Grades

9-12

Strategic Science Teaching

Title of Lesson:

Seeing Stars

Essential Question:

How can observations from Earth give us information that explains the structure of galaxies and the universe?

Conceptual Statement:

Galaxies are the primary structure of the universe. They are made up of a variety of objects themselves, mostly stars.

Student Outcomes:

- Students describe the structure and scaleof objects in the universe.
- Students develop models of a starfield representing common properties of stars.
- Students use "Learing Log and KWL Plus" to orgnaize information from text about structures of the universe.

Conceptual Learning Sequence:

This is an introductory lesson for a conceptual unit about the structure and scale of stars, galaxies, and the universe.

Lesson Overview:

Students use the learning strategy, "KWL Plus" to organize prior knowledge and new information about galactic objects from the book *Contact,* the investigation, and reference sources. Students also use the learning strategy, "Learning Log", with a reading selection from the book *Contact*, to record information about objects in a galaxy. Students will observe a demonstration of a two-dimensional star field then use their observations, research, and data to build a three-dimensional model of a star field that more accurately represents the structure of an actual galaxy.

English Language Learning:

English Language Development standards are referenced in the lesson where appropriate. The hand icon appears throughout the lesson when learning strategies and lesson components are identified as pathways for academic success and reflect critical developmental differences for students who are English learners.

Literature in the Science Learning Cycle:

The book *Contact*, chapter 19, is used as the EXPLORE phase in the instructional model. It provides observational data, in a narrative form, to simulate actual travel to distant objects in the Milky Way. Students record this data in the "Learning Log". This provides information about galactic structures for the KWL and set a context for the construction of a three-dimensional star field model.

Learning Strategy:

This lesson uses "Learning Log" to have students record gathered information from text and resources as needed to complete a KWL. "KWL Plus " is utilized to organize information and demonstrate knowledge. (See Appendix pages 167-170.)

Literature Selection:

Title: *Contact.*

Author: Sagan, Carl.

Carl Sagan was an award-winning writer and Professor of Astronomy and Space Sciences at Cornell University. He popularized science, reaching millions of people through newspapers, magazines and television broadcasts including the PBS series Cosmos, which became the most watched series in public television history.

Publisher, Year: Simon and Schuster, New York, 1985.

Annotation: In this science fiction story, Eleanor Arroway is a brilliant physicist who heads the team listening for a signal from an outer space project. When the message arrives, scientists mobilize their efforts to decode and respond to this message.

Genre: Science Fiction.

California Content Standards:*

Science: Grades 9 -12, Strand Earth Sciences, Sub-Strand Earth's Place in the Universe

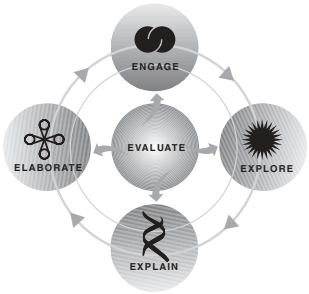
1. Astronomy and planetary exploration reveal the solar system's structure, scale, and change over time. As a basis for understanding this concept:
   d. Students know the evidence indicating that the planets are much closer to Earth than the stars are.

2. Earth-based and space-based astronomy reveal the structure, scale, and changes in stars, galaxies, and the universe over time. As a basis for understanding this concept:
   a. Students know the solar system is located in an outer edge of the disc-shaped Milky Way galaxy, which spans 100,000 light years.
   b. Students know galaxies are made of billions of stars and comprise most of the visible mass of the universe.
   d. Students know that stars differ in their life cycles and that visual, radio, and X-ray telescopes may be used to collect data that reveal those differences.

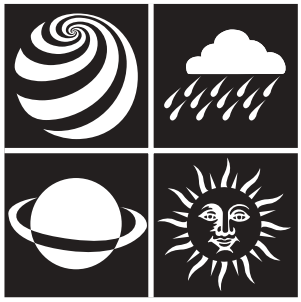
1. Investigation and Experimentation

g. Recognize the usefulness and limitations of models and theories as scientific representations of reality.
i. Analyze the locations, sequences, or time intervals that are characteristic of natural phenomena.
k. Recognize the cumulative nature of scientific evidence.

*Selected standards addressed within this lesson.

Lesson at  a Glance

Science Learning Cycle	Objective Science Thinking Process	Suggested Time
ENGAGE	Students record prior knowledge of “Galactic Structures” in a KWL. Students observe demonstration. Communicating, Observing	1 hour
EXPLORE	Students read chapter 19 of *Contact*, Students begin “Learning Log” of the galactic observations, targeting KWL. Observing, Communicating, Comparing, Ordering	will vary
EXPLAIN	Students complete star models and investigation record sheet and present to class. Students organize KWL into categories using reference sources as needed. Comparing, Ordering, Categorizing, Relating	1 or 2 hours
ELABORATE	Elaborate research into EM spectra, singularities, and space travel.	As Needed
EVALUATE	Students complete “KWL Plus” concept map. Students produce an accurate account of objects in a galaxy.	2 or 3 hours



Seeing Stars

Teacher Background:

When astronomers first observed the sky, they imagined the stars were on the single surface of a giant "crystalline sphere" that encompassed the Earth and the sun. They believed that the planets were on a smaller sphere inside the one on which the stars moved.

We now recognize stars as diverse structures that make up galaxies and the galaxies as the basic units of the universe. However astronomers now talk of strings and superstructures in the galaxy, reflecting a possible change in our understanding of these structures.

Over time astronomers realized that as the Earth moved around the sun, some stars shifted in position relative to the background of others. They realized that this shifting occurred because of a parallax effect when the Earth was on opposite sides of the Sun.

Further observation of stars using telescopes that collect visible light, radio waves and x-ray energy allowed astronomers to understand the structure and properties of many types of stars.

Any discussion of scale and structure would relate to this lesson.

Related California Content Standards

Science: Grades 9 -12, Strand Physics, Sub-Strand Waves

4. Waves have characteristic properties that do not depend on the type of wave. As a basis for understanding this concept:
    a. Students know waves carry energy from one place to another.
    e. Students know radio waves, light, and X-rays are different wavelength bands in the spectrum of electromagnetic waves whose speed in a vacuum is approximately 3 x 108 m/s (186,000 miles/second).
    f. Students know how to identify the characteristic properties of waves: interference (beats), diffraction, refraction, Doppler effect, and polarization.

Science: Grades 9 -12, Strand Physics, Sub-Strand Electric and Magnetic Phenomena

5. Electric and magnetic phenomena are related and have many practical applications. As a basis for understanding this concept:
    i. Students know plasmas, the fourth state of matter, contain ions or free electrons or both and conduct electricity.

Science: Grades 9 -12, Strand Chemistry, Sub-Strand Atomic and Molecular Structure

1. The periodic table displays the elements in increasing atomic number and shows how periodicity of the physical and chemical properties of the elements relates to atomic structure. As a basis for understanding this concept:
    j. Students know that spectral lines are the result of transitions of electrons between energy levels and that these lines correspond to photons with a frequency related to the energy spacing between levels by using Plank's relationship (E = hv).

Science: Grades 9 -12, Strand Chemistry, Sub-Strand Nuclear Processes

11. Nuclear process are those in which an atomic nucleus changes, including radioactive decay of naturally occurring and human-made isotopes, nuclear fission, and nuclear fusion. As a basis for understanding this concept:
    b. Students know the energy release per gram of material is much larger in nuclear fusion or fission reactions than in chemical reactions. The change in mass (calculated by E = mc2) is small but significant in nuclear reactions.
    e. Students know alpha, beta, and gamma radiation produce different amounts and kinds of damage in matter and have different penetrations.

Math: Grades 9 - 12

Geometry 15.0 Students use the Pythagorean theorem to determine distance and find missing lengths of sides of right triangles.

Language Arts: Grades 9 -10

Reading 2.0 Students read and understand grade-level appropriate material. They analyze structural patterns, arguments and positions advanced.
Writing 2.1 Write biographical or autobiographical narratives or short stories:
    a. Relate a sequence of events and communicate the significance of the events to the audience.
    e. Make effective use of descriptions of appearance, images, shifting perspectives, and sensory details.

English Language Development Standards

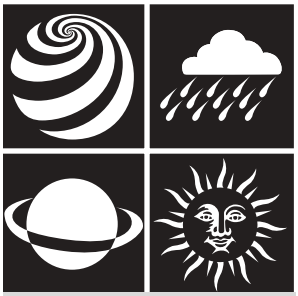
Written and Oral Conventions
1.0 Students write and speak with a command of standards English conventions.

English Language Development: Grades 9-12

Writing Strategies and Applications
Present a brief report while clarifying facts presented in two to three forms of expository text.
Write expository compositions such as descriptions, compare/contrast, and problem/solution that include a main idea and some details using simple sentences.

English Language Development: Grades 9-12

Written and Oral Conventions
Narrate a sequence of events and communicate their significance to the audience.



Grouping: Varies throughout the learning cycle

Students will work independently for the demonstration.
Students will work in groups of 3-4 for the investigation.

Group EL with native speakers during the demonstration. Group EL with like language as well as with native speakers during the investigation

Materials:

Per Class

Overhead projector
black construction paper
Single hole punch, pencil and pin
Large (projection screen size) black sheet or paper
Video *Contact*, produced and directed by Robert Zemeckus, 150 minutes, Warner Brothers Films, 1997.

Per Student

One string/group, cut in 2 meter lengths
One-inch Styrofoam™ balls
Paint, markers and other art supplies
Thumbtacks
Tape, as needed
Step ladder or foot stool to reach ceiling

Advanced Preparation:

For Demonstration

Punch holes in a variety of sizes in the black paper.
Position the overhead as far back in the room as possible to project a large star field.
Tape black paper to flat glass surface of the overhead to keep the star field projection constant.
Post a large black sheet or black bulletin board paper across the wall to fit the projected star field.

For Investigation

Determine the number of Styrofoam™ balls needed to provide one per group for each student group.
Measure and cut string.
Provide a recording sheet for each student. See Student Pages 1.0, 1.1

VOCABULARY

galaxy – a group of billions of stars and their planets, gas and dust that extends over many thousands of light years and forms a unit within the universe

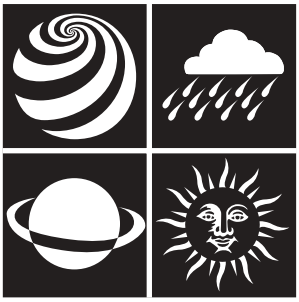
parallax – the angle between two imaginary lines from two different observation points meeting at a star or celestial body that is used to measure the distance from the Earth

properties – the characteristic qualities or distinctive features of something

star – a gaseous object in space such as the sun, ranging in size from that of a planet to larger than the Earth's orbit, which generates energy by thermonuclear reactions

universe – all matter and space that exists, considered as a whole; the cosmos

Provide still and video images to support understanding of new vocabulary



Teacher Resources:

California Science Content Standards. California Department of Education, 1998.

The California Science Framework. California Department of Education, expected 2002.

California Science Framework. California Department of Education, 1990.

Strategic Teaching and Learning; Standards-Based Instruction to Promote Content Literacy in Grade Four Through Twelve. California Department of Education, 2000.

Conceptual Physical Science. Second Ed., Hewitt, Suchocki and Hewitt, Addison Wesley Longman, 1999.

Space Mathematics. NASA / NCTM, 1985. Math of parallax pgs 23-24, planets pgs 20-23 and light years p 24.

Integrated Science Curriculum. Pages 692-722. Total Reading, 1987.

Once Upon a GEMS Guide. Pages 81-93. Lawrence Hall of Science. The Regents of the University of California, 1994.

Astronomy Village: Investigating the Universe. CD version 1.0. Wheeling Jesuit College/NASA Classroom of the Future. 1995.

Astronomy web sites:

PBS Teacher Source http://www.pbs.org/teachersource/science_tech/high_galaxy.shtm

Star Distance www.pbs.org/deepspace/classroom/activity3.html

Black Holes www.pbs.org/deepspace/classroom/activity4.html

Stars and other objects: http://www.cnde.iastate.edu/staff/jroeger/stars.html

Teacher Tips:

- Plan a trip to a planetarium for a show on galaxies or the structure of the universe.
- A "Word Wall" is a vocabulary reference source kept visible during an entire instructional unit. Usually a bulletin board format.
- Allow students revision time to avoid any misunderstandings.
- Prior knowledge of Grade 8 California Science standards 4.0 is assumed for this lesson.
- The movie *Contact* may be used, with discretion, as a culminating event. Note that it is significantly different from the book, without much of the challenging thinking.
- This lesson can easily be followed by a lesson on parallax.

Related Student Resources:

Krauss, Lawrence M.. *Physics of Star Trek*. BasicBooks, a division of Harper Collins, 1995.

Mitton, Simon and Mitton, Jaqueline. *Astronomía (The Young Oxford Book of Astronomy)*. Edebé, 1995.

Henbest, Nigel. *El universo: Un viaje a través del espacio y del tiempo (The Universe)*. Folio, 1995.

Lesson Credits:

The contributions and support of Don Scott, NASA educator, are appreciated.

ENGAGE
EXPLORE
EXPLAIN
ELABORATE
EVALUATE

The Science Learning Cycle:

Seeing Stars

ENGAGE:

1. Students will begin with a KWL brainstorm session. Title the KWL 'Galactic Structures" Encourage students to list all they Know and Wonder about this topic.
2. Use the star field demonstration to illustrate the limits we encounter when observing the sky with the naked eye. Ask students: What objects do we see and what can we tell about them?
3. Have students do #1 on the Reporting Sheet
4. Have students begin a “Learning Log” to record their observations of the star field demonstration and prepare to record information about the objects that make up a common galaxy.
5. Direct them to organize the “Learning Log” into sections that record:
   What I Read/Observed
   How I Understood
   What I Learned
6. Ask students to add to their “KWL Plus” if anything has come to mind.

EXPLORE:

7. Read chapter 19 (15 pgs) in *Contact*.
   Have students use their “Learning Log”s to record the names and descriptions of galactic structures.
   Ask them to record the properties that distinguish types of stars.
   Provide 5-15 minutes of writing time after each reading session required.
8. Direct students to take their “Learning Log” information and categorize it in the three KWL columns.
9. Ask them to look for corrected misunderstandings or something new they learned, something they wanted to know, or new questions they generated.
10. Are there any items on the KWL that need to be researched further? If so provide access to resources, as needed.
11. Have students determine large concepts (group the topics) that are now apparent on the KWL. Explain that these will be used to organize their information about galactic structures.

EXPLAIN:

12. Working as a whole class have the students use their “Learning Logs” to contribute to the revision and categorization of the “KWL Plus”.
13. Keep a "Word Wall" to facilitate vocabulary for students. This lesson component works well for English Language Learners.
14. Have students construct their own Concept Maps based on the “KWL Plus”.
15. Encourage students with questions to use the KWL method on their own to seek out the things they still wonder about.
16. Students will select one of the structures they have learned about to be their model.

17. In groups students will:
    a. identify the characteristics of the star, or other object selected.
    b. find a visual way to "design" their model.
    c. prepare a short presentation for the rest of the class using the reporting sheet as their outline.
    d. hang the model from the ceiling so that a beam of light from the overhead projector (making the star field) will illuminate it.

18. Have students do # 2-4 on the Reporting Sheet.

ELABORATE

19. Some students may want to investigate how to use the classroom star field for a parallax investigation.

20. Those ready to work on further topics may pursue EM spectra, space travel, life cycles of stars, or singularities.

21. Compare the film *Contact* to the book.

EVALUATION

22. Have students confirm correct understanding of the objects presented by the class using the “KWL Plus”.

23. Have students do # 5-9 on the Reporting Sheet.

24. Have students use the “KWL Plus” categories, agreed upon by the whole class, to construct their final Concept Maps titled "Galactic Structures".

25. Accurate Concept Maps can then be used to compose a structured “Learning Log” (journal-like) about a journey to a common galactic object. (Use travel promotions, hyper-studio or Power Point slide shows, or other evaluation options). The criteria for a complete journal will include:

    a) accurate properties (at least 3);
    b) information on the energy emitted and how it is detected;
    c) a reasonable description of the object's general location in the galaxy;
    d) how rare or common an object it is.

Teacher Reflection:

1. How dose the student work provide evidence that they learned the scle and structure of galazies in the universe?
2. What instructional strategies used in this lesson promote student understanding? How do you know?
3. How does the literature selection support student understanding of the science concepts?
4. How would you modify instruction to ensure understanding of student outcomes by all students?

Seeing Stars - Reporting Sheet

Name: _____ Date: _____

1. Describe the star field as you first see it. How is it similar to the way we observe the sky from Earth?

   a. What can we tell about stars this way?

   b. Is the size we observe accurate?

   c. The distance?

2. Name the "Galactic Object" your group will be modeling.

   a. How is its location described in *Contact*?

   b. What are the characteristics that identify this object to astronomers like Ellie Arroway? Give at least three.

   c. How do astronomers detect/observe your object?

      What tool is used to detect it?

      What energy is observed?

3. Assume the overhead projector is our sun and the black wall screen is the center of the Milky Way. Estimate where in that distance your model should be hung from the ceiling. (Half way, one-fourth, etc.)

Seeing Stars - Reporting Sheet

4. Prepare a 5-10 minute presentation based on your investigation. Inform the class about the object you are modeling. This Reporting Sheet will work as your outline.

a. Describe the star field as it appears with the models.

b. How can models help someone understand something like stars?

c. Review your answers to question #1. How would you answer now?
Write about any new ideas or information you have.

d. What is the relationship between stars and galaxies?

e. What generalizations could you support with observational data about the structure of the universe?
Make some generalizations about the structure of the universe. Use observational data to support your statement.