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“Astro-Cosmos The Last Frontier”

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This Astronomy Unit, “Astro-Cosmos, The Last Frontier”, will help primary level students, to bring their personal knowledge and sense of exploration of the Universe and the Solar System to a cooperative learning setting.

I work as a magnet resource teacher with students from kindergarten through fifth grade. I have found construction of scientific models beneficial tools in the study of Astronomy, “The science of the celestial bodies and their motion, magnitudes, and constitution”. (Webster’s Dictionary).

Hands on experiences establish concrete thinking processes in the investigative steps of the scientific method. Students learn how apply principles and laws governing scientific genre. The proposed activities will work wonderfully for students in grades three through five. Modifications can be made for students in upper and lower grades. Modifications can be adapted as a result of the cognitive development of children around the world. Major shifts occur in children between ages 5 and 7 and last until age 12. (Piaget’s concrete operational stage.) This is where children internalize mental actions (operations) and fit them into a logical system and apply concrete thinking. Linked to students increased competence is pride in accomplishments. Howard Gardner (1998) implies that there are multiple intelligence: linguistic, musical, logical, mathematical, spatial bodily, and kinesthetic, all linked to interpersonal and intrapersonal outcomes. This suggests that each child follows a different developmental path.

The science thematic unit approach to education, coupled with the child development philosophy, to build on a child’s prior knowledge base, is a good thing. Every student brings some powerful ability and varied learning style to the classroom. Integration of subject matter, collaborative learning, and organized investigative methods are all processes to help children assimilate information.

An important aspect of learning is the wonderment in the eyes of children clearly seen in the questions they ask about the sky above them by day and night. Fiction literature, television shows, movies, and mythologies invade their minds daily along with seemingly non-fiction stories of travels of aliens, UFO’s and other mysteries of the Universe.

As children develop methods for ascertaining skills to learn, the premise is not to teach them what to believe or think, but how to think. Exploration of scientific facts develop knowledge. Using available scientific principles and laws children come to understand the Universe and Solar System in which they live and move and have their very beings. This doesn’t mean that children can’t enjoy the various, mythical, fancy filled fantasies, or cultural mythical stories of the planets, stars and the universe around them. In fact students may have greater appreciation of diverse literature especially when they have the knowledge to determine the difference between reality and fun filled fantasy.

OVERVIEW OF CONCEPTS AND GOALS

In approaching this unit of study students will use various skills in listening and reading comprehension, problem solving, and critical thinking. These skills are tested on the Connecticut Mastery Tests. Strategies to facilitate learning will be through graphic organizers to build background and organization of information. In using the integrated approach, students will learn to use cooperative group skills. In each group there is a leader, whose job it is to direct the discussions, a recorder who will present the groups method for solving a given problem, and a time keeper to whom all must listen as he/she keeps the group on task and focused. The teacher is the manager/facilatator of the groups.

Key ingredients to success is to have the activities fun, exciting, and challenging. The need for dependency upon one another shows the importance of collaboration. Also, the class learns to work with no-fault policies. This reduces the negativity and blame in the group for ideas that might lead to an incorrect conclusion or solution. There are several examples of students engaged in data collecting of pieces of information, like in a puzzle, with culminating activities.

THE SCIENTIFIC METHOD

In addition to concepts and goals mentioned, the Science of Astronomy, as with all other sciences, calls for the scientific method to be employed. Obtaining investigative knowledge of the Universe and the Solar System include the following six steps: stating a problem, forming an opinion or hypothesis, performing experiments to test the hypothesis, recording and analyzing data, and stating a conclusion. Learning to collect accurate information through observation, measurements, and research experimentation develops a scientific attitude within students.

INTEGRATION OF CURRICULUM

The integrated approach of curriculum in this unit shows interfacing of academic disciplines in various ways. Mathematics is used in measurement, Geography in location and movement, Art in creativity of the student’s models, various sciences for whatever is relevant, and social sciences for cooperative caring, sharing and learning together. Hands on experiences give various ability level children opportunities to hypothesize, experiment, and record observational data in cooperative groups. A logical knowledge base is built based on brainstorming, that is sharing of ideas. These techniques are realized throughout the unit lessons. They will help students answer some questions of the astronomical mysteries. The answers, however, will lead to more questions and so on as exploration and discovery of the vast Universe and Solar System continues.

TRIPS AND VIEWING GOALS

Teaching is more effective when students witness the practical application of the ideas being taught. Throughout the unit “Learning trips” will be taken to expose students to collaborative work of Astronomers and other scientists engaged in collaborative research of the Universe and our Solar System. Major Universities all have Departments of Astronomy and some planetariums. Viewing of movies such as Apollo 13 and computer software programs such as, The Encyclopedia of Space and the Universe, (Multi-media DK, Doring, Kindershey, C. 1998), will show how scientists collaborate to solve problem situations and explore in space. The objective is that students will learn quickly it is better to have more than one brain working on a problem. Expectations of team work is seen throughout the unit.

Another advantage for students to align and integrate with logical reasoning skills is to have tools to relate to and with beliefs and philosophies of mankind. Students will hopefully know how to think to resolve questions considering so called interpretations and inconsistencies.

IMPLEMENTATION OF UNIT

The first steps to implementing this unit and to assure student success, is to introduce concepts that will help students set a plan of action. I always find out where everybody is in their knowledge of the Universe and their Solar System. Here I establish the objective that: Students will be able to use prior knowledge through the graphic organizer process, KWL to clarify and present: K = What they Know, from their prior knowledge base; W = What they Want to Know, usually generated by their brainstorming and questions; and L = What they Learned, after discussions, questions, observations and informational research of resources, i.e group work, computer programs, books, movies, learning trips, hands on experiences and other multi-sensory interactive experiences.

Lessons are presented with looking first at concepts of Cosmology, The beginning of the Universe. The purpose is to expose and allow children simple concrete experiences to understand Universal Expansion. The objectives are focused on students gaining a workable knowledge of the shape of the Universe and the vastness of space and the stars and their relative distances. Drawings, pictures, models, experiments and other hands on activities will be the vehicles by which objectives will be met.

Secondly, lessons are presented on the Solar System in which we live. The purpose is to relate to concepts presented and allow for concrete experiences to help students understand the Solar System in which they live. The objectives are focused on students use of prior knowledge and to gain a workable knowledge of the Sun and Planets, and their relative distances. A number of other concepts and objectives will be developed through students interests and investigations. Drawings, pictures, models, experiments, projects and a wide range of literature and technological research tools will be the vehicles for student mastery.

Students will create dictionaries as they come to words or terms they don’t know. This supports and motivates independent learning skills.

EVALUATION PROCESS

Holistic Rubrics for writing science journals, group activities, participation, and presentation of projects will be used for assessments and evaluations. Students become very aware of the scoring process and expectations of their work. This is important for self evaluation, group evaluation and teacher assessment for mastery of objectives. The evaluation would be on a Rubric Scale Point of 0-6. 0 being no effort exemplified in contrast to a 6 being excellent. The Rubric designed should align with the Connecticut Mastery Test Objectives and the districts objectives.

LESSONS ON THE BEGINNING AND EXPANSION OF THE UNIVERSE

The Beginning and Expansion of the Universe, Lesson One: Grades 3-5

Objectives Students will use hands on activities to understand the possible beginnings of the Universe and the vastness of the Universe and the Stars.

Materials Balloons, large clear plastic trash bags, large sheets of butcher paper, magic markers, and crayons.

Strategies Introduction to the Unit begins with group activities where each group is given a KWL, GRAPHIC ORGANIZER CHART, to complete, which is a 9” X 11” sheet of paper with the following headings.

K	W	L
What I Know.	What I Want to Know.	What I Learned.

Students write what they know about the Universe under K. They should use brief descriptive words or sentences. A lot of brainstorming about the beginning of the Universe takes place. Students share what they already know about the beginning of the Universe. They then formulate questions about what they would like to know, under the W column.

Next each group is given either a balloon and markers, butcher paper and crayons, or a large clear plastic trash bag and markers.

As I give out the materials, I give the instructions that they must get started making dots all over the balloons, butcher paper, or garbage bags. I ask them to predict the purpose of all this and I write their ideas on newsprint paper or the blackboard.

I monitor the activity and I challenge them to make some of the dots large and some small. I ask them to predict the purpose of this. Each response is recorded on the newsprint. Discussion will come later. The purpose is to give the impression of distance, some stars appear larger and closer, some are further away, some brighter and some darker. (An extension would be for students to research and brainstorms the reasons, “Why some stars appear as they do?”)

After about ten minutes of making dots, I ask them to consider how long it would take for them to place dots representing every star in the Universe. (Graphing their predictions is always fun.)

I give students the example that they could do this for 30 minutes everyday for a year and still not have enough dots to represent each star in the vast Universe. Using star charts students can make comparisons to see the great vastness of stars in the Universe.

I then ask the group with the balloon to have someone blow up the balloon and watch it expand. This balloon represents the expansion of the Universe and the dots the stars. This observational example should help students to understand the shape of the Universe, the movement of the stars away from each other and their distances, as they observe the balloon expanding.

The group or groups with the clear garbage bag, uses a fan to blow air into the opening. As it expands students can relate to the balloons and discuss the questions, “What is happening to the garbage bag and Why?” The result is another example of the vastness of the Universe and the stars.

In the culmination of the activities I ask each group reporter to share what they observed and what other questions their group might want answered as a result. These questions are written on the large classroom KWL, GRAPHIC ORGANIZER CHART, under the W, WHAT I WANT TO KNOW? These questions should be recorded by each student in their science journal.

(A comparison between the energy of air, that filled the balloons and trash bags, could be made with, the energy released in explosions of different kinds.) After the students record their ideas in their science journal. I suggest an investigation of the most noted theory of the beginning of the Universe, THE BIG BANG, be done.

Extensions can be to investigate what other theories there are and how they contrast with the Big Bang.

The Beginning and Expansion of the Universe, Lesson Two, The Big Bang Theory: Grades 3-5

Objectives In the second lesson on the Beginning and Expansion of the Universe, the objectives are for students to research, understand and demonstrate the primeval explosion that possibly gave birth to the Galaxies and the Universe.

Materials Drawings, pictures, books and magazines on Astronomy are needed for a print rich environment to aid student research. One Suggestion is Isaac Asimov’s New Library of the Universe. (See bibliographies for other suggested readings.) Balloons and markers are items needed for the expansion activity.

Strategies Students will observe pictures and drawings of different Galaxies, the main focus being the Big Bang Theory and its effect on what we observe in the Universe.

In introducing this lesson I present the theory that the universe had its birthing from a primeval explosion and that the galaxies, grouping of stars, are the debris of that explosion. (For Demonstration purpose some sort of explosion, like a firecracker in a small empty fish bowl, would help them understand these concepts.) I explain that the force of that explosion hurtled out through space the debris which formed the Galaxies.

Next I explain that there is a thing called a Red Shift, which shows by examination that the Galaxies are moving away from us. The Red Shift is measured by a Spectra-graph. A Spectra-graph does two things, first it divides light into its components, that is into its colors, like a rainbow or a prism. Secondly, It tells what velocity or speed an object is moving at. If the color of an object is toward the Red Spectra Line, it is moving away. If the object moves toward the Blue Spectra Line, it is moving toward us.

Another example to help students comprehend the Red Shift is that of a train whistle. As a train approaches us its whistle gets louder. In the analogy it is approaching the Blue Spectra Line. As it moves away the whistle sound gets quieter. The analogy is that it is moving toward the Red Spectra Line, toward. us. This movement or Red Shift is called the Doppler Effect. Students are usually aware of the Doppler Radar for detecting bad weather. A comparison could be made with the weather Doppler radar.

I then speak of A Belgian Mathematician, Abbe Georges Lemaitre, first put forth the idea of a primeval explosion in 1927 and his idea of expansion would later be called by astronomers as the Big Bang Theory.

Extended activities could be to research the evolution of Galaxies as well as contrasting the different types.

The balloons are used to demonstrate the shape of the Universe as well as the expansion of Galaxies and how they might be moving. First students are paired and sit across from each other. This is so that one partner can observe and record what takes place in their Science/Astronomy Journal. Then they switch.

I pass out the balloons and markers and explain to the students to enlarge the balloon to the size of a baseball. Holding the air hole tight use the marker to place 30 dots on the balloon. Next I have the students blow up the balloons and observe what happens to the dots as the balloons inflate.

The conclusion is that the dots expand away from each other and some move farther away than others. Thus Astronomers believe Galaxies are moving away from each other as the dots move away on the balloons. We do know according to Dr. Edwin Hubble, 1929, that the farther away a Galaxy is the faster it seems to move away from us. Since no Galaxies are getting closer as they move, Scientists and Astronomers believe the Universe is expanding.

The Beginning and Expansion of the Universe, Lesson Three: Grades 3-5

Introduction and Considerations:

Logical reasoning comes from having knowledge and use of that knowledge. In the academic world some scholars may argue over a word and its meaning. Such issues may have value and interest in the academic world, but the day to day life experiences force most of us to deal with making decisions in a pragmatic way. To prove how much money you had in your pocket, if someone asked you, the simple solution would be to take it out and show it. In abstract things common sense and practical reasoning are cognitive tools to use. If somebody asks if a certain person is trustful or not, examples and evidence would be given one way or another.

A speech on trust wouldn’t be appropriate only evidence of one persons trustworthiness. In this lesson and others in the unit, “Astro-Cosmos, The Last Frontier”, many difficult abstract ideas can be shown through common sense and practical reasoning that the Science of Astronomy has unveiled. Many of the concepts in this lesson have been as a result of the influence of John Clayton who is a scientist, author, teacher, and lecturer. (See Bibliographies, Clayton, John N.)

Objective Students will use practical reasoning and common sense in abstract things such as the beginning of the Universe.

Materials Models, pictures, and drawings of the Galaxies and their movement, relative to each other, show very distinct patterns of Galaxtic distances growing daily.

Strategies To present situations to students that are common to present day value judgments and have them relate to logical, practical, pragmatic proof of the beginning of the Universe from a purely scientific perspective.

Pictures of Galaxies and their movement relative to each other, show very distinct patterns of Universal expansion. They show the idea of a beginning. Simple drawings showing representations of the expansion concept could be three squares with relative distances showing corners lettered A, B, C, and D. Each letter represents a Galaxy. Each Galaxy has its relative distance between each letter which represents a contrast in time. Yesterday's time, is represented in the background of a drawing. As the square comes forward in the drawing, lettered corners show it larger in today's time, with the pattern assumed that tomorrows foreground square will be larger with relative distances between A,B,C, and D shown as relative expansion.

We exist in a Universe that gets larger and larger with each passing day. If we ran time backward each Galaxy in the above examples would be closer together and relative distances would shrink accordingly. The ultimate question is where must all Galaxies have been?

As students think about this question and respond, many should see that the answer would be at a beginning. At a point! At the beginning which scientists call a singularity! (See examples of drawings below)

POINT OF

SINGULARITY

A B

A B

C D A B

Yesterday

C D

Today

C D

Tomorrow

Evaluation Science Journal notes and evidence of discussions and reflection on questions asked and answers given.

The Beginning and Expansion of the Universe, Lesson Four, "What Does Sand Got To Do With It?": Grades 3-5

Objectives Students will be given analogies and create there own analogies of the Beginning and Expansion of the Universe using sand. Also students will demonstrate prior knowledge skills as they build new knowledge and make prediction.

Materials A lot of sand, a large area or space, Science/Astronomy Journals and colored pencils, a large piece of butcher paper. and bags or paper cups.

Procedure Students will first work as a whole class in a large area such as a playground, with lots of sand. A baseball park or a beach is even better. However, it can also be done in the classroom

over butcher paper. Students will make predictions about the area and how it could represent our Universe. They will also make predictions about how objects around them in the area could represent objects in space. Using prior knowledge of the vastness of the Universe and analogy skills, students will imagine what might have taken place during the Big Bang.
First I have the class make a big circle holding hands. Then I have them drop hands and take two giant step back. I tell them to imagine that this was the Universe. I then pick up a handful of sand and walk around letting each student choose only one speck of sand.

Without anyone else seeing each student will examine their speck of sand real carefully.

Then they will record their description in their Science/ Astronomy Journals. They can use the colored pencils to draw their speck of sand.

Then I have all the students look at my one piece of sand and ask several to describe it and touch it. Next I ask the students to predict what would happen if I threw my piece of sand as far as I could? Then I ask what would be the chance I could find it again? All responses are accepted that have a reasonable prediction. The answers will vary. The chances of finding the same speck of sand, especially at the beach, would be impossible.

Lastly I have them throw their specks of sand as far as they can and imagine it being a Star out in Space. The analogy is the speck of sand is like one star out of a whole lot of stars. Finding their speck of sand is like trying to find a star that might support a planetary system similar to ours.

Another hands on activity that lends it self very well to the vastness of our Universe is as follows:

Procedures

1. Fill a small home sized aquarium with sand and have each student pick out one piece of sand and observe it very carefully. Then have each student close their eyes and drop their piece back into the aquarium and have each one predict the chances of finding it. Use other objects like a BB shot or ballbearing and have them make other predictions.
2. The teacher will demonstrate to the groups how difficult it is to locate various items.

Another example of the vastness of the Universe is through a project demonstration. Students will put lots of pin holes into a card board shoe box. Then they will hold it up to a light source in a darkroom. They are to come up with a relative explanation as to the purpose of their demonstration. The pin holes represent stars in relationship to the shoe box which represents the Universe. Students will relate to the fact that, no matter how many pin holes they make representing stars it would be impossible represent all of them.

Evaluation will be through participation, effective note taking in their Science/Astronomy Journals. Reading logs with books, magazines and other research materials will be listed. A brief reaction to information read and what they learned from it would be required.

OUR MARVELOUS PLANETARY SYSTEM, How Big are the Planets?: Grades 3-5, Lesson five.

Objectives Students will review the sequential order of the planets; determine planet sizes using different scale measurements; and compare and contrast customary units of length with metric.

Materials Scissors, Ruler with inches and centimeters, Large White Butcher Paper, String, Cooperative Logic Planet Cards from prior lesson. Overhead of planets with diameters and scaled down measurement using Mercury as a guide, at 1 inch diameter.

Process Students will be in groups with each student responsible for a task. One each of the following: group leader, time keeper, recorder, and reporter.

Questions and Steps in the Process:

1. What is the order of the planets in our Solar System? In cooperative groups students can record answers under K= What I know column, listing the Planets 1-9, from the Sun.
2. What does it mean to scale up? What does it mean to scale down? Teacher will present on an overhead the planets with their diameters, and scale down using Mercury at 1 inch diameter to which all other planets will be made relative to in comparison.
3. Students will record the values on their group and individual charts.
4. Students will also half all the diameters and scale measurements of the planets. What is the radii of each planet? Students will record their responses.
5. Using materials available in a bag each group will come up with a string make shift compass in order to draw circles for each planet, the halved scale measurements or radii will be used for the length of each string.
8. Each student will record any observations they make in their Science/Astronomy Journal.
7. Use the Large Butcher Paper and tack the various sized planets in order for visual relationships of scaling down.
8. Repeat the process scaling Mercury at one centimeter. Students will recalculate all the radii relative to Mercury at one centimeter.
9. Place the metric scale planets on top of customary scaled planets and have students record observations and comparisons.

Extensions of these activities are numerous to allow students to make observations and comparisons, integrating mathematics into the science theme of the Solar System.

An Example of a Journal Record Sheet is a follows:

PLANETS	DIAMETER IN MILES	HALVED	SCALE MEASUREMENT	HALVED

***Evaluation** Journal records of observations and group work observations reflecting knowledge of scaling up and down.*

PERSPECTIVE AND PLACEMENT OF THE PLANETS IN OUR SOLAR SYSTEM: Grades 3-5,Lesson six.

***Objectives** Students will use prior knowledge of scaling down to create mobiles of the Solar System.*

***Materials** This list is what each student will need to create a mobile: 2 coat hangers, 1 wire cutter, scissors, ruler with both inches and centimeters, string, poster board, markers of different colors. 10 gauge wire and glue for metal and poster board.*

***Procedure** Students can work in groups and share materials. Each student will use prior knowledge of diameters and radius scaling down size. Students will create mobiles of the Solar System using organizational steps as follows.*

STEPS TO CREATING MOBILES:

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1. Using the scaled down radius measurement of each planet in inches, Mercury's diameter at one inch, students will mimic the real colors of the planets using colored poster board. Draw circles according to the scale, representing the planets.
2. Cut out the circles and label each planet.
3. Cut 2, 15 inch pieces of wire from the coat hangers and cross them at the center and secure with 10 gauge wire. This is where the Sun, represented by yellow poster board, will be located. (Size and distances of planets are modified for this activity.)
4. Cut string or fishing line for each planet to hang on. Suggested lengths for string or fishing line are as follows: Mars 8 inches, Earth 7 in., Neptune 10 in, Jupiter 9 in., Uranus 10 in., Venus 10 in., Mercury 7 in., Saturn 9 in., and Pluto 12 in.
5. Punch a hole in the top of each planet and place one end of the string through about an inch and tie a knot at that end.
6. Cut 2, 24 inch pieces of string and tie the ends of each string to the ends of the coat hanger wire, at the 12 inch center place a paper clip to hang the mobile up with.
7. Use a marker to write the name of each planet on both sides of the planet, permanent adhesive labels, such as file folder labels, are good for this.
8. Secure each planet with a knot on coat hanger wire. (These directions and materials can be adapted as necessary. A suggestion might be to use pre-cut sticks, for younger children, and a wood glue to secure them at the center.)

Evaluation The evaluation would be on a Rubric Scale Point System of 0-8. 0 being no effort exemplified in contrast to a 6 being excellent. The scoring would be in each of the following areas: Student participation, following of directions, use of prior knowledge skills, recording of research information accurately and neatly in Science/Astronomy Journals, and use of Journals in the development of the Solar System Mobile, and the completed Mobile in a timely manner.
I would present a teacher made test to evaluate students understanding of concepts taught. Also, the test will help me identify problem areas in which I need to reteach for mastery. All of the skills in this lesson are aligned with the Connecticut Mastery Tests and the district goals of developing critical thinking skills.

OUR MARVELOUS PLANETARY SYSTEM, Cooperative Problem Solving, Grade 3-5, Lesson seven.

Objective Students will use deductive reasoning in a cooperative setting to Understand the order of planets in their Solar System.

Materials Copies of written directions and clues prepared on index cards. Envelopes with index cards and pictures of the planets and Solar System.

Strategies For each problem students will be astronomers. Clues will be presented and students will use the process of elimination. Divide the class into equal groups give each group an envelope with one clue. There can be four—six students in each group depending on class size.

Group rules

1. One student is group leader, whose job it is to direct the discussion.
2. One student is the recorder of data and reasoning ideas.
3. One student is the reporter to the class of how the group solved the problem.
4. There is one time keeper to keep everyone on task and focused.
5. Only one person speaks at a time.
8. There is a no-fault policy, no one blames another for ideas that might lead to an incorrect solution.
7. If a small group of students, four-six, are working on solving the over all problem, each student is given one clue. Only four clues are needed to solve the problem.
8. Students may read their clues to each other but not show the written clues.

Solar System Problem Each group has a set of out of order pictures of the Sun, Pluto, Mercury, Jupiter, Venus, Mars, Neptune, Saturn, Uranus, and Earth.
(Solar System Cooperative Problem Solving Activity materials should be laminated for continual use.)

Directions should read These clues are for solving your group problem. Only read the clues to the group. Don't show the written clues to any other student. Problem reads: Order the Sun and the planet pictures based on the clues that you have on the index cards.

Two clues are written on each index card, for example:

1. Five planets furthest from our star are Neptune, Pluto, Saturn, Jupiter, Uranus, not in that order.
2. Four of the planets have a lower density even though they are much larger than the other five.

Other examples of clues are as follows:

*Uranus is between Saturn and Neptune.

*Saturn is nearer Earth than Neptune.

*Mercury and Pluto have seven planets between them.

*There is just one planet between Uranus and Pluto.

*Venus and Mercury were the only two planets closer to the Sun than our Earth planet.

*The five planets nearest the Sun are Venus, Mars, Jupiter, and Mercury, not in that order.

*The five terrestrial planets, (Earth like planets), are Earth, Mars, Mercury, Pluto, and Venus.

*Earth is approximately 93 million miles from the Sun. Copernicus of the 18th century only knew six planets: Earth, Mars, Mercury, Jupiter, Saturn, and Venus. These are the six planets closest to the Sun.

Note For students who want more challenging activities add other pictures and clues such as the Earth's Moon and other moons or rings around planets.

The possibilities of this type of cooperative, hands-on discovery and reasoning, are endless. Another adaptation could be to use this process with new information as research and new evidence becomes available. It could also be used for the various jobs individuals have in the various Sciences for Space Exploration.

Evaluation The evaluation would be on the outcome of the student/groups placement of the planets based on the clues. Observation by the teacher of the groups working together to solve the problem presented. Journal entries in Science Journals about what was learned by each student would be another indicator for evaluation.

OUR MARVELOUS PLANETARY SYSTEM, RELATIVE TO SIZE AND DISTANCE, Grades 3-5,Lesson Eight.

Explain terms used when discussing distances and sizes this great, such as light years. A good question to identify where students are in their knowledge is to ask things like, “What is a light year?” (Students love to have a question asked and then you act like you don’t know and need their help.) Explanation should be the time/distance light travels in one Earth year. Light travels approximately 186,300 miles per second, equal to about 6 trillion miles is the distance light travels in one year. Relative distances and time to travel to places in The Solar System are as follows: (Note that a space craft traveling at the speed of a jet is figured at 600 miles an hour.

Also note that the figures are approximations.)

PLANET	DIAMETER	DISTANCE	A SPACE CRAFT LIGHT	
TRAVEL	At Equators	In Miles	AT JET SPEED	
Sun	870,000	93,000,000	17.7 yrs	8.5 min
Mercury	3,030	57,000,000	10.8 yrs	5 min
Venus	7,500	26,000,000	5.4 yrs	2.5 min
Mars	4,200	40,000,000	8.8 yrs	4 min.
Jupiter	89,000	390,000,000	74.25 yrs	35 min.
Saturn	75,000	794,000,000	150.4 yrs	1.2 hrs.
Uranus	32,000	1.7 billion	318.5 yrs	2.5 hrs
Neptune	31,000	2.7 billion	513.2 yrs	4 hrs
Pluto	1,500	3.6 billion	690.1 yrs	5.4 hrs

EXTENDED LESSONS You could go on for example, the distance to nearest star Proxima Centauri is

25.trillion 4.8 million yrs 4.2yrs.

I would also use travel guides in relationship to travel around the world and how long it takes by jet to travel from place to place (A little geography here). Show how that relates to the travel we are talking about to the various planets.

OUR MARVELOUS PLANETARY SYSTEM, RELATIVE TO SIZE AND DISTANCE, Grades 3-5, Lesson Eight.

Objectives Students will be able to identify and relate through analogies, the size and distance of planets in relationship to Earth.

Materials Overheads for direct teaching by teacher. Rich print environment of Astronomy books, magazines, and computer software for research. Sand, sifter made out of screen, small ball-bearings, and a large container made out of glass, such as an Aquarium. Large boxes to create models with.

Procedures Students can be grouped during presentation and activities.

1. Teacher will direct teach approximate sizes and distances of the planets on the over head.
2. Teacher will present analogies to students for relative size and distance concepts.
3. Example of Chart presented is as follows:
   (Some information could be left out and used as research questions for students.)

OPENING EXAMPLE: Earth's approximate diameter is 8,000 miles. What is a diameter? What is a circumference? Wait for responses to check prior knowledge. The Earth's circumference is about 24,000 miles. The Sun's diameter is approximately 870,000 miles, over 100 times thicker than the Earth's. The Sun's circumference is more than 2,700,000 miles. The Solar System is approximately 5.5 billion miles across. (Use the scaling down process from prior lessons to compare sizes and distances from student background knowledge.) "What would it take scale the Earth to appear as a speck of sand if the classroom was the Solar System?" "What would the size of the Sun be in relationship to the Earth?" "Would it appear as the size of a small ball bearing. (Hold each item up when you refer to them, ie. a speck of sand, and the ball bearing.)

4. Fill the fish tank with sand and have each student pick out one piece of sand and observe it very carefully. Then have each student close their eyes and drop their piece back into the fish tank and ask each one to predict the chances of finding it. Use other objects like a BB shot or ballbearing and have them make other predictions. Demonstrate to the groups how difficult it is to locate the various items.

5. Have students put lots of pin holes in the card-board boxes and hold it up to the light and have them come up with a relative explanation as to the purpose. (It is to see the size and distance of the universe and stars in relationship to the pin holes. Letting light through.)

Evaluation Students take notes in their Science/ Astronomy Journals and then record procedures and results from activities. Quizzes that are teacher made, to help evaluate the learning of concepts, is suggested. Rubrics, similar to previous lessons can be used.

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