Models and Manipulatives for Teaching Astronomy in the Elementary Classroom

An Honors Thesis (ID 499)

by

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Introduction

The purpose of this paper is to provide the elementary classroom teacher with lesson plans, activity sheets, and a large resource section for teaching the astronomy section of their science curriculum. The paper has been divided into two major sections. The first is the section with the plans and the second half is the resource section.

In the first section you will find lessons that are ready for you to use with your students. They have been written so that you, the teacher, has a basic plan form, but also so that they can be understood by the students. A very special thanks goes to Peter Hirt who did all of the wonderful illustrations in this part of the paper.

The resources make up the second half of the paper, and they, themselves, consist of three parts. The first part is a listing of all of the major planetariums, space museums, and observatories in the five state area of Illinois, Indiana, Kentucky, Michigan, and Ohio. The address and phone number for each in alphabetical order under the state heading. The second section contains 63 addresses of companies and organizations that provide information, models, material, or other visual aids for teaching astronomy in your classroom. Finally, the third section is a brief listing of some of the trade books that you might want to use with your students.
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Making a Sun Calendar

People have not always had a calendar to hang on the wall so that they would know the time of the year. Many years ago, people had to watch the sky to know what the seasons were. By placing markers in the ground they could watch the shadows that the sun cast and they could tell by the change in the shadows when the shorter days of winter were on their way, as well as, the arrival of the longer, warmer days of spring and summer. Because the earth is tilted on its axis, the position in which the sun rises and sets changes some throughout the year, hence the change in the position of the shadows cast by the sun.

Here is how you can make your own sun calendar.

1. You will need the following materials:
   - lump of clay
   - tape
   - white paper
   - a toothpick

2. In front of a window that receives direct sunlight, tape down the piece of white paper.

3. Roll the clay into a ball and press it down firmly onto the paper, close to the edge by the window.

4. Put the toothpick into the clay, making sure that it is standing up straight so you can get an accurate shadow.

5. Look to see where the shadow falls, and make a small mark on the paper where the shadow ends.

6. Repeat #5 everyday at the same time for at least 3 weeks. Do you see any type of a pattern forming?
Making a Shadow-Clock

Do you think you could tell what time it is without using a watch or a clock? Many years ago, before there were clocks and watches, people used the sun to determine the time of the day. Some people can tell what time it is by looking to see where the sun is in the sky. Another way, is to look at the shadows that are cast by the sunlight.

To make a shadow-clock you will need the following materials:

- a new, unsharpened pencil
- a piece of cardboard
- a marker

1. Take the unsharpened pencil and poke it into the cardboard close to one end. Be sure that the pencil is standing up straight. You may need to use some glue or tape to secure the pencil.

2. Now set the shadow-clock in front of a window where it will be in direct sunlight, and will not get bumped.

3. With your marker, draw a line on the cardboard where the shadow of the pencil falls. Be sure that your line stays exactly on the shadow, then label your line with the time.

4. Repeat #3 five other times during the course of the day. Do you see any type of a pattern that might be forming?

How do you think this relates to how people long ago told time? What might have been some problems with this method of telling time?
MAKING A SUNDIAL

A sundial is a fancier, more accurate version of the shadow-clock that we have already discussed.

To make your sundial you will need the following items:

- 2 pieces of cardboard
- glue
- a protractor
- a ruler
- a marker or a pen

1. On one of the pieces of cardboard you will need to make your time markings. Close to the bottom of this piece of cardboard you need to draw a base line. Then, from the center of this line you should draw another line that is perpendicular to the base and the same length as 1/2 of the base line.

2. After you have the base line and the center line drawn, you should label the center line "12 Noon", the left end of the base line "6 AM", and the right end of the base line "6 PM".

3. Now, using your ruler and protractor, divide the dial face into equal sections for the hours from 6 AM to 12 Noon and from 12 Noon to 6 PM. After you have made your marks, draw a line from the center of the base to each marking. Be sure that all of your lines are the same length. Then, label each line with its appropriate time.

4. Take your other piece of cardboard and cut it into the shape of a right triangle. One of the sides of the triangle should be slightly shorter than the length of the time lines, and the other side should only be about half this length. This triangular piece is called the "gnomon" of your sundial.

5. You are now ready to glue the gnomon to the dial face. The longest side of the gnomon should be down against the sundial and the shorter side should be toward the 12 of the dial with the slope ending on the center of the base line.

6. Take your sundial outside and place it in an area where it won't be in any shadows. The 12 Noon should be pointing to the north.
Check to see if the shadow of the gnomon is falling on the correct hour. If the shadows are falling beyond the point, you should trim some off of the top of the gnomon until it is correct.
Making a Model of Our Solar System

How did we get here? How did our planet get here? How were the planets made? These are all questions, that scientists ask themselves and others everyday. There are a lot of theories about how the things in our universe came about, and we are going to look at one of them in this activity.

Some people believe that at one time, a very long time ago, there was nothing but "chunks" floating in space. The "chunks" that were similar to one another began to be pulled together and the planets of our solar system were eventually created.

To see how something like this might have happened, we are going to use Play-doh, and recreate the possible events.

You will need the following:

- Several different colors of Play-doh
- A dozen toothpicks
- A ball that is about 33cm in diameter (a kickball)

This scale tell you the actual diameters of each planet and the actual distances from the Sun. The chart also gives you the distance that your planets should be from your ball-sun.

<table>
<thead>
<tr>
<th>Planets</th>
<th>Actual Diameter (km)</th>
<th>Actual Distance from Sun (km)</th>
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<tr>
<td>Mercury</td>
<td>4,800</td>
<td>57,900,000</td>
<td>14</td>
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<tr>
<td>Venus</td>
<td>12,200</td>
<td>108,630,000</td>
<td>26</td>
</tr>
<tr>
<td>Earth</td>
<td>12,700</td>
<td>149,600,000</td>
<td>36</td>
</tr>
<tr>
<td>Mars</td>
<td>6,700</td>
<td>228,500,000</td>
<td>55</td>
</tr>
<tr>
<td>Jupiter</td>
<td>139,700</td>
<td>778,900,000</td>
<td>188</td>
</tr>
<tr>
<td>Saturn</td>
<td>115,000</td>
<td>1,429,000,000</td>
<td>342</td>
</tr>
<tr>
<td>Uranus</td>
<td>47,300</td>
<td>2,880,000,000</td>
<td>690</td>
</tr>
<tr>
<td>Neptune</td>
<td>45,000</td>
<td>4,500,000,000</td>
<td>1,080</td>
</tr>
<tr>
<td>Pluto</td>
<td>5,800</td>
<td>5,950,000,000</td>
<td>1,430 (4)</td>
</tr>
</tbody>
</table>

* Use the planet pictures below as a size pattern for your scale size planets.
1. For whichever planet you are working on, get as much play-doh as is needed to make that planet according to the size scale.

2. After you have that amount, on the top of your desk, tear the play-doh up into as tiny of pieces as you can. These pieces represent the "chunks" in space.

3. Now, carefully so that you don't knock any on the floor, swirl your pieces around on your desk top and start having them collecting so that you eventually have a ball of play-doh that represents a planet.

4. After this has been done, and you have a scale model of each of the nine planets, place a toothpick carefully into the bottom of each planet.

5. Now, take your model planets outside either in the schoolyard or on a football field. Using the kickball as the Sun, place the appropriate planets in their places using the distances in the chart. Depending on how much space you have, you may not be able to actually place all of the planets in the right places. A good thing to do, though, is to figure out about where the other planets would go. (i.e., Neptune would be down the street somewhere around the drug store.) (5)
Drawing the Orbit of a Comet

Do you know what the orbit of a comet looks like? Do you think it will look any different than the orbit of a planet? In what way do you think it will be different? Let's draw a model and see whether or not the orbit of a comet is the same of different from that of a planet.

Before we start, you will need the following items:

- a piece of string (20 cm)
- a large piece of cardboard
- 2 brass fasteners
- a ruler
- 2 colored pencils

1. Take your piece of string and tie the ends together so that you have a big loop.

2. Put one of the brass fasteners through the middle of the cardboard.

3. Hook the loop of string underneath the fastener and put the point of one of the colored pencils in the other end of the loop.

4. Hold the pencil so that the string stays tight, but do not pull on it.

5. Now draw!

6. What does the orbit look like? Describe it.

7. Now, place the other brass fastener about 5 cm from the first one, and move the string so that it goes around both.

8. After you have hooked the string around both fasteners, put the other colored pencil in place, and you are ready to draw again.

9. How is this orbit different from the first one that you drew?

The second orbit you drew was one that would be the most like a comet's. It does not just go around the Sun in a circle, but swings out farther away in parts of its path.
Remaining in Your Orbit

Why does the moon continue to orbit around the earth? What keeps it from floating off into space? We can say that the reason the moon continues to orbit the earth is because the earth is pulling on the moon. What do you think would happen to the moon if the earth quit pulling on it? Would it remain in its orbit? Let's find out.

You will need:

- a paper plate
- 2 index cards
- a crayon
- scissors
- a pencil
- a book
- a ruler
- a marble
- tape
- pencil

1. Take your crayon and draw a circle on the paper plate where the edges begin to bend up.

2. Take your scissors and cut a wedge out of the plate.

3. With your pencil and ruler, draw a line lengthwise through the middle of one of the index cards. Then line up the line on the card with the line on the plate on one side where you cut out the wedge.

4. Fold the other index card in half lengthwise, line it up with the crayon line on the other edge of the cut out wedge, and tape the card in place.

5. Now, place the book underneath the end of the folded index card to make a ramp.

6. Put the marble at the top of the ramp, and let it go. Watch to see if it follows the orbit path of the plate or if its path changes when it leaves the plate.

7. Repeat #6 several times to make sure your conclusions are accurate. (7)

[Diagram of a ramp with a book and a marble at the top]
Edible Constellation Models

Do you like to look at the stars to see if you can find a pattern or picture in them? Many people do this and have done this for many years.
A long time ago, some of those people, like you, who were looking at the stars did find some pictures that have become well known today. We call these pictures in the stars constellations.

To make your own constellation models you will need the following:

- box of toothpicks
- bag of jellybeans
- string

1. Using the pictures of the constellations that are given, make a model of one using the jellybeans to represent the stars and the toothpicks will hold them together, as well as, show the connecting lines of the picture.

2. You may want to carefully break some of the toothpicks into different sizes to show the different distances between the stars.

3. After you have finished your constellation(s), you may either tie a piece of string to it and display it for others to look at, or you may share your constellation(s) and then eat them if your teacher allows. (8)
Making a Constellation Box

To make your own constellation box, you will need a shoebox, a flashlight, black construction paper, a paper clip, and the given pages of constellations.

1. **The teacher may need to do this part.** Very carefully, cut out a window in the end of the shoebox that is at least 4"x3".

2. Cut the black construction paper into pieces that are slightly larger than the window in the shoebox.

3. Use the given constellation pictures as patterns, and draw them onto the piece of construction paper.

4. Carefully, use the point of your pencil and poke a small hole in the construction paper where each star should be.

5. Now you are ready to show your constellations. Paper clip one of your constellations to the inside of the shoebox in front of the window.

6. Turn off the lights in the room, turn on the flashlight, place it in the box shining at the constellation, and put the lid on the box.

7. Your constellations should now be able to be seen on a nearby wall or chalkboard. (9)
BIG DIPPER

LITTLE DIPPER

ORION

AQUARIUS
Making an Astrolabe

An astrolabe is an instrument that you can make to observe the movement of the stars and planets. You can watch a planet or star over a course of several days and see how its position changes, or you can also just watch it path during one evening if you prefer.

To make your astrolabe, you will need the following:

- a brass fastener
- tape
- a meter stick
- a ruler
- a protractor
- a 20 cm round piece of cardboard (a heavy paper plate or the supporter from a pizza box may work)

1. With your protractor, mark the degrees from 0 to 180 on the outside edge of the cardboard.

2. Using the brass fastener, you are now going to put everything together. Put the fastener through the center of the ruler, the center of the circle, and through the hole in the end of the meter stick. For additional support, you may want to use a couple of pieces of tape to hold the circle in place.
3. Now take your astrolabe outside and you are ready to begin.

4. Sit the bottom of the meter stick on the ground, but be sure it is straight and not leaning one way or the other. Find the star or planet you want to measure. Turn your astrolabe in that direction. Line up the planet or star with the ruler by looking the length of the ruler, and then read your angle. (10)
Making a Balloon Rocket

We are going to see how the engine of a rocket works. You know that in a real rocket, fuel and oxygen mix together and burn. This burning process gives off a gas that is pushed out the back of the engine and pushes the rocket forward.

What we are going to need today for our model is:

2 balloons  a clothespin
string      a straw
tape        2 chairs

1. Take one of the balloons and blow it up. What is inside of the balloon? ______________. Is air a gas? ______________. What do you think will happen if you let go of the balloon? __________________________. What is going to happen to the gas (air) that is inside the balloon? ___________? __________________________. What is going to happen to the balloon? __________________________.

When you let go of the balloon, the gas came out of the back of the balloon and pushed the balloon forward just like in a rocket engine.

If you were an astronaut, would you want to be in a rocket that flew like the balloon flew? A real rocket has instruments and equipment that help the astronaut steer and control the rocket. Let's add some of this type of equipment to our rocket.

2. Take your two chairs and place them about 10 to 12 feet apart with their backs toward each other.

3. Now tie the string to the back of one of the chairs.

4. Blow up the other balloon and use the clothespin to seal the end so that the air does not leak out.

5. Carefully, tape the straw to the side of the balloon very securely. Then, take the loose end of the string and slide it through the straw, and then tie it to the back of the other chair. Make sure that the string is tight, but not stretched.

6. How do you think this balloon rocket will fly differently from the first one? ______________. Take off the clothespin and see. (11)
How Does a Rocket Engine Work?

Do you know how the engine of a jet of a rocket works? This experiment is going to give you an idea of what goes on inside a carbon dioxide engine. For a rocket of jet engine to work, you have to have oxygen and fuel that when mixed together burn. The burning process gives off a gas that is pushed out the back of the engine and moves the rocket or jet in the opposite direction.

To make this model, we will need the following items:

- small, clean milk carton
- measuring cup
- measuring spoons
- thread (50 cm)
- needle
- water
- baking soda
- vinegar
- a cup
- a paper clip

1. Unfold part of the paper clip. Using that end, poke a little hole in one side of the top of the carton, and make another hole in the opposite side.

2. Fasten one end of the thread to the paper clip and put the other end through the needle. *(Depending on the situation, the teacher may find it necessary to do the parts using a needle.)*

3. With the top of the milk carton open, put the needle and thread through the top hole from the inside. Pull the thread through until the paper clip rests against the inside of the milk carton. It would be best if you put a drop of glue or a piece of tape over this hole to seal it.

4. Now, fold down the top of the carton into a square so that the side with the thread coming out of it is on top.

5. Mix together 30 ml of water and 30 ml of vinegar in a cup, and set it aside for a few minutes.

6. Put 1 teaspoon of baking soda in the milk carton. Quickly pour the water and vinegar mixture into the carton and reclose it so the top is once again flat.
7. Now hold the carton by the string that is coming out of the top, and watch to see what happens. Describe what you saw and what you think caused that to happen.
Planetariums and Museums

In this section is a listing of the major planetariums and museums in the states of Illinois, Indiana, Kentucky, Michigan, and Ohio. They are listed in alphabetical order by the city in which they are located under the heading of their state.

ILLINOIS:

The Adler Planetarium
1300 S. Lake Shore Drive
Chicago, IL. 60605
(312) 322-0304

Joilet Junior College Planetarium
1216 Houbolt Ave.
Joilet, IL. 60436
(815) 729-9020

Stickler Planetarium
Olivet Nazarene University
P. O. Box 592
Kankakee, IL. 60901
(815) 939-5267

Physics Department Planetarium
Illinois State University
Normal, IL. 61761
(309) 438-8758

Lakeview Museum of Arts and Sciences
1125 W. Lake Ave.
Peoria, IL. 61614
(309) 686-7000

Cernan Earth and Space Center
Triton College
2000 5th Ave.
River Grove, IL. 60171
(312) 456-0300

Discovery Center Museum
401 S. Main St.
Rockford, IL. 61101
(815) 963-6769

John Deere Planetarium
Augustana College
Rock Island, IL. 61201
(309) 794-7327
INDIANA:

Indiana University Planetarium
Astronomy Department, Swain Hall West 319
Bloomington, In. 47405

Evansville Museum of Arts and Sciences
411 SE Riverside Drive
Evansville, In. 47713
(812) 425-2406

E. C. Schouweiler Planetarium
Saint Francis College
2701 Sprint St.
Fort Wayne, In. 46808
(219) 432-3551

Ball State University Planetarium
Ball State Univ., Dept. of Physics and Astronomy
Muncie, In. 47306
(317) 285-8871

KENTUCKY:

Hardin Planetarium
Western Kentucky University
Bowling Green, Ky. 42101
(502) 745-4044

Georgetown College Planetarium
Georgetown College
Georgetown, Ky. 40324
(502) 863-8094

Museum of History and Science
727 W. Main St.
Louisville, Ky. 40202
(502) 589-4584

Rauch Memorial Planetarium
University of Louisville
Louisville, Ky. 40292
(502) 588-6665

Arnim H. Hummel Planetarium
Eastern Kentucky University
Richmond, Ky. 40475
(606) 622-1547
MICHIGAN:

Jesse Besser Museum and Sky Theatre
491 Johnson St.
Alpena, MI 49707
(517) 356-2202

University of Michigan Exhibit Museum
Ann Arbor, MI 48109
(313) 764-0478

Kingman Museum of Natural History
W. Michigan Ave., at 20th St.
Battle Creek, MI 49008
(616) 965-5117

McMath Planetarium
Cranorook Institute of Science
500 Lone Pine Rd.
Bloomfield Hills, MI 48013
(313) 645-3235

Detroit Science Center
5020 John Rd.
Detroit, MI 48202
(313) 577-8400

Abrams Planetarium
Michigan State University
East Lansing, MI 48824
(517) 355-4676

Robert T. Longway Planetarium
1310 E. Kearsley St.
Flint, MI 48503
(313) 762-1182

Grand Rapids Public Museum
233 Washington SE
Grand Rapids, MI 49503
(616) 456-3985

Kalamazoo Public Museum
315 S. Rose St.
Kalamazoo, MI 49007
(616) 345-7092

Impression 5 Science Museum
200 Museum Drive
Lansing, MI 48933
(517) 485-8116
Lansing Community College Planetarium  
P. O. Box 40010  
Lansing, MI  48910  
(517) 483-1092

OHIO:

Bowling Green State University Planetarium  
Department of Physics and Astronomy  
Bowling Green, OH  43403  
(419) 372-8666

McKinley Museum of History, Science, & Industry  
P. O. Box 483  
800 McKinley Monument Drive  
Canton, OH  44701  
(216) 455-7043

Cincinnati Museum of Natural History  
1720 Gilbert Ave.  
Cincinnati, OH  45202  
(513) 621-3889

Cleveland Museum of Natural History  
Wade Oval, University Circle  
Cleveland, OH  44106  
(216) 231-4600

Lewis Research Center  
Visitor Information Center  
21000 Brookpark Rd.  
Cleveland, OH  44135  
(216) 267-2001

Center of Science and Industry  
280 E. Broad St.  
Columbus, OH  44135  
(614) 228-5619

Dayton Museum of Natural History  
2629 Ridge Ave.  
Dayton, OH  45414  
(513) 275-7431

Copernicus Planetarium  
Lourdes College  
6832 Convent Blvd.  
Sylvania, OH  43560  
(419) 885-3211
Observatories

ILLINOIS:

Illinois Wesleyan University Obs.
Bloomington, IL 61701
(309) 556-3060

Dearborn Obs.
2131 Sheridan
Northwestern University
Evanston, IL 60201
(312) 491-5633

INDIANA:

Goethe Link Obs.
Indiana University Astronomy Dept.
Swain Hall West 319
Bloomington, IN 47405
(812) 335-6915

Holcomb Obs.
4600 Sunset
Butler University
Indianapolis, IN 46208
(317) 283-9440

Indiana State University Obs.
Terre Haute, IN 47809
(812) 237-3294

OHIO:

S. B. P. Obs.
Box 601
Cedarville College
Cedarville, OH 45314
(513) 766-2211
Cincinnati Obs.
3489 Observatory Place
Cincinnati, OH 45208
(513) 321-5186

Warner & Swasey Obs.
Department of Astronomy
Case Western Reserve University
Cleveland, OH 44106
(216) 368-3729

Perkins Obs.
Box 449
Delaware, OH 43015
(614) 292-7876
RESOURCES

In this section you will find the names and addresses of many different organizations and companies. These groups have been included because they should be able to provide you with information on all types of materials that you can obtain to help in teaching the astronomy section of your science curriculum.

1. ABC Science Company
   3907 Belle Rive Terrace
   P.O. Box 15273
   Alexandria, VA 22309
   (703) 780-3842

2. Addison-Wesley Publishing Co.
   2757 Sand Hill Rd.
   Menlo Park, CA 94025
   (415) 854-0300

   1515 Wilson Blvd.
   Arlington, VA 22209
   (703) 841-8676

4. Ampersand Press
   691 26th St.
   Oakland, CA 94612
   (415) 832-6669

5. Apple Computer, Inc.
   20525 Mariani Ave.
   Cupertino, CA 95014
   (408) 996-1010

6. AstroMedia Corp.
   625 E. St. Paul Ave.
   P.O. Box 92788
   (414) 276-2689

7. Astronomical Society of the Pacific
   1290 24th Ave.
   San Francisco, CA 94122
   (415) 661-8660

8. Carolina Biological Supply Co.
   2700 York Rd.
   Burlington, NC 27215
   (919) 584-0381
9. Celestial Products, Inc.
P. O. Box 801
10 W. Washington St.
Middleburg, VA 22117
(703) 687-6881

10. Central Scientific Co. (CENCO)
11222 Melrose Ave.
Franklin Park, IL 60131
(312) 451-0150

11. Chem Scientific, Inc.
67 Chapel St.
Newton, MA 02158
(617) 527-6626

12. CIBA-GEIGY Corp.
444 Saw Mill River Rd.
Ardsley, NY 10502
(914) 478-3131

13. College Biological Supply Co.
8857 Mount Isreal Rd.
Escondido, CA 92025
(619) 745-1445

82 Valley Rd.
Southampton, MA 01073
(413) 527-4030 or (800) 628-7748

15. Creative Dimensions
P. O. Box 1393
Bellingham, WA 98227
(206) 733-5024

16. Crystal Productions
Box 12317
Aspen, CO 81612
(303) 925-8160

17. Damon/Instructional System
80 Wilson Way
Westwood, MA 02090
(617) 449-0800, ext. 654

18. Delta Education, Inc.
P. O. Box M
Nashua, NH 03061-6012
(800) 258-1302
136 Fairbanks
Oak Ridge, TN 37830
(615) 483-4915

20. Educational Dimensions Group
P. O. Box 126
Stamford, CT 06904
(203) 327-4612

P. O. Box 17
Pelham, NJ 10803
(914) 576-1121

22. Encyclopedia Britannica Educational Corp.
425 N. Michigan Ave.
Chicago, IL 60611
(312) 321-6800

23. Estes Industries
Dept. 27N
Penrose, CO 81240

4901 W. LeMoyne St.
Chicago, IL 60651
(312) 378-7770 or (800) 621-4769

25. Forestry Suppliers, Inc.
205 West Rankin St.
P. O. Box 8397
Jackson, MS 39204
(601) 354-3565

905 Hickory Lane
Mansfield, OH 44905
(419) 589-9905 or (800) 225-3739

27. General Supply Corp.
P. O. Box 9347
Jackson, MS 39206
(800) 647-6450

28. Hansen Planetarium Publications
15 S. State St.
Salt Lake City, UT 84111
(801) 533-7317
29. Harcourt Brace Jovanovich
   757 Third Ave.
   New York, NY 10017
   (212) 888-4444

   125 Spring St.
   Lexington, MA 02173
   (617) 862-6650

31. Hubbard Scientific
   P. O. Box 104
   1946 Raymond Dr.
   Northbrook, IL 60062
   (312) 272-7810 or (800) 323-8368

32. Ideal School Supply Co.
   11000 S. Lavergne Ave.
   Oak Lawn, IL 60453
   (312) 425-0800

33. International Film Bureau, Inc.
   332 S. Michigan Ave.
   Chicago, IL 60604
   (312) 427-4545

   5615 Raytown Rd.
   Raytown, MO 64133
   (816) 353-4787

35. Lab-Aids, Inc.
   130 Wilbur Place
   P. O. Box 158
   Bohemia, NY 11716
   (516) 567-6120

36. Lawrence Hall of Science
    Discovery Corner
    University of California
    Berkeley, CA 94720
    (415) 642-1016

37. MMI Space Science Corp.
    2303 N. Charles St.
    Dept. SC-83, P. O. Box 19907
    Baltimore, MD 21211
    (301) 366-1222

38. McGraw-Hill Webster Division
    1221 Avenue of the Americas
    New York, NY 10020
    (212) 997-4978
435 Main St.
Johnson City, NY 13790
(607) 729-6511

40. Milliken Publishing Co.
1100 Research Blvd.
St. Louis, MO 63132
(314) 991-4220

41. Moody Institute of Science
12000 E. Washington Blvd.
Whittier, CA 90606
(213) 857-7377

42. NASCO
901 Janeville Ave.
Fort Atkinson, WI 53538
(414) 563-2446

43. NASCO West, Inc.
P. O. Box 3837
Modesto, CA 95352
(209) 529-6957

44. National Geographic Society
17th & M. Sts. NW
Washington, DC 20007
(202) 857-7377

45. National Science Programs, Inc.
P. O. Box 41
Batavia, IL 60510
(312) 879-6901

46. National Teaching Aids, Inc.
120 Fulton Ave.
Garden City Park, NY 11040
(516) 248-5590

47. NICEM
University of S. California Films
3716 S. Hope St.
Los Angeles, CA 90007
(213) 743-5408

48. Phoenix/BFA Films & Video, Inc.
468 Park Ave. S.
New York, NY 10016
(212) 684-5910 or (800) 221-1274
49. Radio Shack/Tandy Corp.
   1400 One Tandy Center
   Fort Worth, TX 76102
   (817) 390-3382

50. Sargent-Welch Scientific Co.
    7300 N. Linder
    Skokie, IL 60077
    (312) 677-0600

51. Schoolmasters
    745 State Circle
    P. O. Box 1941
    Ann Arbor, MI 48106
    (313) 761-5072

52. Science and Mankind, Inc.
    Communication Park
    Box 2000
    Mount Kisco, NY 10549
    (914) 666-4100

53. Science Kit and Boreal Labs
    777 E. Park Dr.
    Tonawanda, NY 14150
    (716) 874-6020 or (800) 828-7777

    11899 W. Rio Mill
    W. Los Angeles, CA 90064
    (800) 421-6636

55. Scott, Foresman, and Co.
    1900 E. Lake Ave.
    Glenview, IL 60025
    (312) 729-3000

56. Scott Resources/ESNR Division
    1300 Blue Spruce Dr., Suite B
    P. O. Box 2121
    Fort Collins, CO 80522
    (303) 484-7445

57. Silver Burdett Co.
    250 James St.
    Morristown, NJ 07960
    (201) 285-7740

58. Sky Publications Co.
    49 Bay State Rd.
    P. O. Box 9102
    Cambridge, MA 02238-9102
1345 Diversey Parkway
Chicago, IL 60614
(312) 525-1500

60. Sunstone Publications
P. O. Box 788
Copperstown, NY 13326
(607) 547-8207

61. Trippensee Planetarium Co.
301 Class St.
Saginaw, MI 48602
(517) 799-8102

62. Unitron Instruments, Inc.
175 Express St.
Plainview, NY 11803
(516) 822-4601

63. Ward’s Natural Science Establishment, Inc.
5100 West Henrietta Rd.
P. O. Box 92912
Rochester, NY 14692
(716) 359-2502
Trade Books

The following is a partial listing of some of the trade books that can be used with your students if they are available to you. Of course, there are many other good books out there that can be used.

The ABC's of Astronomy
by Roy A. Gallant

Experiments in Sky Watching
by Franklyn M. Branley
Thomas Y. Crowell Co., New York, 1959

The First Book of Astronomy
by Vivian Grey
Franklin Watts, Inc., New York, 1959

Junior Science Book of Stars
by Phoebe Crosby
The Garrard Press, Champaign, 1960

The New Astronomy: Probing the Secrets of Space
by Fred D'Ignazio
Franklin Watts, New York, 1982

Origins of the Universe
by Albert Hinkelbein
Franklin Watts, London, 1972

The Prentice-Hall Concise Book of Astronomy
by Jacqueline and Simon Mitton

by R. Newton Mayall, Margaret Mayall, and Jerome Wyckoff
Golden Press, New York, 1965

Space Scientist: Galaxies and Quasars
by Heather Couper and Nigel Henbest
Franklin Watts, London, 1986

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Stars and Planets
by Robin Kerrod

Stars and the Universe
by David Dietz
Random House, New York, 1968

The Universe
by Robin Kerrod
Warwick Press, Great Britian, 1975

The Universe
by Herbert S. Zim
William Morrow and Co., New York, 1973

Windows in Space
by Ann Elwood and Linda C. Wood
Walker and Co., New York, 1982
Works Cited


3. Ibid., pp. 70 & 71.


7. Ibid., p. 106.


10. Ibid., p. 122.


Bibliography


