CubeSat Model Building

Level	
Middle School	

Time Required	Lesson Summary
3- 50 minute lessons (150 min.)	This lesson will help students visualize the size and scope of cube satellites (CubeSat). First, students will use a printable template to build cardstock CubeSat models to get an idea of the size and scale of these satellites. Then, they will research what a satellite of this size can do.

Standards

NGSS

MS-ESS1-3. Analyze and interpret data to determine scale properties of objects in the solar system.

MS-PS4-3. Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

See Option 3 on Day 1 to incorporate MS-ETS1-1 *Engineering Design.*

Vocabulary	Objectives
CubeSat	• Students will create a full-size CubeSat satellite and will be able to describe its size in comparison to other satellites. • Students will be able to describe how satellites of this size are used for communication

Materials

- Cardstock
- Scissors
- Box cutter
- Tape
- Glue sticks
- Student computers

Pre-Requisites
Students should have a basic introduction to satellites

Safety Considerations
Carefully monitor students' use of scissors or box cutters.

Pacing Notes
Day 1: Build a model satellite Days 2 and 3: Introduction to CubeSats and their uses around the world using hyperdoc

Before the Lesson
Before the lesson, decide on the group size for model building. Then print and copy enough of the templates on cardstock (preferred over plain paper, but not required) for each group. If students do not have a device they can use for research, you will need to print and copy the activities and embedded links.

Assessments	**Classroom Instructions**
Pre-Activity Assessments	**Introduction**
K-W-L chart on CubeSats	First, ask students to complete the K (What they know) and possibly W (What they want to know) of a K-W-L chart on CubeSats. Students can either draw this into their notebooks, or the teacher can download a readily available template such as this one: https://www.papertraildesign.com/free-kwl-chart-printable-graphic-organizer/. After asking what students already know about CubeSats, watch this introductory video: https://youtu.be/HZMiJ_Q47qk. This should give students some ideas for the W (Want to know) column for their chart. For example, maybe they'd want to know how to get a CubeSat aboard a space shuttle. Discuss students' charts so far.
Activity Embedded Assessments	**Activities**
All students are working walk around and ask some of the	**Day 1** 1. In partners or small groups, have students build their cardstock model. a. Option 1: Using predesigned printables from ArduSat Space

following questions. What are you doing right now? Why did you make that choice? Can you explain that to me? If you were to do this again what would you do differently?	Program found at https://tinyurl.com/papersat (print and fold) b. Option 2: Using the dimensions found at NASA's 3D resources (https://nasa3d.arc.nasa.gov/detail/cubesat) to measure them and draw by hand c. Option3: Engineering design challenges found in Lesson 4 here Boeing/Teaching Channel Science and Innovation CubeSat Handbook. d. Note that Options 2 and 3 will extend the lesson time to at least two periods for models. This option adds in Standard MS-ETS1-1 Engineering Design. 2. Conclusions a. After putting models together, ask students to predict what a satellite of this size is capable of, either in their notebook or on the back of the K-W-L chart. **Day 2** 1. While you are taking attendance have students research the size of other types of satellites. Ask them to estimate the fraction of a whole satellite represented by a CubeSat (i.e. a CubeSat is ¼ the size of …) 2. After you are finished with the administrative duties hold a brief discussion about the first activity. Allow students to share what they found but also allow them to challenge other students' estimates. A student must have evidence to support their challenge. For example, if a student found a volume for a type of satellite that contradicts another student's claim then they could challenge it using that as evidence. 3. Now that students have their CubeSat models to inspire them, it's time for them to research what CubeSats can do, using the CubeSat Hyper doc. All the web pages in the document were last accessed on 9/18/23. a. Either give students access to the document on your LMS (suggested) or print out the documents and hand them out. b. Go over the directions including how you want students to complete the assignment: alone, in pairs, or with a small group. 4. Day 2 Conclusions a. At the end of the class period have students pull out that KWL chart and add to it.
While students are working walk around and ask some of the following questions. What are you working on? What did you just learn? What are you doing next? What questions do you have? What is most interesting so far?	

	Day 3 1. As you are working on attendance have students pull out the sheets from the day before and start working.
Post Activity Assessments	**Closure**
The last section of the hyperdoc asks students to plan their own CubeSat mission including use and cost. Students can also return to complete the L (what I learned) section of the K-W-L.	Discuss what students learned and what they would do with their own CubeSat to close lesson, comparing these ideas to their original predictions for what CubeSats can do. You may wish to formally break the hyperdoc into two days by discussing sections A-C on one day and then D-F on the next.

Culturally Inclusive/Responsive Components

Option 1: One of the co-inventors of the CubeSat, Dr. Jordi Puig-Suari, emigrated to the US from Spain. In this episode of Ask Nanosite Mission Design (https://youtu.be/lcajhcxfxQ8), Dr. Puig-Suari talks about growing up in Spain without an aerospace program and discusses aerospace around the world, including Africa.
Option 2: Students can research an early satellite pioneer: Valerie Thomas, by reading the following: https://tinyurl.com/valerietnasa

All web pages last accessed 4/12/23.

Educator Resources

CubeSat HyperDoc Answer Key: https://tinyurl.com/cubesatkey
Teacher Reference Material:
https://www.nasa.gov/sites/default/files/atoms/files/nasa_csli_cubesat_101_508.pdf
Extension Activities:
If you have a 3D printer at your school, you may want to try this:
https://www.instructables.com/HyperDuino-based-CubeSat/.
Have students research sizes of different types of satellites, using something like this:
https://www.viasat.com/about/newsroom/blog/how-big-is-that-satellite--a-primer-on-satellite-categories0/

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Below is a list of the lesson titles included in the series. All lessons can be accessed from this web page, https://superknova.org/educational-resources/.

Middle School

Introduction to Satellites
Weather Predicting
Introduction to Radio Wave Communication
The Importance of Radio Astronomy
Cubesat Model Building
Understanding FM Radio
Radio Frequency Technology
Who Decides if You Get 5G?

High School

The Uses of Radio Waves and Frequency Allocation
Is Radio Technology Safe?
Diffraction of Radio Waves
Measuring Sea Surface Temperatures with Satellites
Marine Animal Tracking and Bathymetry
How to Design Your Own Crystal Radio
How Radio Waves Changed the World
Simple Wireless Communication
Seeing and Hearing the Invisible
Local Wireless Radio Frequency Communication
Investigating the Internet Connection
The Geometry of Radio Astronomy

Informal

Modeling Radio Astronomy