NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 50 MINS

Investigating Map Projections

Students use oranges to investigate the effects of changing a 3-D surface to a 2-D surface. They then examine the distortions of different map projections while comparing land and ocean to its representation on a globe.

GRADES

5 - 12+

SUBJECTS

Geography

CONTENTS

1 Video, 4 PDFs, 4 Images, 1 Resource, 1 Link

OVERVIEW

Students use oranges to investigate the effects of changing a 3-D surface to a 2-D surface. They then examine the distortions of different map projections while comparing land and ocean to its representation on a globe.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/investigating-map-projections/

DIRECTIONS

1. Demonstrate the challenge of transferring a spherical surface to a flat surface.

Explain that cartographers and others needing flat maps for practical uses have long been challenged to show Earth, a three-dimensional sphere, on a flat, two-dimensional plane. To demonstrate the challenge of moving from 3-D to 2-D with a sphere, invite 4-6 volunteers to the front of the room and give each a navel orange or other type of orange that is easily

peeled. Ask them to peel the orange, trying as best they can to keep the peel in one piece. One at a time, place the peels on an overhead projector and discuss the shapes as a whole class. Have them imagine this is the surface of Earth or a globe. Ask: *What happens to the Earth when it's flattened in this way?* (Responses will vary; students should recognize that it's difficult to flatten it without splitting it into pieces or having several finger-like projections coming from a center.) Show the video, The Cartographer's Dilemma, to introduce the challenges that cartographers face with representing Earth on a flat surface. Tell students they will next test the reverse, changing from a flat map to 3-D.

2. Have students create globes from different maps.

Divide students into small groups of three. Give each group one copy of the 3-page worksheet Map to Globe: 2-D to 3-D Models, scissors, and transparent tape. Have groups study these versions of the globe. Ask: *What is the relationship between lines of longitude and the black lines* (cuts) on the map? (The cuts are all made along lines of longitude.) *What is the relationship to the Equator?* (Cutlines stop at the Equator.) Have each member of each group work with one page to cut and tape together a model, attempting to make a globe from the maps. Ask:

- *Do these come close to being a sphere?*
- *Which comes closest to being a sphere?*
- *Which is best for seeing the shapes of the land?*
- *Which is best for showing the ocean?*

3. Have students compare different map projections.

Project the three maps (Mercator, Mollweide, and Robinson) showing different map projections that have been developed by cartographers. Read the captions for each. Ask: *What do you observe about the lines of longitude in each of these map projections?* (Some have lines of longitude meeting at the poles; some have parallel lines of longitude; some have curved lines of longitude but do not meet at north and south poles.)

Give students the worksheet Comparing Map Projections to the Globe and the handout Map Projections. Have students analyze the three projections and the globe to note the distortions found. Have students also compare the size (that area is proportional) and the shapes of land and water on the maps with what they see on the globe.

4. Show a video about map projections.

Show students the Selecting a Map Projection video about National Geographic's mapping considerations for its media needs. You may want to show this short video more than once. Allow students to revise their findings based on this information.

5. Have students debate the best projection.

Have students refer to the Map Projections handout, and use the provided answer key to have a whole class discussion about their answers in the chart. Next, project the upside-down map of the world and the Pacific-centered world map. Have students in small groups discuss what's accurate and inaccurate about all of the different maps. Ask: *Do you think it makes a difference if a continent is at the "top" or "bottom" of the map? Does it matter if a continent is larger or smaller in relation to other continents and on the map and on the globe?* Have them debate what they believe is the best map for use in classrooms and the general media, such as news reporting. Ask: *Is there a map that's accurate for everyone? What recommendations do you have for school settings?*

Tip

For Step 1, peel an orange in one piece ahead of time and have it wrapped around an orange. If students have a hard time getting one piece as they peel, you'll have a back-up. You can also show the video if you have limited time.

Modification

If you have limited time, in Step 2, have students work in pairs to build only the first projection.

Tip

Show students two examples of map distortion in interactive maps. Project the MapMaker Interactive and tell students that it uses a Web Mercator projection. Zoom out and then back in with the tool to show students that distortion in action. Then project a satellite view in Google Maps. Zoom out to the world level and toggle between the regular map view and the "Earth" view to see the map distortion.

Tip

You can also add to the orange two dots for the poles and an Equator line with a permanent marker an hour or more beforehand to let the ink dry. This enables discussion of the changes to the Equator.

Informal Assessment

Have students write a persuasive essay about the need for use of a particular world map projection. Have them choose an audience: the head of the federal Department of Education, the chief navigation expert for a shipping company, or the editor of *National Geographic* magazine. Have them explain why they think a particular projection is ideal and the reasons why other projections are not ideal.

Extending the Learning

Have students create a visual display or bulletin board about the challenges cartographers have faced and the issues that different projections present. If time allows, have them include more projections, such as Mollweide (Interrupted), Goode's (Interrupted), and the Winkel Tripel and also a Pacific-centered map and an upside down world map.

OBJECTIVES

Subjects & Disciplines

Geography

Learning Objectives

Students will:

- investigate the effect on a surface when changing from a 3-D surface to 2-D

- recreate a 3-D surface from a 2-D map
- explain the effects of different map projections by comparing map projections with representation of Earth's land and water on a globe

Teaching Approach

- Learning-for-use

Teaching Methods

- Demonstrations
- Discussions
- Visual instruction
- Writing

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Understanding
- Geographic Skills
  - Analyzing Geographic Information

National Standards, Principles, and Practices

NATIONAL COUNCIL FOR SOCIAL STUDIES CURRICULUM STANDARDS

- **Theme 2:**

Time, Continuity, and Change

• **Theme 3:**
People, Places, and Environments

NATIONAL GEOGRAPHY STANDARDS

• **Standard 1:**
How to use maps and other geographic representations, geospatial technologies, and spatial thinking to understand and communicate information
• **Standard 3:**
How to analyze the spatial organization of people, places, and environments on Earth's surface

COMMON CORE STATE STANDARDS FOR ENGLISH LANGUAGE ARTS & LITERACY

• **Speaking and Listening Standards K-5:**
Comprehension and Collaboration, SL.5.1
• **Writing Standards 6-12:**
Text Types and Purposes, W.6.2

THE COLLEGE, CAREER & CIVIC LIFE (C3) FRAMEWORK FOR SOCIAL STUDIES STATE STANDARDS

• **Geographic Representations: Spatial Views of the World: D2.Geo.1.6-8:**
Construct maps to represent and explain the spatial patterns of cultural and environmental characteristics.

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- 4-6 navel oranges, or other easily peeled oranges
- Globes or beach ball globes (1 per group or 1 per two groups)
- Permanent markers (optional)
- Scissors
- Transparent tape

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Projector

PHYSICAL SPACE

- Classroom

GROUPING

- Large-group instruction

BACKGROUND & VOCABULARY

Background Information

Cartographers through the ages have developed maps to be used for different purposes. In the 16th century, Mercator developed a world map mainly used for ocean navigation, and this projection is still used to this day for a number of purposes. The land masses, however, are distorted in shape and size. Cartographers have wrestled for centuries with how to represent Earth's spherical surface as a flat map and have come up with a wide variety of projections. No projection represents Earth precisely.

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
area	*noun*	a geographic region.

Term	Part of Speech	Definition
direction	*noun*	the way in which somebody or something goes, points, or faces.
distance	*noun*	measurable space between two or more objects.
distortion	*noun*	representation that is twisted, mistaken, or false.
map projection	*noun*	method by which shapes on a globe are transferred to a flat surface.
map scale	*noun*	relationship between distance on a map and distance on the ground.
map skills	*noun*	skills for reading and interpreting maps, from learning basic map conventions to analyzing and comprehending maps to address higher-order goals.

For Further Exploration

Books

- Mitchel, Lucy S. *Young Geographers*. 1934. Reprinted by Bank Street College of Education, 1991.