



## **VOYAGE: A JOURNEY THROUGH OUR SOLAR SYSTEM**

**GRADES K-2**

### **LESSON 1: MAKING MODELS TO UNDERSTAND OUR HOME**

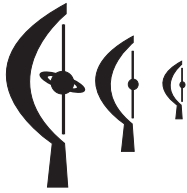
On October 17, 2001, a one to ten billion scale model Solar System exhibition opened on the National Mall in Washington, DC. Created by Challenger Center for Space Science Education, the Smithsonian Institution, and NASA, the *Voyage* exhibition stretches nearly half a mile from the National Air and Space Museum to the Smithsonian's Castle Building. *Voyage* is a celebration of what we know of Earth's place in space and our ability to explore beyond the confines of this tiny world. It is a celebration worthy of the National Mall. Take the *Voyage* at [www.voyageonline.org](http://www.voyageonline.org).

This lesson is one of many grade K-12 lessons developed by Challenger Center to bring the *Voyage* experience to classrooms across the nation through Challenger Center's *Journey through the Universe* program. *Journey through the Universe* takes entire communities to the space frontier. Start the *Journey* at [www.challenger.org/journey](http://www.challenger.org/journey).



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## LESSON 1: MAKING MODELS TO UNDERSTAND OUR HOME

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### LESSON AT A GLANCE

#### LESSON OVERVIEW

Models are powerful tools of exploration, especially as students investigate the size and distance relationships between the Sun and the planets in the Solar System. By examining the relative sizes of the planets using models at a one to ten billion scale, students realize that the Earth, the biggest thing they have ever touched, is quite small in comparison to the Sun and some of the other planets. Moving outdoors, students then create a one to ten billion scale model of the Solar System. Walking through their model as cosmic giants, students are awed by the tiny worlds in a vast space, and gain a new appreciation for Earth, their home.

#### LESSON DURATION

One 45-minute class period



#### CORE EDUCATION STANDARDS

##### National Science Education Standards

##### Standard B1: Properties of objects and materials

- Objects have many observable properties, including size, weight, shape, color, temperature, and the ability to react with other substances.

##### AAAS Benchmarks for Science Literacy

##### Benchmark 11B2:

- A model of something is different from the real thing but can be used to learn about the real thing.

##### Benchmark 11B1:

- Many of the toys children play with are like real things only in some ways. They are not the same size, are missing many details, or are not able to do all of the same things.



#### RELATED EDUCATION STANDARDS

*AAAS Benchmarks for Science Literacy*

Benchmark 6D1:

- ▶ People use their senses to find out about their surroundings and themselves.

Benchmark 11B3:

- ▶ One way to describe something is to say how it is like something else.

Benchmark 12A1:

- ▶ Raise questions about the world around them and be willing to seek answers to some of them by making careful observations and trying things out.



#### ESSENTIAL QUESTIONS

- ▶ What is a model, and how can it help us learn about objects around us?
- ▶ How can we use a model to describe our home?



#### CONCEPTS

Students will learn the following concepts:

- ▶ A model is a two- or three-dimensional representation of another object.
- ▶ A model shares one or more characteristics of the object it is representing.
- ▶ Models help us learn about things that would otherwise be difficult or impossible to learn about.



#### OBJECTIVES

Students will be able to do the following:

- ▶ Provide a basic definition of a model.
- ▶ Recognize that a model shares certain characteristics with the object it represents.
- ▶ Make a two-dimensional model (drawing) of a house or apartment, and describe it to the class.

## SCIENCE OVERVIEW

### DEFINITIONS OF A MODEL

For the purposes of this unit, a model is defined as a physical (three-dimensional with surface and mass, or two-dimensional “flat”) representation, sharing one or more characteristics of the object under study.

The purpose of a model is to

- represent an object or a phenomenon in a manageable way, and
- learn about the object or phenomenon that the model represents by altering certain characteristics that make the real thing otherwise difficult or impossible to study.

Some ways to make physical models more accessible include making the model larger or smaller, or colder or hotter than the real object. For example, three-dimensional and flat models may be smaller copies of their counterparts, (e.g., model train, toy car, plastic dinosaur). Models may also be bigger versions of the real thing to illustrate objects usually too small for study (e.g., an enlarged chart of letters or handwriting, a large model of an insect, a three-foot long toothbrush). Other versions may help us explore things too hot for study (e.g., a play kitchen unit built to simulate an oven, colored paper cut to the shape of a flame), or too cold for study (e.g., a snowman rebuilt from styrofoam, an igloo made of plastic).

### PROPORTION IN SCALE MODELS

A physical model is particularly useful if it is a scale model. This means that all parts of the model are scaled up or down by the same factor. If you have a  $1/50$  scale model of an airplane, then the model airplane is  $1/50$  the size of the real airplane, the length of the model wing is  $1/50$  the length of the real wing, the height of the tail is  $1/50$  the height of the real tail, etc. Caution: Areas and volumes will not scale the same way. For example, the real airplane will contain much more than 50 times the volume of the  $1/50$  scale model. Note: The idea of scale modeling may be too advanced for some early elementary grades.

### PROFESSIONAL NEED FOR MODELS

Models are not just toys. Scientists, engineers, architects, and other professionals use them to see how parts fit together, how something will look from different angles, how much bigger some parts are than others, or whether a new kind of product will actually work.

For any kind of model, its purpose is to show one or more characteristics of the actual object, though it does not usually portray them all. However, some models are perfect replicas and are used, for example, in simulations and re-enactments, historical films, safety tests, or in museum exhibits.

Many details may be omitted from models, since their inclusion could make the model unnecessarily complicated. Often, the characteristic not accurately conveyed is size, though on a scale model, at least the relative size of parts is correct. Another characteristic you would not want to accurately represent is the temperature of a very hot object, such as the Sun.

In addition to size, other model characteristics might include: color, shape, density, texture, weight, smell, taste, sound, and physical state (solid, liquid, or gas).

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## CONDUCTING THE LESSON

### WARM-UP



#### TEACHER MATERIALS

- ▶ Globe of Earth
- ▶ Gather at least three of the following three-dimensional models: toy car or fire truck, doll, toy airplane, stuffed animal, etc.

#### PREPARATION & PROCEDURES

1. Ask the students to name the smallest thing they've ever touched. They may list ants, bugs, sand.
2. Ask them to think about the largest thing they've ever touched. They may say a house, an elephant, an airplane.
3. Ask if they could bring these things into the classroom if they wanted to look at them more closely.
4. Ask what some of the problems of bringing these big and small things into the classroom would be.
5. Tell them to keep thinking larger. Tell them that you are touching something really big right now... and that they are too. So is the principal. So are their friends! Continue to give them clues (such as "And what is that built on?") for a minute until someone says the "world" or the "Earth"!
6. Ask, "And if you wanted to look closely at the whole Earth, how would you do it? Could you bring it into the classroom?" Continue until they determine that it's not very easy, or even possible, to bring such big objects into the classroom to study them, and that there must be a better way.

#### TEACHING TIPS

- ▶ Be careful not to merely tell students something is a model. Use leading questions about characteristics of an object to help them decide whether or not it can be considered a model.
- ▶ Don't use the word "model" right away; see if the students use it and know what it means.

## PRE-ASSESSMENT

### PREPARATION & PROCEDURES

1. Show the class the three-dimensional models (toy car or fire truck, toy airplane, doll, etc.). Ask students to describe the object and what it does. They may say, "It's a fire engine; it puts out fires." Show a globe of the Earth. Ask the students if they know what it is. (Wait to see if they use the word, "model.") Tell them these objects are models, which are copies of a real thing we might want to learn about—even play with. If the real thing is not available—even too big to handle like the Earth—then the model is the next best thing. We can truly learn something about real cars, trucks, airplanes, and even the Earth using models of them.
2. Determine if students can see the characteristics that differentiate models from the real thing by asking, for example, "Does it work like the real thing?" "Is it made of the same stuff as the real thing?" "Can you fit inside like you can into a real school bus?"

### TEACHING TIPS

- Choose both realistic (e.g., detailed fire engine) and crude models (e.g., quick drawings on the blackboard) to check for understanding.
- Keep a list of the students' answers, especially their misconceptions. They may differentiate models from the real thing by saying that a small object is a model just because it is small. They may claim that a red object is a model of another red object, when the two are unrelated. Use the list to refine your own teaching points throughout the lesson.

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## ACTIVITY 1: I SPY



### TEACHER MATERIALS

- Wall map (any kind)
- Sampling of photographs and drawings of objects and people
- Sampling of three-dimensional models: toy car or fire truck, doll, toy plane, stuffed animal, etc.

### PREPARATION & PROCEDURES

1. Place the examples of models (wall map, photos/drawings, and three-dimensional models) around the room prior to the start of the class.
2. Review the definition of a model. Tell students that a model is a smaller or larger version of something we want to look at more closely. Ask students if they have ever been to a toy store and seen a model of something. Ask them to provide examples.
3. Ask students, "Is a globe a model?" Have them explain their answers. See if they can determine that the brown color is ground, and the blue is water. Show them where your city is located on the globe. Tell them to imagine how small their house (and they, themselves) would have to be if they were to fit in the city.
4. Question the students so they reveal that a model does not necessarily do the thing for which it is intended; rather, it might be just "pretend," a "miniature," or a "model." Use leading questions such as "Can a person fit inside? Does the engine work? Could you drive it to the fire?"
5. Based on students' answers, conclude, for example with the fire truck, "So, since it has wheels and the shape of the real thing, but is much smaller and doesn't actually work, it must be a model!"
6. Explain the rules of "I Spy." Demonstrate by looking around the room and by saying, "I spy a model of something that is.... [black and white and swims in cold water]!" Have the students find the stuffed penguin (or whatever you have described). Wonder out loud if there are any more models in the room. Have the students continue.

### TEACHING TIP

Let students find three-dimensional models but remind them if needed that models can also be flat (wall maps, photos, pictures, drawings) too. Cue them to look for models that are both bigger and smaller than real objects.



7. Play "I Spy" until everyone spies a model.

#### REFLECTION & DISCUSSION

1. A model is a powerful tool for exploring things in a classroom. There are many reasons why it may be better to use models than the real thing to study the world. Have students discuss these reasons, and create a list of their reasons.
2. Ask one of these suggested questions, or replace the main idea with something that interests your students: "If I wanted to see what an elephant's ears look like, what would I do?" "If I wanted to count the teeth in a shark's mouth, what would I do?" "If I wanted to see what's inside a fire engine, what would I do?"
3. Students may say they would go to a zoo, or pry open a shark's mouth at the aquarium, or visit a firehouse. But exploring photographs (good models) of those things, or physical (3-D) models would likely be easier (even less dangerous). So models are powerful tools of exploration.
4. Discuss the value of models. Ask why it is sometimes good to have models instead of the real thing. (It's too dangerous to have the real thing; it's too far away; it's too big to have in the classroom; it's too small to see with just our eyes; it's too hot; it's too cold.)

#### TRANSFER OF KNOWLEDGE

1. Have the students extend their thinking by explaining the value of a full-size model (e.g., a 'model home' in a new housing development or wax fruit), a tactile model, and the advantages of a color photograph rather than one that is black and white.
2. To address common misconceptions such as the Earth is flat, ask "What can we see on the globe?" (spherical shape, color representations of land and water). Point out that if we live on the ground in one part, then people must live on other parts, too, even on the "bottom" of the world, and they don't fall off. (Try and see if the students can answer why this is true.)

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#### CURRICULUM CONNECTIONS

*Art:* Discuss some of a model's basic characteristics (size, shape, texture, and temperature). Ask students to identify details that can be left out of a model, (i.e., a stick figure can represent a person, some wooden blocks may represent a house). On the other hand, sometimes it is the details that differentiate an object from something else. Discuss how a model-maker could add or remove details to improve a model.



### ASSESSMENT CRITERIA FOR ACTIVITY 1

During *Reflection & Discussion*, determine if students can recognize models, identify characteristics which differentiate them from the objects they represent, and explain their value. Determine if students could extend their thinking in the *Transfer of Knowledge* section.

K-2 students may be evaluated as follows. They need not demonstrate all the characteristics of a category to fall within it, though strong evidence of their classification by the teacher should be provided.

#### 4 Points

- Clearly and consistently demonstrates a sophisticated understanding of the concepts nearly 100% of the time by applying them accurately in activities, questions, comments, work, and projects both in the classroom and elsewhere.

#### 3 Points

- Shows a nearly complete grasp of the concepts by using them appropriately at least 75% of the time in class, asking pertinent questions, and by making viable attempts at applying the concepts to other aspects of learning.

#### 2 Points

- Responds correctly to direct questions regarding the meaning of the concepts, but cannot yet express them or demonstrate them consistently and accurately; still makes errors about 50% of the time.

#### 1 Point

- Indicates little more than random guessing at understanding the concepts; cannot focus on essential elements or regularly respond correctly to leading questions; less than 50% accurate.

#### 0 Points

- No work completed.

#### PLACING THE ACTIVITY WITHIN THE LESSON

Discuss with students how they might begin to plan to build a model of their own.

LESSON  
ADAPTATIONS

*Talented and Gifted*

- Place at least six models on a table and see if the students can match two or more of similar scales. Ask, for example, “Which doll could drive this truck? Could she see out the front window?” Where appropriate, conclude that these models must or must not be on about the same scale.
- Place three models of about the same scale (e.g., dollhouse, doll’s bed, and doll) on a table. Have the students put the models in order of their real object size. Discuss how they are all built to the same scale.
- Place three models of the same size but clearly different scales (e.g. a foot-long fire truck, a foot-long toothbrush, and a foot-long doll) on a table. Have the students put the models in order of their real object size. Discuss how they differ in scale.

*Special Education*

- Use a familiar object such as an automobile. Take a model car and the children to the school parking lot. Have them look for differences between the model and the real cars. Use a ruler or unconventional measure (length of a common toy) to compare size. Consider function as well when prompting, “Could a person be taken to school in the model?”

*English as a Second Language*

- Identify repetitive speech and dialogue patterns and common phrases, naturally used by the non-ESL children, such as “I spy a model of something that is...” For readers, write beginning phrases on a visible board so they can easily start sentences. Use comparative and superlative vocabulary words (such as bigger, smaller, biggest, and smallest) in conjunction with arm movements.

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## ACTIVITY 2: BUILD A MODEL



### STUDENT MATERIALS

- ▶ One 8.5" x 11" sheet of unlined paper per student
- ▶ Crayons, colored pencils or markers

### PREPARATION & PROCEDURES

1. Write the title, "My Home from the Front Door" at the top of the sheets of paper.
2. Ask students how they could create a model of their home. Remind them that models can be either two- or three-dimensional.
3. After students have suggested a drawing of their home, distribute one sheet of paper to each student.
4. Tell the students to imagine that they are standing in front of the front door of their house or building. Ask them what they see. Suggestions: windows, door, curtains, etc.
5. Tell the students to draw on their card what they see. Explain that they will now make a model ("picture") of their home (or school). It will be a flat model (like a map). It could also become part of a bigger model if they make pictures of what their house looks like from farther and farther away.
6. Circulate around the room to coach students; have them include colorful details which differentiate their home from others.

### TEACHING TIP

Tell students they can imagine that they have the power to see through the walls, as if the house had invisible walls, showing everything inside. Let them draw interiors as well as exteriors.

### REFLECTION & DISCUSSION

**Show & Tell:** Have students present their models to the class, describing what they have drawn, and how well their model represents the real house. Students conduct the discussion as much as possible, and may take questions from their peers.

TRANSFER OF KNOWLEDGE

1. Ask students, "Why would models of the Earth and other objects still be very useful, even if we can't show every detail and characteristic on them?" Review if necessary why a model of an object is sometimes better than the real thing, which may be too big to fit in the room, too small to see, too far away, too hot to touch, etc.
2. Have the students hypothesize as to why a model may not be as good as the real thing (it won't work; you can't ride in it; it doesn't make the same sounds, it can't really put out a fire).

CURRICULUM CONNECTIONS

*Mathematics:* Sorting. Sort objects which are models and which are not (e.g., this is a tree; it's not a model of a tree. This is a model of a rocket; it's not a real rocket.).

LESSON ADAPTATIONS

*Talented and Gifted:* Have the students make working models of an object (build a windmill with popsicle sticks, a glider airplane out of folded paper, etc.).

*Special Education:* Give a model to each child or have them work in pairs. Have the students turn the models around, examine all sides, feel the different textures, play with the models. Tell them to imagine what they could do with the models that they could not actually do with the real objects.  
Discuss.

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## ASSESSMENT CRITERIA FOR ACTIVITY 2

During *Reflection & Discussion*, student presenters should be able to tell the class what their model represents and why it's better than or not as good as having the real thing to explore. Determine if students could extend their thinking in the *Transfer of Knowledge* section.

K-2 students may be evaluated as follows. They need not demonstrate all the characteristics of a category to fall within it, though strong evidence of their classification by the teacher should be provided.

### 4 Points

- Clearly and consistently demonstrates a sophisticated understanding of the concepts nearly 100% of the time by applying them accurately in activities, questions, comments, work, and projects both in the classroom and elsewhere.

### 3 Points

- Shows a nearly complete grasp of the concepts by using them appropriately at least 75% of the time in class, asking pertinent questions, and by making viable attempts at applying the concepts to other aspects of learning.

### 2 Points

- Responds correctly to direct questions regarding the meaning of the concepts, but cannot yet express them or demonstrate them consistently and accurately; still makes errors about 50% of the time.

### 1 Point

- Indicates little more than random guessing at understanding the concepts; cannot focus on essential elements or regularly respond correctly to leading questions; less than 50% accurate.

### 0 Points

- No work completed.



**PLACING THE ACTIVITY WITHIN THE LESSON**

During Activity 2 and later in discussion time, reinforce the students' sense of personal achievement by having chosen things in and around their house to include in their model, and having described it to the class. Ask them to keep an eye out for models everywhere, now that they understand the value of models.

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## LESSON WRAP-UP

### TRANSFER OF KNOWLEDGE FOR THE LESSON

Students should be able to take the knowledge that they gained in the lesson and use it to create other two-dimensional models. For instance, tell them to create a two-dimensional model of their friend, and have them describe in which ways their model is representative of their friend. What features do their friend and the model of their friend share? How are they different?



### ASSESSMENT CRITERIA FOR THE LESSON

Based on *Transfer of Knowledge for the Lesson*, students should be able to create an entirely new two-dimensional model and describe what features it does and does not share with the real thing.

K-2 students may be evaluated as follows. They need not demonstrate all the characteristics of a category to fall within it, though strong evidence of their classification by the teacher should be provided.

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**LESSON CLOSURE**

Ask students to see if they can find any more models in the classroom, now that they have a better idea of what models are. If desired, have them write a list of models that can be seen throughout the school.

**EXTENSIONS FOR THE LESSON**

Assign the students to make flat models (drawings) of big things in their neighborhood. Use the Student Worksheet. (Possible ideas: playground, stores, basketball court, historic buildings, park, places of worship, etc.)

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## RESOURCES

### INTERNET RESOURCES & REFERENCES

#### *Student-Friendly Web Sites:*

Astronomy for Kids

<http://www.frontiernet.net/~kidpower/astronomy.html>

Kids Astronomy

[http://www.kidsastronomy.com/solar\\_system.htm](http://www.kidsastronomy.com/solar_system.htm)

NASA Kids

<http://kids.msfc.nasa.gov/SolarSystem/>

Space Kids

<http://www.spacekids.com/solarsystem/>

#### *Teacher-Oriented Web Sites:*

American Association for the Advancement of Science, Project 2061  
Benchmarks

<http://www.project2061.org/tools/benchol/bolintro.htm>

The Busy Teacher's Web Site

<http://www.ceismc.gatech.edu/busyt/astro.html>

NASA Quest

<http://quest.arc.nasa.gov/sso/teachers/>

National Science Education Standards

<http://www.nap.edu/html/nses/>

The Nine Planets

<http://www.nineplanets.org>

Voyage Online

<http://www.voyageonline.org>

### OTHER RESOURCES

Glaser, Linda. *Our Big Home: An Earth Poem*

Posner, Jackie, et al. *The Magic School Bus Out of This World*

Rabe, Tish. *There's No Place Like Space!* A Dr. Seuss book

Willis, Shirley. *Tell Me How Far It Is*

NOTES:

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# STUDENT WORKSHEET



NAME \_\_\_\_\_ DATE \_\_\_\_\_

## MODELS OF THINGS I SAW IN MY NEIGHBORHOOD:

This is a model of \_\_\_\_\_.

This is a model of \_\_\_\_\_.

This is a model of \_\_\_\_\_.

