds of telescopes and their history from Galileo to Hubble.

Pluto Demoted

Solar system shrinks to eight planets

By Karen Fanning

August 25, 2006

My Very Educated Mother Just Served Us...Noodles? That could be the new way school children everywhere will be taught to remember the planets of the solar system: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, and Neptune.

So what happened to Pluto? The educated mother used to serve Nine Pizzas for Neptune and Pluto. But now that an international group of astronomers have demoted the ninth planet, students everywhere are left with noodles. Some critics of the move say they are left with Nothing!

"Pluto is dead," said Mike Brown, a researcher from Caltech University in California. He was following the group's decision-making process with interest. Brown is known for his discovery of what could have been considered a 10th planet. That object, called 2003 UB313, is actually bigger than Pluto.

Group Decision

New guidelines for planets were adopted this week by the General Assembly of the 2006 International Astronomical Union (IAU). According to these guidelines, Pluto is now a "dwarf planet," after 76 years as a planet. Mercury, Venus, Earth, Mars, Saturn, Jupiter, Uranus, and Neptune are now called "classic" planets.

The new rules state that a celestial body must have "cleared the neighborhood around its orbit" to be considered a classic. Pluto's orbit overlaps with Neptune's, making it the odd planet out.

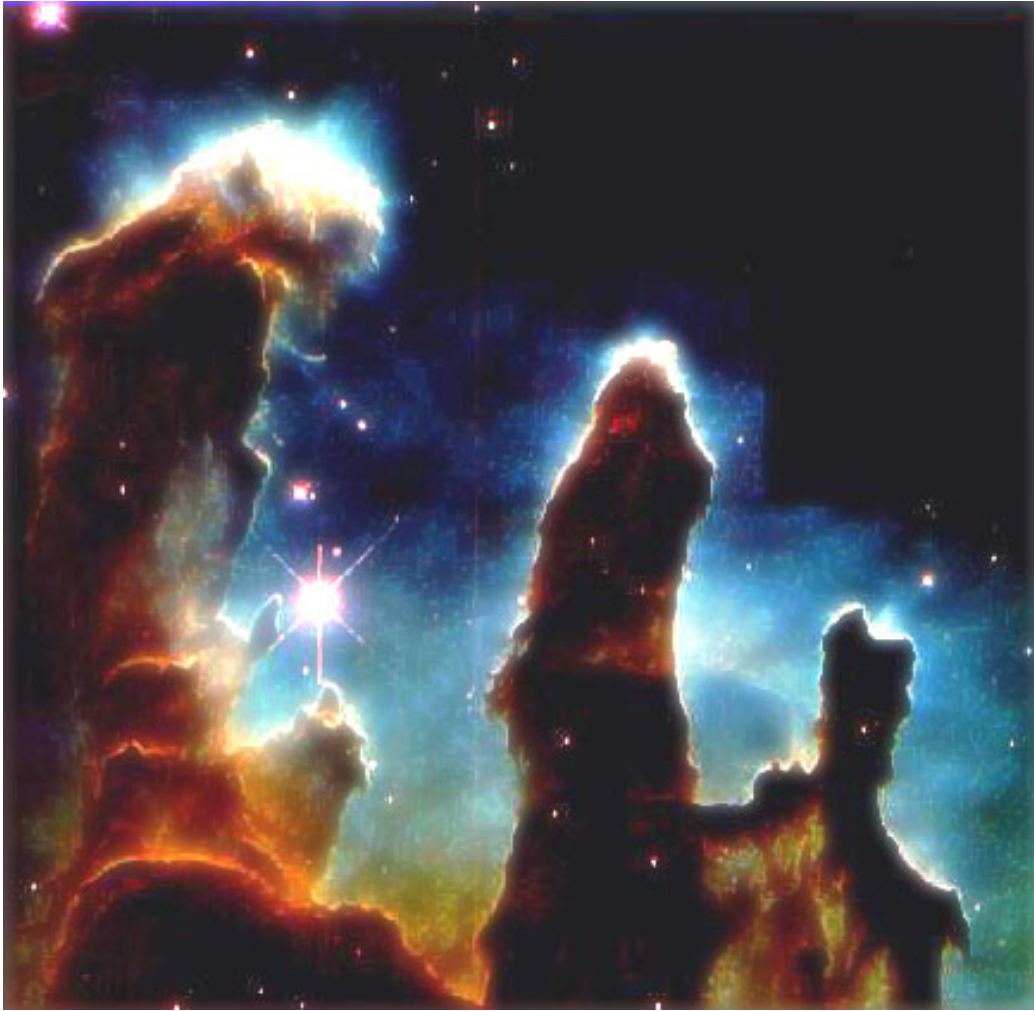
But Pluto is not alone. More than a dozen former asteroids could soon be named dwarf planets. Those include Ceres and Brown's discovery, 2003 UB313.

"More dwarf planets are expected to be announced by the IAU in the coming months and years," said a spokesperson from the group.

While the decision is not earth-shattering for astronomers, it means a lot to school kids around the world. Textbooks will have to be rewritten and science projects updated.

"It's not affecting me personally, but it's kind of depressing," said Nathan Kahn, 13, of New York. "I've been brought up thinking of Pluto as the ninth planet." The eighth grader built a mobile of the solar system when he was in the third grade. "I guess now they are going to have to redo all the text books."

Pluto was discovered in 1930 by Clyde Tombaugh. The young astronomer was just 24 when he made the historic sighting while working at Lowell Observatory in Flagstaff, Arizona.



Images from the Hubble Telescope

