

Investigation 5

Maps and Me

Authors

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Subject

Earth Science

Grade Level

Grades 5-8 (middle school benchmarks)

Driving Questions

How do different types of maps help us identify surface features of the Earth?

What conclusions can be drawn about the location of solid and liquid water on the Earth's surface?

Abstract

In the initial exploration phases of this investigation, students explore and gather data to answer the two driving questions. The first is addressed by students writing a definition of surface features, then brainstorming specific surface features and their locations. Next, students use a variety of maps to compare and contrast designated surface features. They use salt/flour “clay” to create models of an area with contrasting surface features. The second question is answered by using a variety of maps to locate where water is found on the Earth's surface, and what form the water is in (solid or liquid). By charting and graphing the data collected from maps, students will discover a relationship between elevation, latitude, and the form water is in. At the end of each initial exploration activity, students are given time to develop their own questions about the information on maps. Finally, students develop and do their own inquiry of a map-related topic.

Michigan Curriculum Framework Science Benchmarks

<http://www.miclimb.net/content/main.html>

Constructing New Scientific Knowledge Benchmarks:

I.1.M.1 Generate scientific questions about the world based on observation.

Key concepts: Scientific questions can be answered by gathering and analyzing evidence about the world.

Real-world contexts: Any in the sections on Using Scientific Knowledge.

I.1.M.2 Design and conduct scientific investigations.

Key concepts: The process of scientific investigations—test, fair test, hypothesis, theory, evidence, observations, measurements, data, conclusion. Forms for recording and reporting data—tables, graphs, journals. See C-I.1 m-3 (tools).

Real-world contexts: Any in the sections on Using Scientific Knowledge; also, recognizing differences between observations and inferences; recording observations and measurements of everyday phenomena.

I.1.M.3 Use tools and equipment appropriate to scientific investigations.

Tools: various data collection tools suitable for this level, including computers.

Real-world contexts: Any suggested in Using Scientific Knowledge benchmarks for which students would design and/or conduct investigations.

I.1.M.4 Use metric measurement devices to provide consistency in an investigation.

Key concepts: Documentation—laboratory instructions. Measurement units—milliliters, liters, millimeter, centimeter, meter, gram.

Measurement tools: Balancing devices, measuring tape, thermometer, graduated cylinder.

Real-world contexts: Conducting investigations, following or altering laboratory instructions for mixing chemicals.

I.1.M.5 Use sources of information in support of scientific investigations.

Tools: Periodicals, reference books, trade books, web sites, computer software; forms for presenting scientific information, such as figures, tables, graphs. See R-II.1 m-1 (evaluate strengths/weaknesses of claims).

Real-world contexts: Libraries, projects where research is needed.

I.1.M.6 Write and follow procedures in the form of step-by-step instructions, formulas, flow diagrams, and sketches.

Key Concepts: Purpose, procedure, observation, conclusion, data.

Real-world contexts: Listing or creating the directions for completing a task, reporting on investigations.

Reflecting on New Scientific Knowledge Benchmarks:

II.1.M.1 Evaluate the strengths and weaknesses of claims, arguments, or data.

Key concepts: Aspects of arguments, such as data, evidence, sampling, alternate explanation, conclusion; inference, observation.

Real-world contexts: Deciding between alternate explanations or plans for solving problems; evaluating advertising claims or cases made by interest groups; evaluating sources of references.

II.1.M.2 Describe limitations in personal knowledge.

Key concepts: recognizing degrees of confidence in ideas or knowledge from different sources, evaluating dates and sources of references.

Real-world contexts: Any in the sections on Using Scientific Knowledge.

II.1.M.3 Show how common themes of science, mathematics, and technology apply in real-world contexts.

Thematic ideas; Systems-subsystems, feedback models, mathematical constancy, scale, conservation, structure, function, adaptation.

Real-world contexts: Any in the sections on Using Scientific Knowledge.

II.1.M.4 Describe the advantages and risks of new technologies.

Key concepts: Risk, benefit, side effect, advantage, disadvantage.

Real-world contexts: Technological systems of manufacturing, transportation, energy distribution, housing medicine (such as cloning, genetic engineering).

II.1.M.5 Develop an awareness of and sensitivity to the natural world.

Key concepts: Appreciation of the balance of nature and the effects organisms have on each other, including the effects humans have on the natural world.

Real-world contexts: Any in the section on Using Scientific Knowledge appropriate to middle school.

II.1.M.6 Recognize the contributions made in science by cultures and individuals of diverse backgrounds.

Key concepts: Cultural contributions to science, contributions made by people of diverse backgrounds.

Real-world contexts: Biographies of minority and female scientists; histories of cultural contributions to science.

Using Earth Science Knowledge Benchmarks:

Geosphere V.1.M.1 Describe and identify surface features using maps.

Key concepts: Landforms—plains, deserts, plateaus, basin, Great Lakes, rivers, continental divide, mountains, mountain range, or mountain chain.

Tools: Maps—relief, topographic, elevation.

Real-world contexts: Maps showing continental and regional surface features, such as the Great Lakes or local topography.

Hydrosphere V.2.M.1 Use maps of the earth to locate water in its various forms and describe the conditions under which they exist.

Key concepts: Liquid water forms – lakes, rivers, oceans, springs. Frozen water forms –continental glacier, valley glacier, snow on mountains, polar cap. Gaseous water in atmosphere.

Tools: Relief and elevation maps; satellite images.

Real-world contexts: Local lakes, rivers, streams, ponds, springs; examples of frozen water, including snow, glaciers, icebergs, polar regions, frozen Great Lakes shorelines.

Big Ideas

Maps can help us describe and identify surface features of the earth. Maps can help us locate water in its various forms and the conditions under which they exist.

Prerequisites For Students

Students may need to be taught how to read topographic maps, including elevation markings, and how to find latitude and longitude on maps.

Estimated Time Needed

The amount of time needed for these investigations is flexible, depending on the extent of the investigations. Student Exploration activities 1 and 3 each require one class period. Activity 2 requires two class periods, with a couple days separating class period 1 and class period 2 for the clay to dry. The student investigation will take 2 class periods.

Background Information

Map skills can be taught in many ways. This Investigation introduces students to the use of maps through three teacher-directed activities and one inquiry of the students' devising. Additional lessons on the basics of map reading may be desired. Several such sources are listed in the Web sites below. The Web sites can also provide maps, although attention should be paid to the level of detail on maps printed out in the classroom: Make sure the information you desire from the map is readable for students.

Teacher Page 5-1 gives a sample of how a student group might fill out Student Page 5-1, involving investigation design. Teacher Page 5-2 is an example of a group's Research Methods. Teacher Page 5-3 gives an example of the group's Conclusion (Student Page 5-2). These are meant to be used as examples, not as instructions for any group's investigation.

Web sites to consider:

Maps printable by congressional district (not relief maps): <http://nationalatlas.gov> (The congressional district maps do not contain much information; however, this site contains many very interesting maps.)

<http://viz.globe.gov/viz-bin/home.cgi?l=en&b=g&rg=n>

Download-able topographic maps: <http://topozone.com/>

Links to many mapping topics:

<http://www.mhhe.com/earthsci/geography/campbell4e/intro4.mhtml>

Introducing topographic maps: guiding students from concrete models to graphic representations: a set of lessons: http://www2.una.edu/geography/statedepted/lessons/intro_topo/topo.html

Teaching with topographic maps: 25 educational lessons:

<http://rockyweb.cr.usgs.gov/public/outreach/topoteach.html>

The National Map: <http://mapping.usgs.gov>

Also, this publication: Van Burgh, Dana, Lyons, Elizabeth, and Marcy Boyington. *How To Teach With Topographic Maps*. Arlington, VA: National Science Teachers Association, 1994, 1998.

Materials List

For the class

Raised relief maps

GIS (optional)

Topographic maps

Graph paper

Maps showing the following local and regional surface features: Great Lakes, local topography

Rulers

Maps showing the following global surface features: continents, ocean floors

Markers or colored pencils

For each student group

One of the above maps
 5-10 cups of flour
 5-10 cups of salt
 water
 measuring cups or beakers
 1 dishpan or large bowl (for mixing)
 1 spoon or other stirrer
 Tempera paints (brown, green, and blue)

Paint brushes
 1 large piece of cardboard with wax paper
 taped to it
 Glue stick

Recipe for flour/salt clay:

1 part salt
 1 part flour
 2/3 parts water

Have each student group make a batch of this in Part 6 of Section 1. This recipe is soft and dries ready for painting in 1 to 2 days. If you want something more durable, use the same recipe, but with one part water. This takes longer to dry, and must be added in layers.

Advance Preparation

Collect several copies of many types of map.

Procedure

Part 1: Student ExplorationActivity 1: Describing surface features by using map information

1. Break the class into small groups.
2. Give each student group one type of map (i.e., satellite imaging, topographical, physical and relief). Have students look over the map and figure out what their map shows, how it is shown, and one unique feature of their map.
3. Tell each group to hold up its map and report these findings to the class. For example, the group with a global map showing the continents and ocean floors may say, "Our map shows all the land in the world, including the land under the oceans. It is shown by a drawing of the high and low places, and smooth and bumpy places on the earth. The unique thing about our map is that it shows what the land at the bottom of the oceans looks like."
4. Write this question on the board, "How do different types of maps help us to identify surface features of the Earth?" Have each student write her or his personal definition of "surface features."
5. Have students share their definitions. Through discussion, come together in agreement on one common definition of surface features. Be sure that the final definition includes both features below sea level (ocean floor features) and above sea level (continental features).
6. In their small groups, have students examine their maps and list five specific surface features and their locations. They may use any means of describing location that they want. (Locations of large surface features like the Great Lakes or a mountain range are hard to

describe with one latitude/longitude coordinate, but they could describe a mountain range, for example, with coordinates of both ends. They might also describe an extended surface feature in the U.S. by stating the regions of various states that it spans, such as, for example, the northeast corner of Colorado.)

7. Have each group choose a pair of very different surface features from their brainstorm list. These pairs must be on the group's map. Examples are a particular mountain chain, and a particular ocean trench; a particular mountain and a particular low valley; a polar ice cap and a desert. On the board, list all the pairs and the type of map on which they were observed.
8. Have each group create a data collection page for each pair of contrasting surface features listed on the board. Have them draw a line down the middle of each page, and write the name of each contrasting surface feature at the top of each column. Under each surface feature, they will write down what kind of map the group has. They may staple the set of data collection pages together, and write their group members' names on top of the first page.
9. Have each group start with its own pair of contrasting surface features and their own map. Under each surface feature, they are to write all the information that their map provides them about these two features. Circulate at this time and help student groups interpret their maps.
10. Have each group rotate to a nearby group's map, and again write all the information that this map provides about these two features. Have groups continue to rotate until they have filled out all of their data collection pages, and have returned to their original map.
11. In a whole class discussion, ask students to tell what kinds of information they were able to get from different maps. Ask them to explain why we use different kinds of maps (to get different kinds of information.)

Activity 2: Making a model of surface features

1. Ask each group to find a portion of their map that contains several contrasting surface features. Each small group will create a "clay" painted model of this specific area/region showing the contrasting features and other features. They are to start with their map for the information needed, but may use other maps, too. Models may include plains, deserts, plateaus, basins, the Great Lakes, the Continental Divide, a mountain range, a mountain chain, oceans trenches, and other features.
2. Have each group decide exactly what geographic area they will be re-creating with clay.
3. Have each group make up their "clay" at the beginning of the class, using the recipe in the "Materials Needed" section. Then give each group a large piece of wax paper that has been taped to a piece of cardboard.
4. Encourage students to use more than one map of the area they are modeling if possible – different maps give different kinds of information. Ask them to think about how these different types of information can be explained to the class – either by the shape of the clay,

the color of the clay, or things said when the model is presented to the class. If desired, students can create small labels of certain features and glue them directly to the models with glue sticks after models are painted and the paint has dried.

5. Let clay models dry for one to three days, depending on the clay and drying conditions. Make sure groups have a plan as to how to use color to make their models convey additional information. Then allow groups to paint their models with tempera paints. When the paint has dried, they may add labels with a glue stick.
6. After the paint has dried, each group of students will present its model to the class. In their presentations, students will describe in detail the characteristics of the surface features of their model and compare their model to the maps they used.
7. Questions to be asked of each student group may include:
 - What information does your model give us that a flat map does not?
 - What maps did you use to make your model?
 - Are any of the surface features you included in your model ones we can see examples of in our area?
 - How could your model be made “to scale”?

Questions to be discussed by the whole class may include the following:

- Is one type of map better than another?
 - Why have different types of maps?
 - How is the way a surface feature looks on a model different from the way it looks to us in real life?
 - How is a surface feature in a model different than a surface feature on a map?
 - Give some examples of when surface features are important to us in daily life.
8. Ask students to generate new questions about maps, questions that may have come up while they worked with various types of maps. Student questions may include:
 - What percentage on a map is water and how much is land?
 - What percent of Michigan is forests?
 - Are any two continents pretty much the same?
 - Why aren't all maps in color?
 - How can a farmer make use of a map to aid in farming?
 - I love to fish. How can a map help me to increase my catch rate?
 - What is the shortest distance by car between points A and B?

Activity 3: Where can we find solid water on the Earth's surface?

1. Tell students you will all be investigating the question, “Where can we find solid water on the earth's surface?” Ask them to suggest what “solid water” is like when it is on the Earth's surface (snow coverings, glaciers, ice on lakes, polar ice caps).
2. Ask each group to write down a group prediction as to where solid water is found on earth, as opposed to where liquid water and gaseous water are found on earth. (Predictions usually

include the northern latitudes, such as Alaska or the North Pole. Equally high southern latitudes also have snow and ice coverings. What students generally don't consider at this point is that glaciers are also present on the tops of mountains at any latitudes – even Mauna Loa in Hawaii has a snow covering in the winter.)

3. Again, have each student group surround a different type of map. These maps need to have either elevation (altitude) markings or latitude markings.
4. Explain that the group is to design a data table that compares ten locations of water on the earth (by elevation and latitude), and the state of matter that the water is in at these locations (solid or liquid; we will not include gaseous water, as it is present everywhere in the atmosphere). Ask them to find at least 5 locations of solid water and 5 of liquid water.
5. Have students find locations of solid and liquid water and record those locations on their data tables. They may need to use more than one map to collect the data.
6. Ask students to make a graph from their data. Let them try different ways of representing the data. One way to do it is to use latitude as the X axis, and elevation (altitude) as the Y axis, and use two colors of markers to mark what state of water is found at each elevation that the group investigated (red for solid, blue for liquid, for example). A similar graph could be made with latitude figures as the Y axis. Students may have other ideas of ways to display their data. This is fine, too.
7. Have groups discuss whether they see any trends in their data, either from the data tables they used or their graphs. Have each group discuss its conclusion. Help them recognize invalid conclusions.

Students should conclude that water in its solid state is found at higher elevations and higher latitudes. Water in its liquid state is found at lower elevations and lower latitudes. Glaciers can be found at lower latitudes if they are at higher elevations.

8. Have each student group explain its charts or graphs and conclusion to the class. When all classes have finished the activity, post student work where all can see them.

End of Student Exploration Activities

Part 2: Question to Investigate

1. Have each student choose or develop a question that they can investigate using the maps available in the classroom. They can choose a question that has been recorded during the previous days of map study. If multiple students have similar questions, they can work together as a group.
2. Have each student or each group write down a clear statement of their question on Student Page 5-1, Investigation Design, along with any background information that they already know about their question.

Part 3: Method for Gathering Data

1. Have each student or group determine how they can either calculate or observe the information they need. They should draw on their previous experiences with maps.
2. Each group should record its method, along with the type of data they expect to gather, on Student Page 5-1. Type of data can include latitude, longitude, surface area, elevation, temperature, etc. as determined by the question they are investigating.

Part 4: Hypothesis or Prediction

1. Ask each student or group to make a prediction about what they will find. This will be their hypothesis. Record the hypothesis on Student Page 5-1.

Part 5: Research Details

1. On a separate piece of paper, have students write all the details of how they will conduct their investigation. They should title this page “Research Methods.”

Part 6: Data Collection

1. Students should develop a data collection form appropriate for the information they wish to collect, and some sort of measurement unit for what they will collect. Circulate through the room as students are designing the data collection forms and offer assistance. Often, a simple chart works best.
2. Have students do their investigations and collect their data on the forms they have designed.

Part 7: Data Analysis, Use and Communication of Results

1. Ask students if a graphic representation of their data (a map, a chart, a bar graph, a line graph, a pie chart or a labeled diagram) might help them and others better interpret their results. If so, have groups develop the appropriate graphic representation: a chart, map, line graph, bar graph, or diagram explaining the results.
2. Ask each group to consider its data, both in list form and in graphic form, and draw a conclusion about whether its hypothesis is supported by the data.
3. Have each group complete Student Page 5-2. The various parts of a formal conclusion are listed on this page. You may want to write them on the board and discuss what each requires.
4. Have each group or individual present its question, hypothesis, research methods, graphic representation of data, and conclusion to the class. Every group member should have a part in the presentation. Presentations should include these parts (write them on the board):
 - The group’s question

- The full hypothesis
 - The research methods
 - The data, presented as graphs, charts, or drawings
 - The conclusion
 - Participation by each group member
5. Have students turn in all Student Pages, the Research Methods, and the graphic representations of data for assessment purposes. If you wish, you may have groups and individuals put these together on poster board as a display that can be set up where others in the school can see it.

Part 8: Guided Questions for Reflection

1. Questions such as these can be asked of individual students, student groups, and the whole class:
- What does the thing you found out have to do with everyday life?
 - What kinds of information can maps give us?
 - Do maps always give us the information we expect?

Part 9: Student questions for additional inquiry

1. Ask students to list further questions they have, and how they might determine the answers to these questions. As time permits, let them perform these subsequent investigations.

Assessment

Group assessment can be done by ranking proficiency in each of the parts of the final presentation: the hypothesis, the Investigation Design page, the step-by-step Research Methods, the graphic presentation of the data collected, the conclusion, and, finally, the participation of all members. Individual assessments can be done by interviewing individual students about their group's project and assessing their understanding of what the group did and why it was done. If desired, you may require each student fill out their own copy of the Student Pages.

Names _____

Investigation Design

1. What is our question?

2. What do we know? (about our question)

3. What will we do? (to answer our question – what is our data gathering method?)

4. What data will we collect?

5. What is our hypothesis?

Names _____

Conclusion

Answer all of these questions in your conclusion:

1. What was the purpose of the investigation?
2. What did you find out?
3. Was the hypothesis supported by the data?
4. How does what you found out compare with what other researchers have found out?
5. How can you explain what you found out?
6. What else would you like to do with this investigation, and how would you make it better?

Names (Sample Student Responses)

Investigation Design

1. What is our question:

How much of Michigan is covered by forests?

2. What do we know:

I know I see a lot of forests when I drive around Michigan, especially when we go up north in the summer. But I see none where I live.

I know that a map I once saw showed a lot of green on it. Maybe this means forests.

There are less forests where there are a lot of people, like in Detroit and Grand Rapids.

Forests are homes for lots of animals.

There is a US Forest Service.

Some forests are owned by families. Some are owned by the government.

Forests do not cover the whole area of Michigan.

You could see forests from an airplane.

3. What will we do? (to gather data)

Get airplane or satellite maps of Michigan.

Talk to the US Forest Service.

Look up forests in Michigan on the Internet.

Use map web sites that the teacher has.

Look at lots of different kinds of maps.

4. What data will we collect?

We will measure the square miles of forests in the state.

5. I predict (my hypothesis is):

That 2% of Michigan is covered by forests.

(Sample Student Responses)

Research Methods

1. Find a map that shows a photo of Michigan from the sky.
2. Determine how to tell what forests look like on the map.
3. Measure the size of Michigan on the map using a ruler and calculating area.
4. Measure the size of the parts of Michigan covered by forests on the map, using a ruler and calculating area.
5. Calculate what proportion of Michigan is covered by forests.

(Sample Student Responses)

Conclusion

Answer all of these questions in your conclusion:

1. What was the purpose of the investigation?
2. What did you find out?
3. Was the hypothesis supported by the data?
4. How does what you found out compare with what other researchers have found out?
5. How can you explain what you found out?
6. What else would you like to do with this investigation, and how would you make it better?

My conclusion is:

The purpose of my investigation was to find out how much of Michigan is covered by forests. I found that about half of Michigan is covered by forests. The hypothesis that 2% of Michigan is covered by forests was not supported by the data.

Internet research showed me that other researchers have found Michigan to be about 50% covered by forests, too. The percentage of Michigan covered by forests is bigger than I thought because the way things seem on the ground from where I live and where I've visited are sometimes different than the way things really are as shown on maps. Now I would like to find out where most of these forests are.

I would use a grid system instead of a ruler to figure out areas, because it was very hard to figure out the measurements of patches of forest on the map, and I was worried it was not very accurate.