



# Euclidean vs non-Euclidean

from the Esri GeoInquiries™ collection for Mathematics

Target audience – Geometry learners

Time required – 15 minutes

## Activity

Explore flat geometry (Euclidean) that is based on figures on a plane versus spherical geometry (non-Euclidean) that is based on figures on a curved surface.

## Math Standards

**CCSS: MATH.CONTENT.HSG.MG. A.1.** Apply geometric concepts in modeling situations.  
**CCSS: MATH.CONTENT.HSG.CO. C.9.** Prove geometric theorems.

## Learning Outcomes

- Students will measure lengths and calculate scales on a plane.
- Students will measure lengths on a curved surface.

Map URL: <http://esriurl.com/mathGeoInquiry8>

## Engage

### How do you find the shortest distance between two points on a plane?

- Click the link above to launch the map.
- Read aloud: “A high school in Asheville, North Carolina, is making initial plans to trek near Mount Everest in Nepal.”
- ? How can you find the shortest distance between these two points? *[List student suggestions on the whiteboard.]*

## Explore

### What is the shortest distance between Asheville and Mount Everest on a plane (i.e., Mercator projection)?

- Click the button, Bookmarks. Select Overview.
- With the Details button depressed, click the button, Content.
- Check the box to the left of the layer name, Cities.
- ? What countries would you fly over when taking the shortest route? *[The shortest distance between two points on a plane is a straight line. On a map, the route might take you over northern Africa, Saudi Arabia, through India, and into Nepal.]*
- Turn on the layer, Straight Line Route. The layer shows a straight line between Asheville and Mount Everest. Compare student answers to this route.
- Click the button, Bookmark. Select Equator. ,
- Turn on the layer, Equator.
- Read aloud: “Determine the distance between these two locations. You need a scale for judging distances. It is approximately 25,000 miles around the earth at the equator. Measure the width of the map at the equator in inches. Then measure the distance from Asheville to Mount Everest in inches.”
- ? If the scale at the equator works for this route, how far is it from Asheville to Mount Everest? *[Set up a proportion and cross multiply to solve. It is approximately 11,667 miles on this map.]*

## Explain

### What is the shortest distance between Asheville and Mount Everest on a curved surface (i.e., globe)?

- Zoom to the Overview bookmark.
- Read aloud: “We know that the world is not flat like a map. The earth is a sphere, and the shortest distance between two points on a globe is very different than what you calculated on a flat map.”
- Click the button, Measure. Select the Distance tool and set units to Miles.
- Measure the distance between Asheville and Mount Everest.
- Check the box next to the left of the layer name, Great Circle.
- ? What countries would you fly over? What is the distance between these points on a globe? [*Greenland and Russia; approximately 8,000 miles*]
- ? What is this route on a globe called? [*Great Circle Route*]

## Elaborate

### How would you calculate this distance on a globe?

- Read aloud: “To figure this out, you need a scale for judging distances. Again, it is approximately 25,000 miles around the earth at the equator.”
- Measure the width of the globe at the equator in inches.
- Then measure how far it is from Asheville to Mount Everest on the globe in inches.
- ? If the scale at the equator works for this route, how far is it from Asheville to Mount Everest on the globe? [*Approximately 8,000 miles*]

## Evaluate

### Which distance is more accurate and why?

- ? Which distance is more accurate? [*The distance calculated using the globe is more accurate because a globe is a better model for measuring distances between points that are far apart.*]

### USE THE MEASURE TOOL

- Click Measure, select the Distance button, and from the drop-down list, choose a unit of measurement.
- On the map, click once to start the measurement, click again to change direction, and double-click to stop measuring.
- Hint: Position the area of interest on the map so that it is not obscured by the Measure window.

### ADD MAP NOTES

- Click Add and from the drop-down list, choose Add Map Note.
- Type a name, select a template from the drop-down list, and click Create.
- In the Add Features pane, choose a symbol and click in the map to place it.
- In the pop-up window, add your desired information.

## Next Steps

**DID YOU KNOW?** ArcGIS Online is a mapping platform freely available to public, private, and home schools. A school subscription provides additional security, privacy, and content features. Learn more about ArcGIS Online and how to get a school subscription at <http://www.esri.com/schools>.

**THEN TRY THIS...**

- Explore a map projection gallery at <http://esriurl.com/Geo041402>.
- Determine what kind of projection that you would use to find the most remote place on each continent with the story map at <http://esriurl.com/Geo041403>.

## TEXT REFERENCES

This GIS map has been cross-referenced to material in sections of chapters from these high school texts.

- *Math Connections: Book 2A by It's About Time* — Ch 1
- *Geometry by Holt, Rinehart & Winston* — Ch 10
- *Geometry by Moise & Downs* — Ch 1
- *Geometry by Houghton Mifflin* — Ch 6