National Aeronautics and Space Administration

Moon Math

Recommended for Grades 5-8

www.nasa.gov

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Digital Learning Network (DLN)

A DLN interactive videoconferencing event is a one time connection that allows students to experience NASA first-hand. Each event features an integrated educational package of grade-appropriate instruction and activities centered around a 50 minute videoconference. Students participate in a Question and Answer session with a NASA Education Specialist or a NASA Subject Matter Expert.

Overview

NASA is returning humans to the Moon as early as 2020. Today's students will be our next generation of explorers and just may be the first people to live and work in a community on the Moon. Since measurement is a fundamental building block for science, technology and engineering, **Moon Math** is an opportunity for students to learn the basic concepts of measurement and realize how important measurement is in our everyday lives. This module has students exploring measurement quantities, units and their tools, as well as methods of non-standard measurement and indirect measurement. Moon Math is a **two-part series**, so students can learn how to apply basic measurement skills to an applied science activity.

Grade Levels: 5-8

Focus Question: *What kind of measurement can you make of the Moon?*

Instructional Objectives:

- **Engage:** The student will describe methods of measurement used every day.
- **Explore:** The student will conduct basic measurement activities.
- **Explain:** The student will compare the methods of nonstandard and indirect measurement.
- **Elaborate:** The student will apply measurement skills to a scientific investigation.
- **Evaluate:** The student will identify how to apply proportions in other methods of indirect measurement.

IMPORTANT: When scheduling this event, please schedule two time slots approximately one to two weeks apart to ensure your students get the full experience of this module. When registering dates, simply indicate in the NOTES section "Part 1" and "Part 2".

National Standards

National Science Content Standards:

Science as Inquiry

- Abilities necessary to do scientific inquiry

Earth and Space Science

- Earth in the Solar System

National Mathematics Content Standards:

- Understand measurable attributes of objects and the units, systems, and processes of measurement
- Apply appropriate techniques, tools, and formulas to determine measurements
- Develop and evaluate inferences and predictions that are based on data

Sequence of Events

Pre-Conference Requirements

Pre-assessment

A pre-assessment tool is available to determine the students' level of understanding prior to the videoconference. Suggested answers are included. Also, please collect the materials needed for activity as outlined below.

Pre-Videoconference Activity

See page 6.

Videoconference

2 - 50 minute conferences

Post-Conference Requirements

Post-assessment

A post-assessment tool is available to determine changes in student levels of understanding.

Post Videoconference Activity

See page 14

Videoconference Outline

Part One

I. Welcome
II. Introduction of NASA's efforts to Return to the Moon
III. Inquiry Session: What do we do everyday that requires measurement?
    a. Quantities
    b. Units
    c. Tools
    d. Video 1: Apollo lunar lander history and measuring with a map
IV. Non-standard measurement
    a. Activity 1 – Can you determine the length of the classroom?
V. Indirect measurement
    a. Activity 2 – Can you determine the thickness of one sheet of paper?
VI. Homework assignment
VII. Conclusion

Part Two

I. Welcome
II. Recap of Part One
III. Non-standard measurement
    a. Activity 1 – Can you determine the perimeter of your desk?
    b. Range of error around the mean
IV. Indirect measurement
    a. Activity 2 – Can you land a spacecraft in the crater of the Moon?
    b. Video 2: Proportions
    c. Find the crater diameter
V. Conclusion

Videoconference Event

Part One

Pre-Videoconference Activity:

If the gravity on the Moon is 1/6th of the gravity here on Earth, then how would that make things different? Use your mathematical skills to answer the following questions.

1. If you can leap 0.5 meters on Earth. How high would you leap on the Moon?
2. You can spit a watermelon seed 30 cm on Earth in your back yard. How far might that seed travel on the Moon?
3. If the lunar rover weighs about 210 kilograms on Earth, how much does it weigh when it is on the moon?

If you are able to lift 15 kilograms on Earth, how much can you lift when you are on the Moon?

Pre-Videoconference Procedure:

Each student will need paper, pencil, ruler and a calculator (optional). Please also have at least one unopened ream of paper on hand.

During the Videoconference:

1. Assist student volunteers as they take their positions for the non-standard measurement activity.

2. Assist students in building a data chart for the activity. Students will be asked by the host to construct a data table with four columns and four rows.

Table 1. Example of the data chart students will construct during the activity introducing non-standard measurement.

Method of measurement	Length/width of classroom	Non-standard unit in centimeters	Length/width of classroom in centimeters
Amy's armspan	9	110	990
Tom's body length	6.5	145	942.5
Maria's foot	38	32	1216

Activity Summary

Activity 1: Non-Standard Measurement

Students will participate in an interactive session to demonstrate that there are other methods to implement when making a measurement. The host will ask for three volunteers to provide a non-standard method to measure the length or width of the classroom. Students are encouraged to think of ideas that involve their own person, furniture or perhaps floor/ceiling tiles, etc. Those volunteers will then be asked to make their measurement of the room. (Some suggested methods may require the help of an additional student. For example, if a student suggests using his/her armspan, then another student will be needed to mark the start/stop points of each "unit".) The remainder of the class will be asked to construct a data table consisting of four rows and four columns (see example above). After the student volunteers make their measurements, they will need to report their measurements to the rest of the class to be entered in the data tables.

Once all measurements are complete, the host will conduct an inquiry session for students to determine how to standardize their measurements – determine the length of the classroom in centimeters, without measuring the room again. Once the method has been established, students will make their measurements of their "units", and continue to complete the data chart. Lastly, students will set up the mathematical equation to find the length of the room in centimeters. Host will finish the activity by summarizing the effects of estimation per individual measurement.

Non-standard measurement of room ***X*** *non-standard unit (cm)* **=** *length of room (cm)*

Activity 2: Indirect Measurement

During this activity, students will be asked to determine how to measure the thickness of one sheet of paper with a ruler. Obviously, the paper is too thin to measure with just a ruler. Thus, students are asked to think of another method to get the measurement of the paper. Host will prompt students to look at the original source: the ream the paper. Students will measure the thickness of the ream, then divide by the number of sheets in the ream to get the thickness of one sheet.

Thickness of ream **÷** *number of sheets in the ream* **=** *thickness of one sheet*

5 cm **÷** *500 sheets* **=** *0.01 cm*

The host will conduct a final inquiry session asking students to apply this idea of indirect measurement to what we have learned in the field of astronomy. What quantities in our solar system have been measured indirectly? For example, we know the approximate temperature of the sun, but did a human actually go to the sun and stick a thermometer in it?

Students will be given a homework assignment by the host at the end of this session (one image of the Moon – see Part 2).

Part Two

Pre-Videoconference Procedures:

Each student will need paper, pencil, ruler and a calculator. Students will also need one image of a **full** Moon where craters are easily identified. Student may either print an image from the internet, use an image from a textbook or take picture of the Moon with their own digital camera through a telescope.

During the Videoconference:

1. Assist students in building a data chart for the activity. Students will be asked by the host to construct a data table with five columns and two rows.

2. Assist the host in collecting 5 different answers from students around the room after Trial 1, then again after Trial 2.

3. *Optional:* Create an X-Y plot on the chalkboard/whiteboard/projector to graph the data the students provide from the activity. X-axis will be Trial 1 and Trial 2. Y-axis will be the desk/table perimeter.

Table 1. Example of the data chart students will construct during the activity introducing non-standard measurement.

Trial	Method of measurement	Perimeter of table/desk	Non-standard unit in centimeters	Perimeter of table/desk in centimeters
1	Pencils	32	18.5	592
2	Calculators	40	11	440

Activity Summary

Activity 1: Non-standard measurements and effects of estimation

This activity is an extension of the previous non-standard measurement activity to demonstrate how estimation, when compounded from several sources, can create a large range of error. Students will be asked to measure the perimeter of their desks/tables using a non-standard measurement tool. Each student must conduct their own measurement with their own choice of tool, then record their data. Five results will be selected for a class demonstration of error around the mean. Students will be asked to average those five perimeters and report the mean. Next, students will be asked to find the lowest and highest point in the data range (the five perimeters reported). The end result is the mean with a range of error. (If time permits, host may have teacher construct a graph on the board to plot the mean and error bars.) The host will explore with the students how the class can decrease the range of error around the mean, then do the activity a second time. One non-standard measurement tool will be selected for

all students and each student must physically measure the entire perimeter of their table/desk (**note:** often students only measure one width and one length and apply the math). Again, they will record their results, measure their "tools", apply the math to find the perimeter in centimeters. Report five different answers to the teacher to find the mean, the high and the low, and then graph the results (*optional*).

	TRIAL 1 Sample perimeters			TRIAL 2 Sample perimeters	
	468			480	
	501			500	High
	432	Low		496	
	440			473	Low
	535	High		482	
Sum:	2376		Sum:	2431	

TRIAL 1

Mean = 2376 ÷ 5 = 475.2

Range of error around the mean = 535 – 432 = 103 cm

TRIAL 2

Mean = 2431 ÷ 5 = 486.2

Range of error around the mean = 500 – 473 = 27 cm

Activity 2: Can a spacecraft land in the crater of the Moon?

To reinforce the idea of indirect measurement, students will now determine the size of a crater on the Moon using the pictures in front of them. The host will guide the students step by step on how to make their measurements. They will first measure the diameter of the Moon image in millimeters. They then measure a crater in their image in millimeters. Students then find the actual diameter of the Moon in kilometers from the lithograph provided in class. Student then must set up a proportion to solve for X.

Set up the proportion/ratio

$$\frac{\text{Measured crater diameter (mm)}}{\text{Measured Moon diameter (mm)}} = \frac{\text{Actual crater diameter}}{\text{Actual Moon diameter (km)}}$$

Fill in the data

$$\frac{2 \text{ mm}}{178 \text{ mm}} = \frac{X}{3476 \text{ km}}$$

Cancel out millimeters

$$\frac{2}{178} = \frac{X}{3476 \text{ km}}$$

Cross multiply

$$178X = 2(3476 \text{ km})$$

$$178X = 6952 \text{ km}$$

Solve for X

$$X = 39.1 \text{ km}$$

Often students do not grasp the distance in kilometers. A good example to give is to talk about traveling in a car at highway speed (100 km/hr). To drive from one side of the crater to another at highway speed, in this example, would take approximately 20 minutes.

Vocabulary

Basalt: Dark volcanic rock found on the surface of the Moon.

Crater: A circular depression with a floor and enclosed by walls on the surface of the Earth, Moon, or other planetary object.

Data: Facts, statistics, or items of information.

Instrument: A device for controlling, measuring, or recording data.

Lunar maria: The dark basalt plains of the Moon formed by ancient volcanic eruptions.

Proportion: a mathematical relationship between different quantities.

Quantity: in the context of this module, length, mass/weight, volume, time or temperature.

Unit: in the context of this module, an identity element, such as meters, grams, liters, hours or degrees.

Videoconference Guidelines

Teachers, please review the following points with your students prior to the event:

- Videoconference is a two-way event. Students and NASA presenters can see and hear one another.
- Students are sometimes initially shy about responding to questions during a distance learning session. Explain to the students that this is an interactive medium and we encourage questions.
- Students should speak in a loud, clear voice. If a microphone is placed in a central location instruct the students to walk up and speak into the microphone.
- Teacher(s) should moderate students' questions and answers.

Teacher Event Checklist

Date Completed	Pre-Conference Requirements
	1. Print a copy of the module for your reference.
	2. Have the students complete the pre-assessment.
	3. Email questions for the presenter. This will help focus the presentation on the groups' specific needs.
	4. Review the Audience Guidelines listed above with your students.

	Day of the Conference Requirements
	1. The students are encouraged to ask the NASA presenter relevant questions about the videoconference event.
	2. Follow up questions can be continued after the conference through e-mail.

	Post - Conference Requirements
	1. Have the students take the Post-Assessment to demonstrate their knowledge of the subject.
	2. Teacher(s) and students fill out the event feedback.

Pre- and Post Assessment

1. Which of the following is a measuring tool?
    a. Centimeters
    b. Volume
    c. Distance
    d. Ruler

2. Which of the following is not a unit of temperature?
    a. Centigrade
    b. Kelvin
    c. Liter
    d. Fahrenheit

3. Which of the following is a unit of the metric system?
    a. Fahrenheit
    b. Kilometer
    c. Inch
    d. Pound

4. Briefly explain one activity you do that requires measurement *outside* of a science or math class.

_____

_____

_____

5. On your way home from the bus stop, you counted the number of steps it took to get your front door. If it took 234 steps to get home, and you measured your step size as 45 cm, what is the distance between the bus stop and your front door in centimeters? In meters?

_____

_____

_____

Answer Key

1. D

2. C

3. B

4. Cooking or baking, buying clothes in a new size, pumping gas into a car, setting a timer, etc.

5. 10,530 cm, 105.3 m

Post-Conference Activity

In the summer of 2009, the **Lunar Reconnaissance Orbiter** (LRO) and **Lunar Crater Observation and Sensing Satellite (**LCROSS) launched to the Moon to make numerous measurements. The mission of LCROSS is to confirm the presence or absence of water ice in a permanently shadowed crater at the Moon's South Pole. LCROSS will send two heavy impactors to the surface of the Moon to test the theory that ancient ice lies buried there. The impact will eject material from this "man-made" crater to create a plume for scientific instruments to analyze for the presence of water.

How does the crater you just measured compare to the crater that LCROSS will make?

http://quest.nasa.gov/lunar/lcross/CraterSizes.htm

NASA Education Evaluation

Currently the Office of Education is undergoing a major system change for its on-line interface for education evaluation. The new website will be announced later this year. We may need a few minutes of your time before or after a DLN event to answer questions that we will need to record until the new system is up and running.

But remember, to continue to receive these events for free, we need your feedback!

Additional Resources

Educator's Guide: Exploring the Moon

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Exploring.the.Moon.html

Moon Lithograph:

http://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Earths_Moon_Lithograph.html

Lunar Photo of the Day:

http://lpod.wikispaces.com

Contributors and Developers

Dr. Marci Delaney	**Goddard Space Flight Center**
Dr. Susan Hoban	**Goddard Space Flight Center**
Shane Keating	**Goddard Space Flight Center**