Play-Doh Planets

It's hard to imagine the size of Jupiter compared to the size of Pluto. Through this hands-on activity, students will use a scale model to easily visualize such hard to grasp concepts and to learn about the relative volumes of the planets in our solar system.

Grade Level: 3rd Grade

Phenomena:
How do the planets compare to each other in size?

Objectives:

- Students will analyze how a model is representative of a system and how it differs.
- Students will compare and contrast a planet and a dwarf planet.
- Students will construct a scale model of the volumes of the planets in our solar system using play dough.
- Students will evaluate and justify the vast differences in volume among the planets in our solar system.

Materials:

- Examples of models
- Pencils
- Laminated definition of "planet"
- For each group:
- Plastic knives
- Play-dough
- Wax paper
- Worlds in Comparison Instruction Sheet*
- Planet layout sheets
- Printout of Activity Record (pg 13)

Appendixes:

- **Instruction Sheet pg. 6**
- **Activity mats pgs. 7-9**
- **Planet definition pgs. 10,11**
- **Comparing worlds journal pg. 12**
- **Activity Sheet pg. 13**

Time Considerations:
Preparations: 30 minutes
Lesson Time: 50-60 minutes
Activity 1: 10 minutes
Activity 2: 5 minutes
Activity 3: 45 minutes

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Next Generation Science Standards

5-ESS1-1. Support an argument that differences in the apparent brightness of the sun compared to other stars is due to their relative distances from Earth.

Science and Engineering Practices (SEP):
Engaging in Argument from Evidence

Disciplinary Core Ideas:
The Universe and its Stars

Crosscutting Concepts:
Scale, Proportion, and Quantity

Excellence in Environmental Education Guidelines

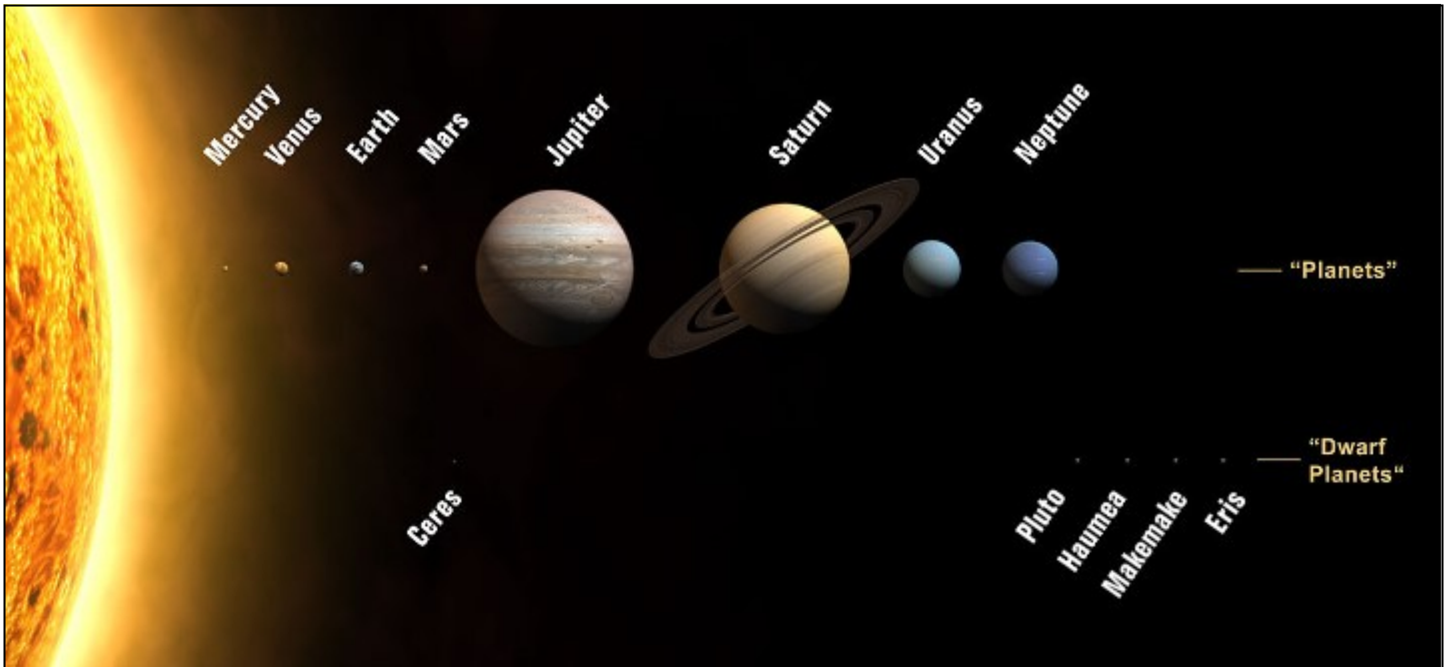
Strand 1– Questioning, Analysis and Interpretation Skills (F—Working with models and simulations): Learners understand that relationships, patterns, and processes can be represented by models.

Background

Our solar system is an engaging topic for students of any age. However, the intricacies of each planet's relationship to the others is often lost in the images readily available to students and teachers. This lesson seeks to address one of those misunderstandings: the relative volume of the planets.

Our solar system is composed of 8 planets and 5 dwarf planets revolving around the sun. In 2006, after astronomers found a planet larger than Pluto in a similar orbit, the International Astronomical Union (IAU), redefined a planet as a round object in space that orbits the sun and *has cleared its neighborhood of smaller objects*. At the same time, they defined a dwarf planet as a round object in space that orbits the Sun but has not cleared its neighborhood of smaller planets and is not a satellite. This decision is what changed Pluto's status from a planet to a dwarf planet—and caused quite an uproar among the general public and the media.

The planets vary greatly in size. The table on this page



Our Solar System: The planets and dwarf planets shown in relative size to each other and the sun. Objects are shown in the correct order, but the model does not represent the relative distance between the planets. http://enigmasastronomy.wordpress.com/the-universe/galaxies-stars/our-solar-system

shows the planet's volumes relative to earth. Earth's volume is 1.1×10^{21} m^3. This number is hard to imagine for most people. To add to the confusion, Jupiter is 1318 times bigger than Earth, but Pluto is 1% the size.

Planet	Relationship to Earth's Volume
Mercury	5%
Venus	86%
Earth	1.1×10^{21} m^3
Mars	15%
Jupiter	1318 times greater
Saturn	744 times greater
Uranus	63 times greater
Neptune	58 times greater
Pluto	1%

This table shows the relationship of each planet's volume to that of Earth. http://www.physlink.com/Education/askexperts/ae419.cfm

To better understand the relationships among planets (and other objects in space), astronomers use models to represent things that we can't interact with. In this lesson, students will follow instructions to create a play-dough model of the solar system according to volume. At the end of this activity students will have a model that accurately represents this relationship.

Preparation

Gather the needed materials. Photocopy the Activity Record for each group. Put together and laminate a poster of the definition of "planet" (pages 9-10). Also, to increase the lifetime of the Planet Layout Sheets and Worlds in Comparison Instruction Sheets it helps to laminate them or cover them with document protectors.

Three pounds of play-dough is kind of a lot, but this activity does not work if you use less. You can order three-pound tubs online cheaply from Toysrus.com. Alternatively, you can make your own play-dough with the recipe on page 5. The only drawback is that this can grow moldy, so if you plan to do this activity often, it is recommended that you invest in the commercial product.

This activity will be easier to teach if you've done it yourself. Practice before you teach it.

With third grade students, it helps to take the play-dough out of the container and roll it into a hot-dog shape.

Wrap the wax paper around the play-dough once it is in an even shape. Lay these out with the rest of the group supplies for one person from each group to use at the beginning of the Worlds in Comparison activity.

Activity 1—Planet Review

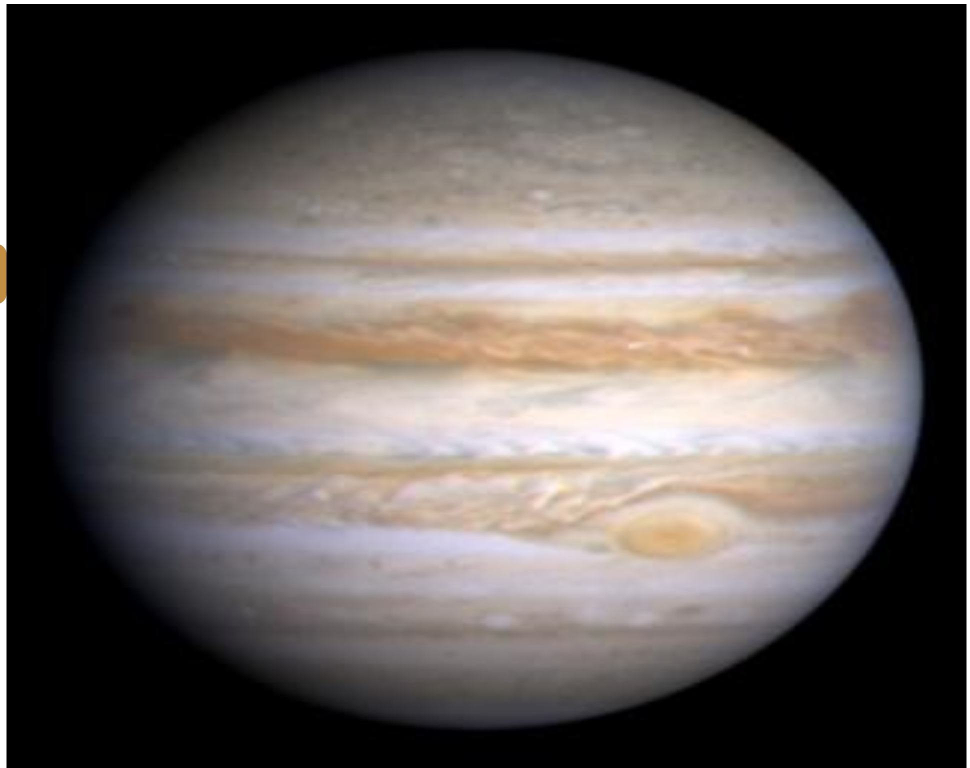
Doing the Activity

Start the lesson by asking students to talk to a partner for one minute and come up with a definition of a planet. Call on groups and work together to come up with a class definition. Then put on the board the Planet definition poster that you created from pages 9 and 10 and officially define a planet as “A round object in space that orbits the sun and has cleared it’s neighborhood of smaller objects.”

Explain to students that the last part of the definition, “has cleared its neighborhood of smaller objects,” is what changed Pluto from a planet to a dwarf planet, because astronomers found other objects in the neighborhood of Pluto.

Next, use the following mnemonic to help students to go through the order of the planets from the Sun, using Pluto to represent all the dwarf planets: My Very Energetic Mother Just Served Us Nine Pizzas (Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, Pluto.) This mnemonic can be changed if you are teaching all the dwarf planets (Pluto, Ceres, Haumea, Makemake, and Eris).

Activity 2—Model Basics



Jupiter is the biggest planet in our Solar System
http://pikimal.com/planet/jupiter

Before building a model, it is helpful to review the concept of a model with students. Ask students for examples of models and then ask them to come up with a definition in groups. Refer to playthings, such as dolls, toy cars, and model airplanes. Give examples of models that might be larger than or the same size as the object you are studying (like a model of an ant or a life-size model). Ask how these models are representative of the object and how they fall short. Define a model as a representation of an object that is used to better understand it and its relationship to other objects.

Now say that today we are going to build a model of the Solar System, in order to better understand the differences among planet’s volumes. We will use Pluto in this model to represent all of the dwarf planets.

Activity 3—Worlds in Comparison

Divide the class into groups of no more than four students. Have the member of each group with the longest hair come up and get supplies (one of each of the following): 3lbs of play-dough, a plastic knife, 2ft of wax paper, a Worlds in Comparison instruction sheet, a set of three planet layout sheets and an Activity Record.

Have students start by making a hypothesis about which planet they think is the biggest. Go over the instructions on the Worlds in Comparison Instruction Sheet and describe the activity. Stress that students need to use ALL the play-dough from the start and to follow the directions very carefully (or the activity will not

The finished product of the Worlds in Comparison activity.

be accurate). Also, it is important to have a very even shape and make even cuts.

It is helpful to model the first step together as a class, so that students understand the process that they have to repeat to do the activity. Stress that they must roll the play-dough into an even hot dog/ snake shape.

Since cutting something into ten even pieces is quite a challenging task, have students follow the directions and use the plastic knife to start by marking the play-dough in half. Then have them make four marks on each half to get five pieces. After marking the cuts, have the students examine to see if they think the pieces will be about equal size. If they are not, have them remark the cuts. When the pieces are relatively even, have the group work together to count the number of parts they need for each planet in that step and only cut the play-dough there. Exhibit that if you need five parts in the Saturn box, you can count out five parts and then only make a cut there.

At this point, allow each group to follow the instructions on their own and create their model of the Solar System.

When students are finished with their model, have them write two things that surprised them about the activity or that they learned on their Activity Record.

If students are done early, ask them to brainstorm with their group about ways that the model represents our solar system and ways that it does not represent it. At the end of the activity, use these answers to have a discussion about the overall accuracy of models. Some things that are accurate: relative volume and planet order. Some things that are not accurate: material the planets are made of, distance between planets, color, shapes, surface, etc.

Conclusion

Wrap-up the activity by asking students to share one thing that surprised them about this activity. Ultimately direct the discussion so that students realize the smaller planets (except the dwarf planet Pluto) are the inner planets, while the larger planets are the outer planets. You may also want to note that more than 96% of the combined volume of the planets is in Jupiter and Saturn (approximately 60% in Jupiter and 36% in Saturn). Those giant planets really ARE giants.

Assessment

Informally evaluate students by their ability to follow directions and make an accurate model of the relative volume of the planets.
Formally assess student's learning by asking students to answer all the questions on the Activity Record and to turn it in for credit.

Extensions

Volume of the Earth

- The volume of the Earth is: 1,097,509,500,000,000,000 cubic kilometers or 1.1 x 10^{18} km^3. This is very large! To better envision this number, let's compare it to something we know (like we did with the model in the lesson). Inside of one cubic meter you could fit about nine third graders. So, this would be 121,945,500,000,000,000 third graders. Is your school this big? What about the city that you live in? This number of students is so large that if you could count one number per second it would take you more than three and a half billion years to count this high. If you counted by millions it would still take you almost four thousand years to get to this number! It would take you over eight million years to count to the number of cubic meters the earth is. So, the earth is very large indeed!

Imagining space

- Have students try to imagine other objects in space on this scale. For instance, the sun would be about 27 feet in diameter, probably bigger than the classroom. Earth would be more than half a mile from the sun. The Moon would be about half-way between the size of Pluto and Mercury.

Vocabulary

Dwarf Planet: A round object in space that orbits the sun and has *not* cleared its neighborhood of smaller objects and is not a satellite.

Planet: A round object in space that orbits the sun and has cleared its neighborhood of smaller objects.

Model: A representation of an object that is used to better understand it and it's relationship to other objects.

Play-dough Recipe

This recipe makes three pounds of colorful, scented play-dough:

5 cups of flour
1 cup salt
4 packages dry unsweetened Kool-Aid™
4 cups boiling water
6 tablespoons vegetable oil

Mix the dry ingredients together in a bowl. Mix the liquids together and pour them over the dry ingredients. Stir the mixture until it forms a ball (this may take a while — keep stirring). As the mixture cools, it will become less sticky. After the mixture has cooled to room temperature, take it out of the bowl and knead it until it is smooth. Store in sealed bags in the refrigerator until ready to use.

Recipe from AFGU lesson

Sources

- Lesson adapted from: Astronomy From the Ground Up. Dennis Schatz (Pacific Science Center). *Worlds in Comparison.* San Francisco, CA: Astronomy from the Ground Up, Astronomical Society of the Pacific, 2008. www.astrosociety.org/afgu
- Volume of the Earth activity adapted from: http://www.physlink.com/Education/askexperts/ae419.cfm

Images:
- Solar System to Scale: Wunder Blog: Weather Undergound: Planets and Extro Planets. http://serbian.wunderground.com/blog/cycloone/comment.html?entrynum=55&tstamp=&page=1
- Doll: The TV Zone: November 2007 Archive. http://weblogs.newsday.com/entertainment/tv/blog/2007/11/. Accessed on 8/5/09/
- Jupiter: NASA Photo Journal. http://photojournal.jpl.nasa.gov/catalog/PIA02821. Accessed on 8/5/09.

Worlds in Comparison Instruction Sheet

Student's Page

What's This About? This activity demonstrates the different sizes of the planets in our solar system.

Instructions: Follow the steps below to see the relative size (volume) of each planet. Start with a big 3-pound ball of play-dough, rolled into a large hot-dog shape, which represents the volume of all the planets combined. Wait until you are all done with the activity to form the dough from each planet box into a ball.

1. Divide the large hot dog shape into two equal pieces. Now make four marks on each half, so that each half will be split into five equal parts. Now you have ten parts.

- Put 6 parts into the Jupiter box.
- Put 3 parts into the Saturn box.

2. Roll the remaining part into a hot dog shape and divide it into two equal pieces.

- Put one half in the Saturn box.

3. On the other half, make four marks, so that it will be split into five equal parts.

- Put 2 parts into the Neptune box.
- Put 2 parts into the Uranus box.

4. Roll the remaining part into a hot dog shape and make three marks so that it will be split into four equal parts.

- Put 3 parts into the Saturn box.

5. Roll the remaining part into a hot dog shape and divide it into two equal pieces. Make four marks on each half so that each half will be split into five equal parts. Now you have ten parts.

- Put 2 parts into the Earth box.
- Put 2 parts into the Venus box.
- Put 4 parts into the Uranus box.

6. Combine the remaining 2 parts, roll them into a hot dog shape and divide it into two equal pieces. Make four marks on each half so that each half will be split into five equal parts. Now you have ten parts.

- Put 1 part into the Mars box.
- Put 4 parts into the Neptune box.
- Put 4 parts into the Uranus box.

7. Roll the remaining part into a hot dog shape and divide it into two equal pieces. Make four marks on each half so that each half will be split into five equal parts. Now you have ten parts.

- Put 7 parts into the Mercury box.
- Put 2 parts into the Uranus box.

8. Roll the remaining part into a hot dog shape and divide it into two equal pieces. Make four marks on each half so that each half will be split into five equal parts. Now you have ten parts.

- Put 9 parts into the Uranus box.
- Put 1 part into the Pluto box.

And Now… Now that you have divided the play-dough to represent the planets by volume, roll the pieces in each planet's box into balls to best represent the shapes of the planets.

Mercury

Venus

Earth

Mars

Jupiter

Saturn

Uranus

Neptune

Pluto

PLANET:

A round object in space that orbits the sun and has cleared it’s neighborhood of smaller objects.

Comparing Worlds Journal

Name: ________________

Hypothesis: Which planet is the biggest? ______________________________

What **two things** surprised you in this activity?

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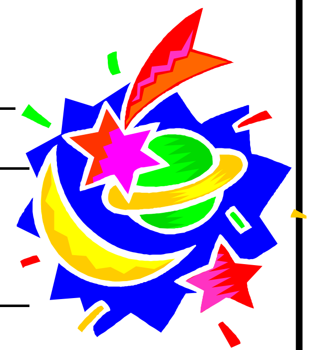

What was accurate about this model of the planets?

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In what ways was this model false?

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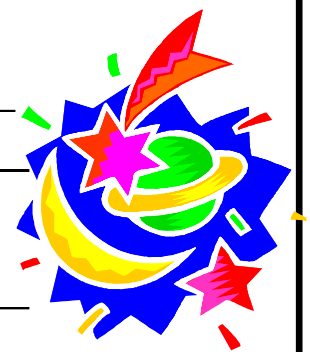

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Names

Student's Page

Comparing Worlds Activity Sheet

Write a hypothesis: Which planet do you think is the biggest?

Write **two things** that surprised you by doing this activity:

Wrap Up: What is an example of a **model**?

How does the model we made today represent the Solar System accurately? How do they fail to represent the Solar System accurately?

Names

Student's Page

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