MAP PROJECTIONS · 30 TO 40 MINUTES · AGES ABOUT 10 TO 16

WHY EVERY MAP YOU KNOW IS WRONG

The same circle, drawn on a web map, from the equator to the north. Watch it grow.



Every gold circle is exactly 600 km across on the globe. Web Mercator, cut at 85° north and south, as most web maps are.

FOR THE TEACHER

LESSON PLAN

Every flat map has to stretch the round Earth somewhere. The map most of us use every day, the web map, keeps shapes and pays with size. This short lesson lets students see where the stretch comes from and measure how big it gets.

STUDENTS WILL

- explain why a flat map cannot keep every area at its real size
- use the rule "area × 1 ÷ cos² of the latitude"
- compare real areas and say how many times as big one is
- name one map that keeps sizes right

YOU NEED

- the video "Why Every Map You Know Is Wrong" (5 min 40 s, no voice, text only): https://youtu.be/ulKsEXKZ_FE
- pages 3 and 4, one per student
- pages 5 and 6 for you (or on the board)

GOING FURTHER

The paid classroom kit "Which Is Really Bigger?" adds worksheets, cut-outs at one scale and 12 classroom posters. Students can drag any country across the map at truescaletv.com/map, and there is a new 10-question quiz every Monday at truescaletv.com/quiz.

ABOUT 35 MINUTES

5 min — Hook
Show the first 25 seconds of the video, then pause. Which is bigger, Greenland or Africa? Take a vote.

8 min — Watch
Watch chapters 1 and 2 (0:25 to 2:15): why sailors loved the map, and how the stretch works.

10 min — Worksheet
Students fill in "Drag it to the equator" on page 4, first from the map, then with the real areas.

5 min — Check
Watch chapter 3 (2:15 to 3:35) and let students check their answers.

7 min — Trade-offs
Page 5: three world maps. Which keeps shapes? Which keeps sizes? Watch chapter 5 (4:15 to 5:00).

5 min — Exit question
"Which map would you choose to compare the size of two countries, and why?"

LICENCE

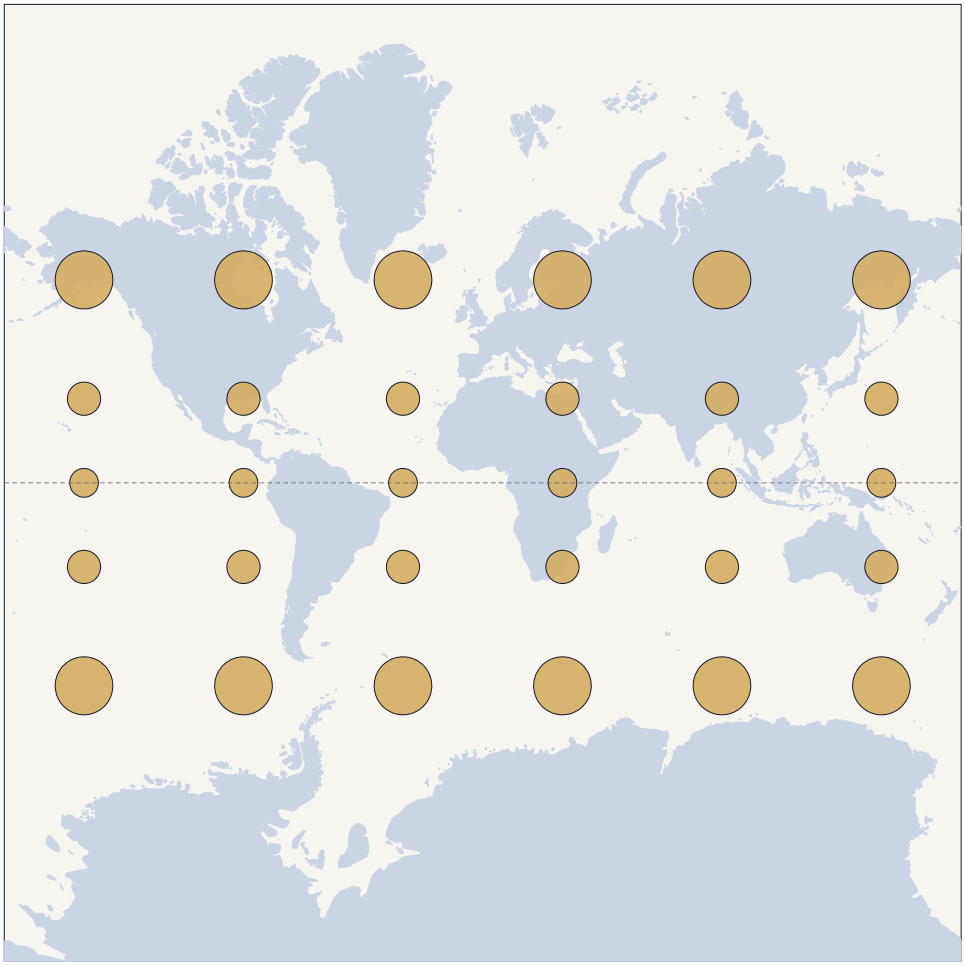
Free. Print and copy it for your classes and share it with other teachers. Please do not sell it.

HANDOUT

How the stretch works

In 1569 Gerardus Mercator made a world map for sailors. On it, a course with one fixed compass heading is a straight line. To make that work, the map stretches the world sideways more and more toward the poles, and then stretches it up and down by the same amount, so shapes stay right. Sizes do not.

Web maps use the same idea (Web Mercator). Each gold circle below is exactly the same size on the globe:



HOW MUCH TOO BIG?

Latitude	Lengths	Areas	For example
0°	× 1.00	× 1.0	the equator: Quito, Singapore, Africa's middle
30°	× 1.15	× 1.3	Cairo, New Orleans
45°	× 1.41	× 2.0	Milan, Minneapolis
60°	× 2.00	× 4.0	Oslo, Helsinki, the south tip of Greenland
72°	× 3.24	× 10.5	about the middle of Greenland
80°	× 5.76	× 33.2	the north of Greenland
90°	∞	∞	the pole cannot be drawn at all, so web maps stop at about 85°

The rule: lengths are multiplied by 1 ÷ cos(latitude), areas by 1 ÷ cos²(latitude). At 60°, cos is 0.5, so every area is drawn 4 times too big.

Sources: J. P. Snyder, Map Projections: A Working Manual, USGS Professional Paper 1395 (1987); History of Science Museum, Oxford (Mercator 1569). Map: Natural Earth 1:50m, no borders drawn.

WORKSHEET

DRAG IT TO THE EQUATOR

Name: _____

Open any web map (or use the map on page 3). Which of the two **looks** bigger? Tick it. Then use the real areas: which is really bigger, and how many times as big? (Divide the big area by the small one.)

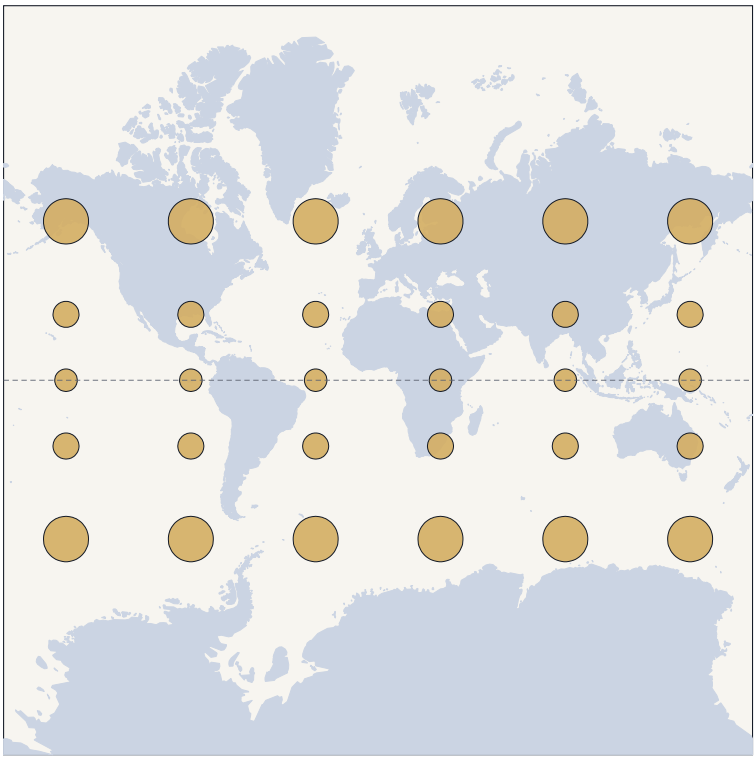
#	ON A WEB MAP	REAL AREAS	REALLY BIGGER · HOW MANY TIMES?
1	☐ Greenland ☐ Africa ☐ about the same	Greenland **2,166,086 km²** Africa **30,365,000 km²**	_____ about _____ times
2	☐ Canada ☐ Africa ☐ about the same	Canada **9,984,670 km²** Africa **30,365,000 km²**	_____ about _____ times
3	☐ Alaska ☐ Mexico ☐ about the same	Alaska **1,723,337 km²** Mexico **1,964,375 km²**	_____ about _____ times
4	☐ Alaska ☐ Brazil ☐ about the same	Alaska **1,723,337 km²** Brazil **8,510,417 km²**	_____ about _____ times
5	☐ Antarctica ☐ Africa ☐ about the same	Antarctica **14,200,000 km²** Africa **30,365,000 km²**	_____ about _____ times
6	☐ Norway ☐ Madagascar ☐ about the same	Norway **323,772 km²** Madagascar **587,041 km²**	_____ about _____ times

Think: all six times, the place that looks too big is the one farther from the equator. Why?

FOR THE BOARD

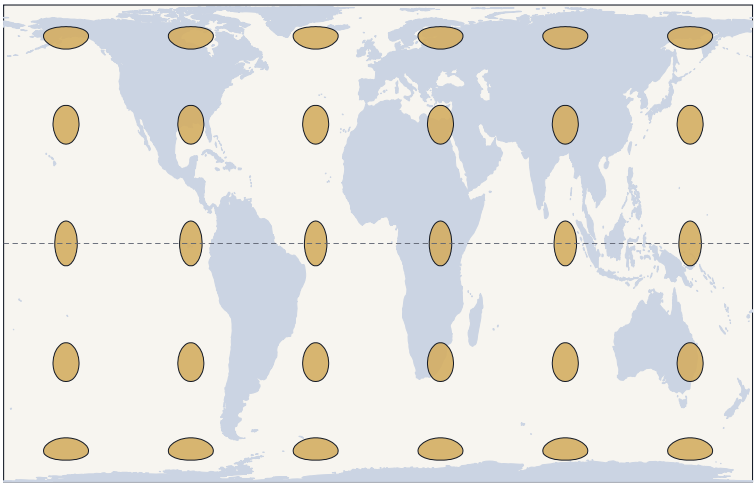
EVERY MAP IS A TRADE-OFF

You cannot flatten a ball without breaking something. Same gold circles, three maps. On the two lower maps every circle covers the same area.



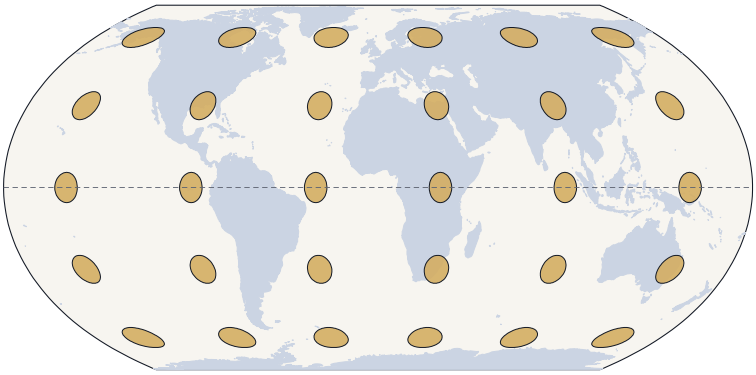
MERCATOR · 1569

Keeps shapes and compass directions. Sizes grow toward the poles. Web maps use it (Web Mercator).



GALL–PETERS · 1855 / 1973

Keeps every area right. Shapes are stretched tall near the equator and squashed near the poles.



EQUAL EARTH · 2018

Keeps every area right, and shapes look familiar. Made by Šavrič, Patterson and Jenny.

Also in the video: Robinson (1963, used by National Geographic 1988 to 1998) and Winkel tripel (National Geographic since 1998), two compromises that get neither shapes nor areas exactly right.

Sources: Wikipedia (Gall–Peters, Robinson, Winkel tripel); Esri ArcUser, "Equal Earth" (2018). Maps drawn from Natural Earth 1:50m without borders.

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ANSWER KEY

DRAG IT TO THE EQUATOR

Answers. "On a web map" is measured on Natural Earth outlines in Web Mercator, so treat it as "about".

#	ON A WEB MAP	REAL AREAS	REALLY BIGGER · HOW MANY TIMES?
1	about the same size	Greenland **2,166,086 km²** Africa **30,365,000 km²**	**Africa**, about 14 times as big
2	Canada looks about 1.5× as big	Canada **9,984,670 km²** Africa **30,365,000 km²**	**Africa**, about 3.0 times as big
3	Alaska looks about 3.5× as big	Alaska **1,723,337 km²** Mexico **1,964,375 km²**	**Mexico**, about 14% bigger
4	about the same size	Alaska **1,723,337 km²** Brazil **8,510,417 km²**	**Brazil**, about 4.9 times as big
5	Antarctica looks over 8× as big	Antarctica **14,200,000 km²** Africa **30,365,000 km²**	**Africa**, about 2.1 times as big
6	Norway looks about 2.6× as big	Norway **323,772 km²** Madagascar **587,041 km²**	**Madagascar**, about 81% bigger

Areas: UN Demographic Yearbook 2024 (table 3); Africa and Antarctica (about 14.2 million km² with ice shelves): Encyclopaedia Britannica; Alaska: US Census Bureau, total area incl. water; Norway without Svalbard is drawn, the area is the UN figure.