Building a Lunar Settlement

Here is a chance for you to use up some of those interesting scraps and snips of things that most people throw away, but could make perfect components for a model lunar settlement. In this activity, students first think of everything they would need to survive for years on a lunar settlement, and then design and build a model of such a settlement.

Objectives

This activity can take on different meanings to different age students. For older students (grades 4-8), the question of what is necessary to survive in space can have special significance, since they soon may be candidates for space missions themselves. For younger students (grades 1-3), this activity is more of an open-ended creative process of building a home on the moon.

In this activity students will be able to:

1. Recognize (brainstorm) needs for human survival in space.
2. Design and build a model lunar settlement.
3. Communicate their design concepts and ideas with other students.

Teacher leaders build a moon settlement in a summer institute of Participatory Oriented Planetariums for Schools (POPS) by Lawrence Hall of Science.

Materials

For the class

- 1 or 2 boxes of raw material or "doo-dads" for settlement building. "Doo-dad" suggestions include: plastic or paper cups, small containers (such as empty yogurt or orange juice containers), packaging material (such as plastic casings on small items, clear "bubble-wrap" and Styrofoam "peanuts" and other packing materials), egg cartons, Styrofoam meat trays, cardboard tubes, corks, straws, film canisters, scrap wood, colored paper or poster board, assorted stickers—YOU NAME IT!

  Note: To reduce clean-up time, limit the amount of Styrofoam peanuts to about four cups.
- 1 or 2 skeins of color yarn or string
- 1 or 2 rolls of foil
- 1 roll of plastic wrap
- 1 box of toothpicks
- 1 box of straws
- 1 package of blank stick-on labels (masking tape can also be used)
- chalk and chalkboard, or overhead projector, unused transparency, and pens

  Optional: tools for use by teacher or under direct supervision, such as pliers for bending wire, utility knife for cutting tubes or Styrofoam, hand saws, hammers, paper clamps, etc.

For each group of 4-5 students:

- 1 poster board, about 30 cm x 60 cm (about 1 ft. x 2 ft.) These serve as the base for each team's settlement (size can be adjusted to your preference)
- 1 or 2 glue bottles or glue sticks
- 1 or 2 scissors
- assorted color marking pens
- 1 roll of masking or cellophane tape

Before Class

1. Gather a few examples of the "doo-dads" listed above. Before the day of the activity, give the students a list of "doo-dads" so that they can start collecting for their projects. To give them an idea of what may be useful, show them the materials you have collected. Encourage the students to save any small objects that might turn into "space material" with a little imagination. Have them bring in their supplies from home.
2. Cut the poster board into approximately 30 x 60 cm (1 x 2 feet) rectangles to serve as bases for each team's settlement.

On the Day of the Class

1. For quick distribution, assemble each group's supplies (glue, scissors, pens, and tape) on a tray or in a container.
2. Place the building materials in an accessible location. Students need to be able to retrieve material easily. Keep the tools such as pliers in a place that you can monitor. You could also wear a "tool belt" or carry a toolbox so you can go from group to group with all the special tools needed to assist students.
3. Arrange desks or tables and chairs so groups of 4-5 students can work together building a settlement for one of Jupiter's moons.

In Class

Part 1: Planning a Moon Settlement

Imagine that you are to be among the first people to create a community on the Moon or on a moon of Jupiter or Saturn. It would take a spacecraft about two or three YEARS to transport people to or from the Jupiter system. You would need to establish settlements on the moons so you could live there for long periods of time. You will be working in teams to design and build a model of a settlement on a moon somewhere in our solar system.

In preparation for this mission, you first need to think about what conditions you will face. Imagine being on one of Jupiter's moons.

How would things be different there?

Take several answers and encourage the students to keep in mind such things as:

- Low gravity (1/3rd to 1/6th the gravity of Earth)
- Bitter cold temperatures: –100°C to –200°C (–148 F to –328 F) except on parts of Io
- Exposure to cosmic rays and radiation. (There is intense radiation on Io, Europa, and Ganymede, because of the interactions of Jupiter's gargantuan magnetic field with the solar wind. Only Callisto lies outside Jupiter's "magnetosphere" and so has less radiation.)
- No liquid water (except maybe on Europa)
- No air
- Little sunlight (1/25th as much as on Earth).

Think of essential items you would need to have with you on a moon settlement. Remember, you must be able to live for a few years there without returning to Earth.

Have the class brainstorm and list their ideas on the chalkboard or use an overhead projector. Among items that have been considered essential in actual planning of similar projects are such things as: living quarters, a greenhouse, solar panels/generators, storage facilities, a launch and landing pad, etc.

Divide the class into teams of 4–5 students who work well together. Arrange seating so they can share materials and work together on the model.

Part 2: Building the Settlement

Here are your raw materials.

Show the class a sample posterboard section and explain that they will be building their model, using a board like this as a base. Show the various raw materials they can use. If certain items are in short supply, you may want to set limits. (e.g. "Only one plastic tube per group, please!") Suggest ways for teams to be reasonable and cooperative in gathering and sharing materials.

After you have been working for a while, you will be given labels and asked to identify and label all the parts and structures you've developed. Your settlement should have all the essential requirements that we listed on the chalkboard.

Distribute group supplies and give a posterboard to each group. Let the teams get the "raw materials," and begin planning and building. Circulate and help as needed. Ask questions and encourage the students to use their imaginations.

When the settlements are well underway, bring around blank labels and have the students label each part of their settlement (launch pad, greenhouse, and so on).
Leave enough time at the end of class for clean up. If the students have not completed their models and you are planning more class time for them to work, encourage them to collect additional materials at home. Have them bring in these materials to incorporate into their settlements.

Part 3: Discussing Lunar Settlements

Now it's time to give the class a "tour" of your facility. Imagine that you are conducting tours for visiting dignitaries! I know you have put a lot of creative energy into your model settlements, and look forward to displaying and explaining your inventions and ingenuity.

Plan sufficient time for them to do this. They could present a "tour of the facilities." The presentations could all be made during one class period, or spread out over two or three days. Allow a few minutes for the other students to ask questions of each team. You may want to help guide and focus some discussion, with questions, such as:

How does your settlement take into account the items on the requirement list?

What do you think it would it be like to live in this settlement?

What would you do for fun in your settlement?

What do you think the food would be like?

Would you really want to go on a mission like this?

Going Further

1. Have the students write a story about daily life in their settlement. They may want to write a special report on an exploration to some of the unusual features of their world, or describe some of their experiments. Or, they may want to write a "letter home," describing, for example, what it is like to look up in the sky and see Jupiter instead of Earth's Moon.
2. An option is to have each student build their own moon settlement. For this, you can supply each student with a baseboard of posterboard, or simply have them do it completely from scratch on their own as an extended home project. A variation on this idea is for the students to build free-floating space communities designed not for a moon's surface but to travel through space or orbit a planet on its own. In such communities, there is a technical challenge of dealing with a weightless environment. Most designs have the whole structure spinning to create artificial gravity in a direction outwards from the center.
3. Ask students to respond to the concern, raised by some people, that perhaps people should not establish settlements on other worlds. Some might say, for example, that these worlds should be left alone, so as not to be polluted or changed by human exploitation of natural resources, or by competition by governments and businesses to control specific areas or establish settlements. Do your students agree or disagree? How would they feel if missions were limited to exploration? How about setting up mines and factories on other worlds?

4. Several videos about the Voyager missions are available from NASA. Videos can be ordered from your nearest local NASA Teacher Resource Center. The Jet Propulsion Laboratory Teacher Resource Center specializes in inquiries related to space and planetary exploration, and other JPL activities. That address is listed below.

Jet Propulsion Laboratory
Teacher Resource Center
JPL Educational Outreach
Mail Stop CS-530
Pasadena, CA 91109

Phone: 818-354-6916

5. There are many great stories related to space settlement. Here are some:

2010: Odyssey Two
by Arthur C. Clarke, Ballantine Books, New York. 1982. Grades: 10–Adult

This complex, mysterious, and thought-provoking sequel to Clarke's 2001: A Space Odyssey had the benefit of being written subsequent to the Voyager mission. Chapter 13 specifically, "The Worlds of Galileo," focuses on the four main moons of Jupiter, although there are fascinating observations, accurate scientific information, and lots of interesting speculation about Jupiter and its moons throughout the book.

Against Infinity
by Gregory Benford, Simon and Schuster, New York. 1983. Grades 10–Adult.

This science fiction novel is an account of human settlement on Jupiter's largest moon, Ganymede. The story takes place several hundred years into the colonization process, and begins from the perspective of a 13-year-old boy whose father is one of the leaders of the settlement. Advanced students may want to read this novel to gather ideas about constructing biospheres, melting ice, obtaining minerals, and other ways humans might possibly survive on the moons of Jupiter.

Jupiter Project
by Gregory Benford, Bantam Books, New York. 1990. Grades 7–10.

A teenager lives with his family as part of a large scientific laboratory that orbits Jupiter, but he is ordered to return home. He has one chance to stay; if he can make an important discovery. There is a nice mix of physics and astronomy with teenage rebellion and growing maturity, some love interest, and an exciting plot. The descriptions in Chapters 6, 7, and 8, which are part of an account of an expedition to Ganymede, could be compared by students to the information they observe and learn about this mammoth moon.

The Planets
edited by Byron Preiss, Bantam Books, New York. 1985. Grades: 8–Adult.

This extremely rich, high-quality anthology pairs a nonfiction essay with a fictional work about the earth, moon, each of the planets, and asteroids and comets. Introductory essays are by Isaac Asimov, Arthur C. Clarke and others. The material is dazzlingly illustrated with color photographs from the archives of NASA and the Jet Propulsion Laboratory, and paintings by astronomical artists such as the movie production designers of 2001 and Star Wars. "The Future of the Jovian System" by Gregory Benford (about colonization and development of Jupiter's moon Ganymede) is a perfect match to the moon settlement activity. However, since the vocabulary is sophisticated it may be more suitable for high-level readers.