The Foldable Map Projection

Teacher Guide

ACTIVITY **Create and analyze a foldable map to learn about coordinates and map projections.**

RESOURCES **Color printer, paper, tape or glue, internet**

The Dymaxion Map Projection

- What does the Dymaxion map say about you?
- Video of folding the Dymaxion map
- Wikipedia entry on the Dymaxion map

Map Projection

- Dymaxion projection tissot indicatrix
- Explanation of tissot indicatrix

Project Files Folder

- Link to Printouts

SOURCES

- Nelson, J. (2019). Make This Dymaxion Globe Ornament Please. https://www.esri.com/arcgis-blog/products/arcgis-pro/mapping/make-this-dymaxion-globe-ornament-please/
- Kessler, & Battersby Sarah E. (2019). Working with map projections: a guide to their selection. CRC PRESS.
- Battersby. (2021). The unicorn of map projections. International Journal of Cartography, 7(2), 146–151. https://doi.org/10.1080/23729333.2021.1911593
- Discussion of polyhedric projections

GRADE LEVEL

- This activity can be modified to fit various grade levels, and students can work individually or in groups. We have designed this guide document to include more information and ideas for extensions, feel free to remove or reconstruct information to your grade level.

THEMES Applied Geography

OUTCOMES Students will learn about coordinates and map projections via active-learning.

STANDARDS

- APHG Topic 1.1 Introduction to Maps -- skill: Identify the different types of data presented in maps and in quantitative and geospatial data.
- APHG Topic 1.2 Geographic Data -- skill: Identify the different types of data presented in maps and in quantitative and geospatial data.

TASK 1 Explore and Fold the Dymaxion Map (All Grade Levels)

→ The Dymaxion map projection, sometimes called the Fuller projection or Airocean world map, is a map projection created by Buckminster Fuller in 1943. It was specifically designed to be fold-able into an *icosahedron*, or a 20-sided polygon.

The Dymaxion map is sometimes placed into the category of “creative projections” (see image below) because its intended function is less practical in nature and instead aimed at creative uses. You can introduce the map projection by exploring some of the resources linked above or get started right away on the folding!

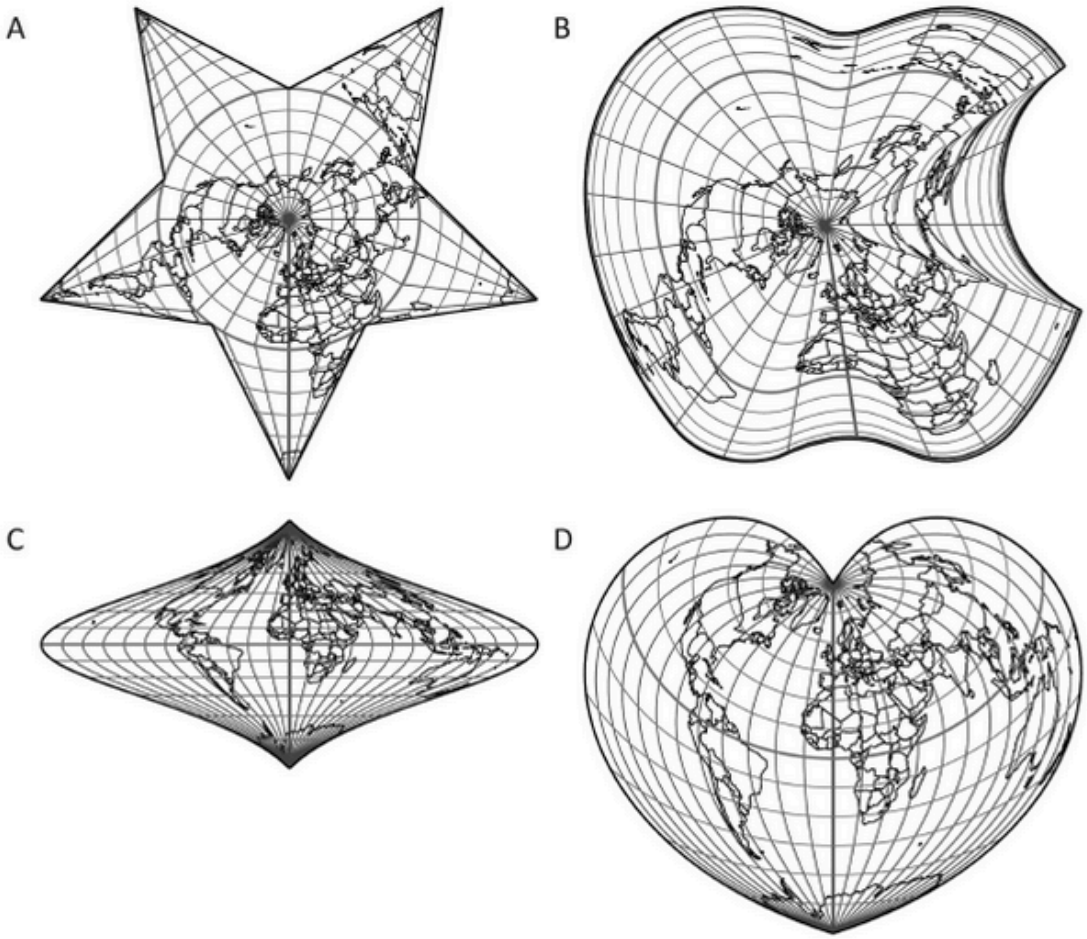

FIGURE 5.8
Creative projection designs, including the Berghaus star (A; equidistant), apple (B; equal area), Foucaut stereographic (C; equal area)—which we think looks a bit like a Christmas tree ornament—and heart (D; equal area).

Source: Kessler, & Battersby Sarah E. (2019). Copy of Figure 5.8.

→ Print and fold the maps from the Link to Printouts.

Printing recommendations:

- The folder linked above has both a black & white and color version, depending on which printer is available.
- Cardstock or slightly heavier weight paper, if available, is recommended for printing. If your school’s printer cannot handle heavier paper weights, a general purpose office supply store (Staples etc.) can print a PDF on cardstock for a reasonably small fee.
    - Regular paper will still work but your globes will just be a little more fragile. When folded, a heavier paper will keep its shape easier and be less likely to crumple inwards after it is taped or glued together.

To create the globes:

1. Cut along the outside edge of the map
    a. Note: ONLY cut the outside edge. Any cuts into the interior of the map will cause your globe to have a missing piece or gash!
2. Crimp and fold along the dotted lines.
    a. Note: make sure not to miss any, towards the end it will be a little harder to notice the fold-lines as the globe starts to take shape. younger students may need to work in groups or with assistance.
3. Fold the helper guides inwards
4. After all folds have been made, the map will already be very close to its globe form. The final step will be to simply tape or glue it together.
    a. Note: The helper guides have been placed with hints for places where it is more likely to tape it in the wrong location. We recommend starting with these.

Optional Task 2 **Find the Error (Junior High & High School Grade Levels)**

→ Students at higher grade levels may wish to discuss distortions from map projections. It is impossible to turn a 3-dimensional shape into a 2-dimensional one without introducing some types of error. It is often the case that map projections make strategic choices to eliminate some types of error (such as making areas the correct size, or making directions accurate). Other map projections do not eliminate any errors fully, but are designed to look pretty or fulfill a unique function.

The Dymaxion map falls into this last category. It does not eliminate any category of map error fully. It has minimal area and angular distortions, but has very large directional distortion. Angular distortion is harder to pinpoint, but area distortion can be reflected by the size of the continents (they are all generally the right size). Directional distortion is easiest to note by asking students to examine lines of latitude and longitude (they are not straight in all locations!).

→ Have students explore the tissot indicatrix for the Dymaxion map and visually explore the globes they folded themselves. You can then direct students to compare this projection with others. Extension ideas include:

- Compare the Dymaxion globe visually to other in-class resources, such as a Mercator map. If possible, have a globe available for students to compare the maps against.
- The map-projections.net site has a tool for comparing map projections to one another, and examining tissot indicatrix. Have the students explore common map projections such as the Mercator, or explore less common map projections and discuss what map distortions they aim to address and why they would be used.

Optional Task 3 **Guess the Data (Junior High & High School Grade Levels)**

→ Under Data Layers in Link to Printouts, you can find alternative globes, each with a unique GIS data layer. After each student or group folds their globe, have them guess their geographic dataset via examining its spatial patterns. The table below shows each dataset and its source for further examination.

Filename	Data Layer	Description

bathymetry.pdf	Ocean Bathymetry	A measure of the depth of the ocean floor (e.g., elevation below sea level). Global dataset from GEBCO. https://livingatlas.arcgis.com/en/home/
earth_night.pdf	NASA Earth at Night	Satellite imagery stitched together from NASA satellites, taken at night and covering the whole world. https://livingatlas.arcgis.com/en/home/
HDI.pdf	Human Development Index	An index created by the United Nations which attempts to track human development via measuring: A long and healthy life, Access to education, And a decent standard of living. https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
human_footprint.pdf	Human Footprint Index	A combined metric of 8 variables that attempts to highlight pressure on the biosphere. https://www.nature.com/articles/s41597-022-01284-8
koppen_climate_codes.pdf	Köppen-Geiger Climate Classification	A widely used system of classifying areas by their primary climate characteristics. Seasonal precipitation and temperature patterns play a large role in the division of climate geographies. https://www.nature.com/articles/sdata2018214
population.pdf	Gridded Population of the World, Version 4 (GPWv4) Population Density	The population of the world gridded into 1 kilometer cells. Population density is the number of people divided by area. https://livingatlas.arcgis.com/en/home/
seabirds.pdf	Number of Seabird Species by Marine Ecoregion	Originally from The Atlas of Global Conservation by the Nature Conservancy.

		https://livingatlas.arcgis.com/en/home/
SST.pdf	Global Sea Surface Temperature	The annual average temperature of the top layer of the ocean, monitored by satellites. https://livingatlas.arcgis.com/en/home/
terrestrial_ecosystems.pdf	Global Terrestrial Ecosystems	The World Terrestrial Ecosystem dataset developed by USGS, The Nature Conservancy, and Esri shows different ecosystems as a function of climate, land cover and landforms. https://livingatlas.arcgis.com/en/home/
undersea_cables.pdf	Global Undersea Telecommunications Cables	Locations of fiber cables that carry internet and other telecommunications. https://livingatlas.arcgis.com/en/home/

The folder also contains the original ArcGIS Project File, modified from the original by John Nelson at ESRI. If the class is learning GIS skills, this file can be used to bring in new datasets or to have students create their own datasets. The sources for the datasets in the table are linked in the description. The ESRI Living Atlas has a number of interesting layers by topic that are easy to include in ArcGIS.

If you are working in ArcGIS, just add the new data layer on top of the land or oceans layer. Then, change the original layers' symbology to create borders or to create a neutral background color where there is no data. The layout will update with your new data and keep the printout lines in the correct location. The new globes can then be exported to a PDF and students can fold their own creations.

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