HOW FAR TO THE STARS?

Performance Standard 12F/11A/13A/13B.F

Students will apply the processes of scientific inquiry to examine the features of the universe accordingly:

- *Knowledge*: Identify the approximate distances to various stars and nebulae in light-years.
- *Application*: Comparing the time it takes light to travel these distances to the length of time in terms of certain earthly historical events.
- *Communication*: Displaying the light-travel time to these stars and nebulae on a timeline of Earth's historical events.

Procedures

1. ***In order to know and apply concepts explain the composition and structure of the universe and the Earth's place in it and the processes, concepts and principles of scientific inquiry (12F) and the concepts, principles and processes of scientific inquiry (11A) and apply scientific habits of mind (13A) and concepts that describe the interaction of science, technology and society (13B),*** students should experience sufficient learning opportunities to develop the following:
   - Construct an inquiry cause-effect hypothesis associated with the distances to various stars and nebulae and the time it takes light to travel from them.
   - Research pertinent sources of scientific information related to various star/nebulae/universe proportional scales.
   - Research the scientific milestones which revolutionized astronomical research.
   - Compare/contrast scientific methods between observational, remote and experimental observations.
   - Design and conduct scientific research inquiry related to hypothesis to associate approximate distances to stars and nebulae in light-years to historical earthly events.
   - Prepare data tables, charts and visualizations to correlate astronomical factors.
   - Group technological innovations to historic time periods and changes in communities and countries.
   - Report the process and results of the investigation by presenting oral and/or written report using available technologies.
   - Generate additional questions for future investigations into distances to the stars and nebulae.

   Note to teacher: This activity relates to knowledge associated with the standard 12F, while addressing the performance descriptors for stage F within standard 11A. Applying scientific habits of mind in standard 13A are foundational. The societal implications of scientific discoveries and technological innovations are addressed in performance descriptors in 13B.
2. Have students review and discuss the assessment task and how the rubric will be used to evaluate their work.
3. Begin inquiry investigation about the scope of the universe and the solar system's neighbors by allowing students to develop a class listing of questions about stars in the universe. If possible, display various large posters (from NASA, for example) which show images of nebulae, star clusters, etc. The questions should lead to references about light years and the speed of light and some theatrical or science fiction examples. Set the foundation about the concepts associated with the speed of light as a known constant and that light from the stars and nebulae must travel to Earth for an amount of time related to their distances for us to see them. It may be advantageous to provide practice at the scope of time and distance associated with distance traveled in seconds, minutes, hours, days, years to reinforce the exponential scope of these distances and the relative ease of using 'light year'. Students should generate predictions for the distances, in light-years, to selected stars and nebulae visible in the night sky or referenced in current science fiction examples. Star, galaxy and nebula images are available for classroom use as starting points at: **http://spaceplace.nasa.gov/teachers_star_images.htm**. Assign research using available technologies to compare their predictions with the known approximate distances. This research should also proceed to find comparable events in Earth's history which happened a number of years ago equivalent to the number of light-years to each object. (Understanding that these events were occurring on Earth at the same time light left the object to be seen in the night sky tonight.) They should also incorporate varying kinds of technological innovations (perhaps in other/all disciplines of science) in to their final timeline.

4. Students should creatively record and present their findings on a timeline, showing present-day on the far right end of the scale, and the point in history when light left the star or nebula (number of years ago = distance in light-years) at the far left end of the scale. Students should choose historical events to be placed correctly at intervening points on the timeline.
5. Encourage students to generate further questions which could follow from their initial research and presentations. Such questions could include: How do we know how far away these objects are? How accurate or inaccurate might these distances be? If can only see these objects as they were long ago, what might have happened to them since then? If it takes light this many years to travel from an object, what would be the travel time for a spaceship (or other mode of transportation with a known speed)?
6. Evaluate each student's work using the Science Rubric as follows and add the scores to determine the performance level:
   - *Knowledge*: The identification of the distances to selected stars and nebulae were complete and correct,
   - *Application*: The comparison of light-travel times to time elapsed since historical events was complete and well-organized, and
   - *Communication*: The explanations were complete and accurate. Questions for future studies were pertinent and applicable.

Examples of Student Work not available

Time Requirements

- 20 to 30 minutes for initial discussion and introduction to assignment:
- 1-3 days/class periods for research and presentation preparation
- 1-2 class periods for presentations and new question generation.

Resources

- Star maps and photographs of selected stars and nebulae
- Resource materials for research (possible Internet access for students in small groups)
- Presentation materials: poster paper, colored pens, rulers, etc.
- Science Rubric

Example: The Lagoon Nebula (M8) is estimated at 5,200 light-years from Earth, so the timeline goes from 3,200 BC to "now".

The caption on the timeline is: *Our view of M8 in tonight's sky is light that left the Lagoon Nebula approximately 5,200 years ago*.

The timeline is marked off in thousand-year intervals, at 4000 BC, 3000 BC, 2000 BC, 1000 BC, 1 AD, 1000 AD, and NOW.

At approximately 3200 BC: Pyramids of Egypt built
At approx. 1800 B.C: Stonehenge
At approx. 1200 B.C: Trojan War
At approx.50 B.C.: Roman Empire
At approx. 1000 A.D.: Vikings sail to N. America