LESSON TITLE
Map Distortion

Guiding Question: How could we improve the world?

Ignite Curiosity

- Are the maps that we use every day accurate?
- How big do you think the United States is compared to India or Africa?
- Do maps affect how we see different parts of the world?
- What are the problems associated with representing a three-dimensional object in two dimensions?

In this lesson, students use the computational thinking strategies of finding patterns and building models to re-imagine world maps. In THINK, students act as teachers and textbook writers working on a geography textbook. They need to determine what kind of world map to use in the textbook to help students picture the world accurately. Students examine the Mercator projection and commonly proposed alternatives. In SOLVE, students look at the criteria used to create the Mercator projection and common criticisms of it. They then work in small groups to evaluate how valid these criticisms are. They examine a number of alternatives and look for patterns that will build accuracy into a two-dimensional representation of our three-dimensional world. In these groups, they will identify aspects of alternate maps that they believe best represent the world as it is. In CREATE they build a model of the world by either hand-drawing a more unbiased map or utilizing a free web-based map creation program. In CONNECT, students explore confronting bias in everyday life. They examine how the problem of two-dimensional versus three-dimensional representations and representations of relative size connect to careers and to problems of tomorrow.

Students will be able to:

- Analyze world maps made using the Mercator projection,
- Evaluate criticisms of the Mercator projection and other map types, and
- Create a map designed to teach students about the world that best conforms to these criteria.
Students act as social studies teachers who are working on a geography textbook. They have been challenged to develop a world map to use in the textbook that helps students picture the world accurately. To gain background in this topic, students will examine various historical maps to find patterns among them.

1. **Show** this image to students:

   ![Image of a historical map](http://www.loc.gov/exhibits/1492/images/igm004601.jpg)

   *World Map in [Donnus Nicolaus Germanus] Cosmographia, Claudeius Ptolemaeus Ulm, 1482. Thacher Collection, Rare Book and Special Collections Division, Library of Congress*

2. **Use the following guiding questions** to begin a group discussion:
   - How is this Ancient Roman map different from modern maps of the world?
   - What are some different purposes for creating and using maps? Specifically, what purposes might mapmakers in the past have had in mind?
   - What limitations did mapmakers in the past face?
   - What discoveries or technologies have helped mapmakers overcome these limitations?
   - Are there limitations on mapmakers today? If so, what are they?

3. **Next**, divide the class into groups and pass out the A Historic Look at Maps capture sheet. Provide students with time to look over the material (including browsing websites if your classroom is equipped with devices that can access the Internet). At the end of the allotted time, ask students to think of an accurate way to determine how big countries are compared to others. For example, ask **How big do you think the United States is compared to India?**
4 Instruct students to complete the following activity to test their knowledge:

Provide each student with two copies of the map below.

Have students cut out the following countries on one copy of the map and label them:
- United States
- France
- Texas
- Russia
- Great Britain
- India
- Africa
- Chad

Once all of the countries from the map are cut out, make the following comparisons by placing the cut-out country over the other country on the complete map:
- Compare France and Chad
- Compare Texas and Germany
- Compare France and Texas
- Compare the United States and Africa
- Compare Russia, Great Britain, and China

5 When students have completed the activity, check for understanding by asking the following summarizing questions:
- Were you surprised by the scale of some countries compared to others? Why or why not?
- Why does it matter how a country or continent is represented on a map?
- How can thinking like computers help us make more accurate maps?
Students examine airplane shipping routes and criticisms of different projections of maps to determine the most accurate way to represent a three-dimensional object in two dimensions.

1. First, show students an image of airplane shipping routes. The following are good examples:

2. Guide students to interpret the map using the following questions:
   - Look at the lines in this map. What do you notice?
   - What real-life purposes do you think these lines serve?
   - Why do airplanes take these routes?
   - Why would the lines be drawn like this? What does this tell us about the relationship between two-dimensional maps and the three-dimensional globe?

3. Next, students will work in small groups to evaluate the criticisms of the Mercator projection and alternatives. They will determine how valid they believe each criticism is. They will then identify patterns in the criticisms and abstract a list of criteria that their ideal map of the world would demonstrate.

4. Students will begin by viewing images of the three main types of projections of flat maps: cylindrical (Mercator), conic, and azimuthal. They will also explore recent maps created with the goal of eliminating some of the problems in the Mercator projection.

5. Pass out the Map Critique and Criteria student capture sheet. In their small groups, instruct students to complete the Map Critique table. Students should complete the rows for Mercator projection, conic, and Azimuthal maps and additional rows for recent maps.

Teacher’s note: The following resources explain recent maps and criticisms of the Mercator projection:
   - [https://www.flourish.org/upsidedownmap/](https://www.flourish.org/upsidedownmap/)

6. After groups have completed the table, gather students together for a group summary discussion. You can use the following guiding questions to encourage students to evaluate bias in modern maps:
   - Who is “in charge” of creating maps today? Is it developing countries or developed countries?
   - Think back to the size comparison activity you did earlier. How does the size of continents shown on modern maps relate to who creates the maps?
   - Would a map in which “south” is “north” be accurate? Why or why not?
   - Which countries might want a map on which “south” is “north”? Why?
7 After they have identified patterns in the critiques of various maps, instruct students to select the most important criteria they believe a map intended to teach students about the world would have. Working individually or in their small groups, students should fill in the Map Criteria table on the Map Critique and Criteria student capture sheet.
Once students have determined the criteria for their ideal maps, they will apply this list of criteria to sketch their own world map that best conforms to their ideals of an unbiased view of the world.

1 **Instruct** students to apply the criteria they have identified and evaluated to build a two-dimensional map. The following resources can help students create their maps:
   - Students can trace or cut and paste continents from a blank world map. If students do this, remind them to consider the size and placement of the continents as they work.

2 **When students are finished with their maps**, bring them together for a final discussion. Ask them to bring their maps to the front of the room. Ask:
   - Do you think that you were able to eliminate all types of bias and distortion in your map?
   - Do you think that students in all countries of the world would have created a map like yours? How might their maps be different?
Students explore confronting bias in everyday life. They examine how the problem of two-dimensional versus three-dimensional representations and representations of relative size connect to careers and to problems of tomorrow.

Select one of the strategies listed below to help students answer these questions:

- How do this problem and solution connect to me?
- How do this problem and solution connect to real-world careers?
- How do this problem and solution connect to our world?

1. **Write** the three questions on PPT or flip chart slides and invite students to share out responses.
2. **Display** chart paper around the room, each with one question written on it. Ask students to write down their ideas on each sheet.
3. **Assign** one of the questions to three different student groups to brainstorm or research, and then share out responses.
4. **Invite** students to write down responses to each question on a sticky note, and collect them to create an affinity diagram of ideas.

**How does this connect to students?**

Bias can be hard to detect. It appears in sometimes subtle forms, prioritizing some perspectives and ways of seeing the world. By learning to identify biases and inaccuracies in two- and three-dimensional representations, students will see how different aspects of our lives, like where we live or how we measure things, affect us in big ways.

**How does this connect to careers?**

- **Cartographers and Photogrammetrists** collect, measure, and interpret geographic information to create and update maps and charts for regional planning, education, emergency response, and other purposes.
- **Geoscientists** study the physical aspects of Earth, such as its composition, structure, and processes, to learn about its past, present, and future.
- **Historians** research, analyze, interpret, and write about the past by studying historical documents and sources, such as maps.
- **Teachers** instruct students, presenting material in as unbiased a way as possible and encouraging students to use critical-thinking skills.

**How does this connect to our world?**

Representations of geography and relative size change the way that we think about the world. This has connections to careers like cartography and geology and in international relations and politics.

By the end of this lesson, students will have learned more about history in general and maps specifically. They will have experienced the benefit of working in teams, practicing searching for and finding patterns, and compiling the commonalities of the patterns into a new model.
National Standards

**SUGGESTED K-12 PATHWAY FOR COLLEGE, CAREER, AND CIVIC READINESS**
**DIMENSION 2, GEOGRAPHIC REPRESENTATIONS**

**BY THE END OF GRADE 8**

**D2.Geo.1.6-8.**
Construct maps to represent and explain the spatial patterns of cultural and environmental characteristics.

**D2.Geo.3.6-8.**
Use paper based and electronic mapping and graphing techniques to represent and analyze spatial patterns of different environmental and cultural characteristics.

**K-12 COMPUTER SCIENCE FRAMEWORK**

**Practice 3: Recognizing and Defining Computational Problems**
The ability to recognize appropriate and worthwhile opportunities to apply computation is a skill that develops over time and is central to computing. Solving a problem with a computational approach requires defining the problem, breaking it down into parts, and evaluating each part to determine whether a computational solution is appropriate.

**By the end of Grade 12, students should be able to:**
- Identify complex, interdisciplinary, real-world problems that can be solved computationally.
- Decompose complex real-world problems into manageable sub problems that could integrate existing solutions or procedures.
- Evaluate whether it is appropriate and feasible to solve a problem computationally.

**ENGLISH/LANGUAGE ARTS**

**CCSS.ELA-LITERACY.RH.6-8.2**
Determine the central ideas or information of a primary or secondary source; provide an accurate summary of the source distinct from prior knowledge or opinions.

**CCSS.ELA-LITERACY.RH.6-8.7**
Integrate visual information (e.g., in charts, graphs, photographs, videos, or maps) with other information in print and digital texts.

**CCSS.ELA-LITERACY.RH.6-8.8**
Distinguish among fact, opinion, and reasoned judgment in a text.

**CCSS.ELA-LITERACY.RI.6.7**
Integrate information presented in different media or formats (e.g., visually, quantitatively) as well as in words to develop a coherent understanding of a topic or issue.
A Historic Look at Maps

Examine the three maps and record your answers to the questions in the spaces provided.

World Map published in China, approximately 1602

1. What differences do you notice between the three maps?

Italian Map 1457

2. Why do you think they are so different from one another?

Ancient Roman Map

3. What do you think were the purposes of each of these maps?
Map Critiques

In small groups, use the following images to evaluate the criticisms of the Mercator projection and other alternative world map projections.

1. Mercator (Cylindrical)

2. Conic

3. Azimuthal

How valid do you believe each criticism is? Are there certain cases where each projection is useful?

Record your thoughts in the Map Critique table.

Find more easy-to-implement resources to integrate computational thinking practices into your classroom by visiting ignitemyfutureinschool.org
## Map Critique

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<tr>
<th>Map Style</th>
<th>Criticism(s)</th>
<th>Valid or Invalid?</th>
<th>Why or Why Not?</th>
<th>Cases when Useful</th>
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Develop a list of criteria that your ideal map of the world would demonstrate. Remember that your ideal map is for learning about the world, not for transportation purposes.

### Map Criteria

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