Exploring Maps — Teaching Guide

Introduction

Exploring Maps is an inter-disciplinary set of materials on mapping for grades 7-12. Students will learn basic mapmaking and map-reading skills and will see how maps can answer fundamental geographic questions: "Where am I?" "What else is here?" "Where am I going?"

The map images and activities in this packet can be used in various courses, including geography, history, math, art, English, and the sciences. The images on the enclosed poster and the educational activities have been selected both to enrich our knowledge of mapping itself and to present maps as representations of reality.

Contents of this packet

- Two posters illustrating the development of mapping on the front; map-related texts and a do-it-yourself time line on the reverse.
- Teaching Guide.
- Four activity sheets, each with several suggested activities.
- Evaluation sheet.

How to use this packet

The online poster provides the same information and graphics as the printed poster. Poster Side 1 provides timeline information showing the development of maps since 900 B.C. Poster Side 2 provides literary excerpts, also in the form of a timeline, with which a class can work. The writings can be photocopied and distributed to the class to stimulate writing assignments and discussions or to use with the activities.

References listed in the bibliography are recommended further reading; many of these books helped shape the content of the posters and activities.

The lessons are organized around themes: location, navigation, information and exploration. A lesson has an introductory text and two main activities; the format is designed for easy photocopying so that every student will have a copy. Most activities can be completed within 2 hours, but some could become major projects. With each activity is a list of needed materials, the estimated time for completion, step-by-step instructions, and recommended readings and additional activities. Lists of important terms are included in most activities, but definitions are to be collected by students to make a glossary. Important notes about each lesson, definitions of glossary words, and answers to questions are included below.

The Lessons

Location

Activities

Tools of the Ancients (making instruments and measuring latitude and longitude)

A Place in Time (documenting changing characteristics using maps)

Notes

This lesson explores the methods of characterizing places, from the five senses to sophisticated tools of measurement. Every place has important characteristics and a unique location relative to other places. Latitude and longitude measurements indicate a place's absolute location on the globe.

Tools of the Ancients has students make a sundial and an instrument similar to a sextant. The students translate observations from these instruments into latitude and longitude.

A Place in Time has students document the history of a place. Students do research, organize information, and make maps and a timeline for a place of their choice.

Glossary

dead reckoning: The estimation of a ship's position from the distance according to the ship's log and the course steered by the compass, with corrections for currents and other

factors, but without astronomical observations.

Greenwich time: Mean solar time of the meridian of Greenwich, England, used by most navigators and adopted as the basis of standard time throughout the world.

landmark: Any prominent object on land that can be used in determining a location or direction.

latitude: Angular distance measured in degrees, minutes, and seconds north and south to the geographic poles from the equator.

longitude: Angular distance measured in degrees, minutes, and seconds 180 degrees east and west from the Prime Meridian, the imaginary north-south line through Greenwich, England.

magnetic compass: an instrument having a magnetic needle to indicate magnetic north.

mappa mundi: From two Latin words meaning tablecloth and world, a graphic or verbal representation of the world as understood in the Middle Ages in Europe.

marine chronometer: A portable timekeeper with a special mechanism for ensuring and adjusting its accuracy, for use in determining longitude at sea.

photogrammetry: The techniques used to obtain reliable measurements from photographs.

planetable: A device for plotting survey data directly from field observation. Consists of a drawing board on a tripod with a sighting instrument to measure and plot angles.

planisphere: A projection or representation of the whole or part of a sphere on a plane.

portolan chart: A type of sea chart common in the Middle Ages that was used for navigation at sea. Characterized by rhumb lines, or lines of constant compass heading, and the names of ports. From the Italian, portolano, a collection of sailing directions.

remote sensing: The process of detecting or monitoring the properties of an object without physically contacting the object.

sextant: An astronomical instrument for measuring angles, primarily altitudes of celestial bodies, to determine latitude.

surveying: The techniques used to make measurements in space to determine the relative positions of map features.

theodolite: A precise surveying instrument having a telescopic sight for measuring horizontal and vertical angles.

triangulation: A method of surveying in which the stations are points on the ground at the vertices of a chain or network of triangles. The angles of the triangles are measured instrumentally and the sides are derived by computation from selected sides or bases, the lengths of which are obtained by direct measurement on the ground or by computation from other triangles.

Answers to questions—

Tools of the Ancients; Columbus . . .

Extension 1. Students will observe slightly different values; this is normal. The range of values will vary. The "best" value is probably an average (the sum of observations divided by the number of observations).

Extension 3. Columbus might not have decided to sail west, since the trip to the Orient would have been so long. Spain's monarchs, Ferdinand and Isabella might not have sponsored a trip that risky.

Extension 4. The analemma shows two kinds of information (1) how high the Sun is in the sky on each day of the year at noon local time on the meridian on which the analemma is centered; and (2) the difference between solar noon time and standard noon according to the clock. The analemma can be placed on any meridian. Apparent changes in the height of the Sun in the sky result from the tilt of the Earth's axis of rotation. The tilt is constant, but at different positions in the Earth's orbit around the Sun, the changing effect causes the seasons. Variation in day lengths is the combined effect of three factors. The speed of the Earth in its elliptical orbit varies. This

effect combined with the effects of the tilt of the Earth's axis of rotation and the counterclockwise direction of rotation and revolution produces the variations in local noon shown on the horizontal axis of the analemma.

Tools of the Ancients; Local Time . . .

Instruction 6. The sun is at its highest when the shadow is shortest. The clock time of this observation differs to the east and west. As the Earth rotates toward the east, local noon time is earlier in the east.

Extension 1. The angular difference between geographic north and magnetic north is the difference between the direction indicated by the sundial at local noon and the direction to north as indicated by a compass needle. Geographic north is the north end of the Earth's axis of rotation. Magnetic north is the north end of the Earth's magnetic field.

Extension 2. To determine the number of degrees in a time zone, divide 360 degrees by 24 hours (360/24=15). To calculate your longitude knowing the time difference from Greenwich, multiply the number of hours difference by 15 degrees. For example, if the time in Greenwich is 6 hours ahead of the time where you are, your approximate longitude is 6 x 15, or about 90 degrees west of Greenwich.

Navigation

Activities

Make a Mercator Projection (transforming the globe to a flat sheet)

In the Wake of Lewis and Clark (following a trail)

Notes

This lesson explores how maps have been used in navigation. Travelers collected observations to keep track of their positions and plotted this information on maps. Navigators and mapmakers devised maps for different needs, translating the three-dimensional globe onto flat maps, sometimes inventing projections with special characteristics.

Make a Mercator Projection has students make a close approximation of the most common projection in use today.

In the Wake of Lewis and Clark has students trace the route of this expedition and plan a trip that follows a part of this route.

Glossary—none

Answers to questions

Make a Mercator Projection

Procedure 14. The outlining of continents need be only as detailed as required to use the map for plotting a few routes. Columbus' route should go from south-western Spain to San Salvador in the Caribbean; that is, from latitude 37°N, longitude 7° W, to latitude 24° N, longitude 74°30'. From your hometown, plot a route to any point on the western coast of Africa. From Kuwait, plot an ocean route to Tokyo. You cannot plot polar explorations because polar areas are not shown on this projection.

Extension 1. To compare properties of projections, collect several maps and look on each for the name of the projection, usually in the lower right or left corner. Different publishers may prefer different projections.

In the Wake of Lewis and Clark

Procedure 3. To estimate how far students might be able to travel in a week, they must decide on a type of boat, estimate its speed and the number of hours a day they will travel. Obstacles include dams, other structures, and river traffic. Supplies can be purchased en route or cached ahead of time. Have students compare their lists of supplies with the list from Lewis and Clark's journal.

Responsibilities in the group might include leading, navigating, handling food, handling finances, keeping written records, taking photographs, conducting scientific investigations, etc. Costs might be paid by travelers themselves and their families or by a sponsoring organization that might want to dictate part of the purpose of the trip. Students might accomplish a variety of goals: documenting conditions along the route, following

the route and schedule of the original explorers as closely as possible, checking the explorers' celestial observations using today's tools, etc.

Information

Activities

On the Trail of Knowledge (plotting data on maps to see spatial relationships)

Maps With a Spin (making thematic maps that convey a message)

Notes

This lesson explores thematic maps: maps that show information on single topics. Characteristics of thematic maps are scale, context, and theme. The design of a thematic map considers the purpose of the map. A typical thematic map consists of a base map with selected spatial data plotted on it. A thematic map needs a descriptive title and an explanation. In plotting spatial data and making thematic maps, students will come to appreciate the diversity of information that can be shown on thematic maps.

On the Trail of Knowledge has students plot spatial data on a base map to see the information better. The students evaluate the data, plot points, and consider what the map shows.

Maps With a Spin has students use maps to present alternative proposals for the location of a new airport. Students gather data, make maps, and represent different points of view in a mock town meeting.

Glossary

base map: a map showing certain fundamental information on which can be compiled additional, specialized data.

compilation: production of a new map from existing maps, aerial photographs, and other sources.

context: the interrelated conditions in which something exists.

distortion: the lack of proper proportion; directions, shapes, distances, and sizes of areas may be shown inaccurately.

generalization: the simplification of data by eliminating unneeded detailed data.

grouping: the simplification of data by sorting data into similar sets.

isoline: a line through points of equal value.

map design: the choices made in creating a map; decisions are generally based on the maps purpose, intended audience, and characteristics of the spatial data.

orientation: alignment, usually in reference to points on the compass.

qualitative: related to quality or kind.

quantitative: related to quantity, value, or amount.

scale: the relationship of the size of a feature on a map to its size in reality.

> ***bar scale:*** scale shown by a line, which is labeled to represent a stated distance.
>
> ***representative fraction scale:*** scale indicated by a ratio of one unit on the map to some number of the same units on the ground, for example 1/24,000.
>
> ***verbal scale:*** scale indicated by a phrase such as "one inch represents one mile."
>
> ***large scale:*** good for showing detail in small areas.
>
> ***small scale:*** good for showing a general view of a large area.

spatial data: information pertaining to a place linked to coordinates or other positional information.

thematic map: a map designed to show information on a single topic.

Answers to questions

On the Trail of Knowledge

Instruction l. The lowest and highest magnitude values are 4.0 and 6.0 respectively. Mid-Atlantic earthquakes would be considered medium-magnitude.

Instruction 2. Symbols for plotting the data should be small, perhaps points. Earthquakes of magnitude 4, 5, and 6 might be shown in different colors.

Instruction 3. A descriptive title might be "Earthquakes of the Mid-Atlantic Ocean Floor, 1990." Thematic maps generally include the authors' names and the dates the map were made. A legend should include an example of each symbol used and an explanation of its meaning.

Instruction 4. The data plotted on this map reveal an S-shaped spatial pattern. Variations in magnitude seem to have a random pattern. The fact that two tsunami warning centers monitor the Pacific Ocean, while none monitors the Atlantic, indicates that magnitudes of earthquakes in the Pacific are expected to be much higher than those recorded in the Atlantic. (See the quotation from Magellan on the poster information.**)**

Maps With a Spin

Instruction 1. County and municipal governments may be good sources of data.

Instruction 2. Sort the data into categories defined by the class, such as economic data, transportation data, or land use data.

Instruction 4. In evaluating data, groups should look for data that relate to their interests—data that may support their point of view. Groups may want to keep their ideas and decisions secret from opposing groups.

Instruction 5. Final copies of materials for the town meeting should be neat and lettering should be large enough for presentation. Groups should plan their presentations: who will do what, when, where, and how. Arrangements for any special presentation plans (for example a slide presentation) should be coordinated with the moderator of the town meeting ahead of time.

Instruction 6. Before the town meeting, decide who will act as moderator. As the meeting begins, restate the time limits and the order of presentation. After presentations and rebuttals, vote to decide which plan the town should recommend to the voters. If time is left, evaluate the role of maps in the presentations.

Exploration

Activities

Mapping the Third Dimension (making and using a stereoscope)

The Landscape of a Novel (mapping imaginary spaces)

Notes

This lesson explores the use of stereoscopic techniques and concept mapping, two mapping developments in this century. Photogrammetry and remote sensing have become the foundation of modern mapping. Computerized data collection, data base management, and data analysis have eliminated many time-consuming mapping tasks and expanded the capabilities of cartographers. Mapping techniques are being used in new, nongeographic applications.

Mapping the Third Dimension has students make a stereoscope and use stereoscopic aerial photographs to see a three-dimensional image. Students make a map of the image they see.

The Landscape of a Novel has students map places described in a story. Students organize and map the data in categories (i.e., roads, buildings, streams, names) much as digital map data are manipulated. After mapping the geographic setting of the story, the class makes a concept map of the plot.

Glossary

concept map: a map-like illustration that shows relationships between concepts.

digital mapping: the making of maps using computerized data and procedures.

electromagnetic spectrum**:** the range of wavelengths or frequencies of electromagnetic radiation including gamma rays, visible light, and the longest radio waves.

image: likeness of an object or view; in remote sensing, a likeness

produced without photography using an electronic spectral sensor.

layer: in digital cartography, map data on a common theme manipulated separately from other types of data.

mosaic: a whole image or map made from parts from more than one source.

optics: the science that deals with light and closely associated phenomena.

perspective: the appearance to the eye of objects in respect to their relative distance and position; the technique of representing the spatial relationship of objects as they might appear to the eye.

positional accuracy: the accuracy of the location of a point.

remote sensing: the process of detecting and monitoring physical characteristics of an area by measuring its reflected and emitted radiation.

stereoscope: a device used to view overlapping photographs to obtain the mental impression of a three-dimensional image, or model.

Answers to questions

Mapping the Third Dimension

Instruction 4. The stereopair of photo-graphs shows a view of the Colorado River in the Grand Canyon. Cartographers would use information acquired from surveying to measure elevations and distances (i.e., scale). For making the topographic map from this image use the following dimensions: top of peak A, altitude 5,600 feet; point B on the river, altitude 2,700 feet; horizontal distance from B to C, 1,000 feet.

The Landscape of a Novel

Instruction 2. Clear plastic may be available from an art supply store. Handling different kinds of information separately (i.e., as layers) mimics the methods of digital mapping and allows the cartographer to make various maps from the information. In combining layers for a frontispiece map, some or all layers may be used.

Instruction 4. In concept mapping, there are no right or wrong connections. Concepts can appear in more than one place or be connected to more than one other concept.

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