Ohio's Systemic Initiative
Discovery

Finding Areas Using Maps

One-Page Overview

By Robert B. Brown, The Ohio State University

Topics:

Geometry, Measurement, Mathematics as Communication

Levels:

Grades 6 – 9

Problem:

Find the area of the feature using the map and the scale of the map.

Getting Started:

Take a map that includes some geographical feature, such as a lake or forest. Ask students to find the area of the feature using the map and the scale of the map.

Ohio Academic Content Standards, 2002

5-7		8-10		11-12	
1. Number, Number Sense and Operations	x	1. Number, Number Sense and Operations		1. Number, Number Sense and Operations	
2. Measurement	X	2. Measurement	X	2. Measurement	
3. Geometry and Spatial Sense	X	3. Geometry and Spatial Sense	X	3. Geometry and Spatial Sense	
4. Patterns, Functions and Algebra		4. Patterns, Functions and Algebra		4. Patterns, Functions and Algebra	
5. Data Analysis and Probability		5. Data Analysis and Probability		5. Data Analysis and Probability	
Mathematical Processes Communication Connections		**Mathematical Processes** Communication Connections		**Mathematical Processes**	

NCTM Principles and Standards, 2000

6-8		9-12	
1. Number and Operations		1. Number and Operations	
2. Algebra		2. Algebra	
3. Geometry	X	3. Geometry	X
4. Measurement	X	4. Measurement	X
5. Data Analysis and Probability		5. Data Analysis and Probability	
6. Problem Solving		6. Problem Solving	
7. Reasoning and Proof		7. Reasoning and Proof	
8. Communication	X	8. Communication	X
9. Connections	X	9. Connections	X
10.Representation		10.Representation	

Note: Capital X denotes major emphasis; lower case x denotes minor emphasis.

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Finding Areas Using Maps

By Robert B. Brown, The Ohio State University

Topics: Geometry, Measurement, Mathematics as communication	
Levels: Grades 6 – 9	*Timing:* One hour
Materials: Maps	*Prerequisites:* Experience with areas of simple geometric figures

Problem:

Find the area of the feature using the map and the scale of the map.

Goals:

- Appreciation of what area means
- Relationship between lengths and areas
- Effects on areas of uniformly reducing or magnifying lengths by a fixed ratio

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Procedure:

1. Take a map that includes some geographical feature, such as a lake or forest.
2. Ask each group of students to estimate the area of the feature using the map and the scale of the map.
3. Have each group report its estimate and more importantly how they arrived at it.
4. Discuss the possible sources of differences between the estimates from the different groups.
5. Discuss what features of the maps aid or hinder making the estimates.

6. How could students estimate the range of the possible error of their estimate, without knowing what the true area is? See if they can arrive at the following ideas. If you count unit squares which are completely inside the outline of the feature, you probably get an estimate which is too small. On the other hand, if you completely cover the feature with unit squares, some of the squares will also cover bits which are outside the feature and the estimate will be too large. The "true area" will be somewhere in between the small and the large estimates.
7. Discuss whether you would you get a better or worse estimate by using smaller squares.
8. Have each group of students use squares that have sides half the length of their original squares, and find the area again, again estimating the error as well. If the students understand the "small" and "large" estimates from point 6 above, they may see that the area gap between the two estimates is smaller when they use smaller squares. Of course, the number of squares in the "gap" may be larger, but the actual combined area of the gap should be smaller.
9. Have the class as a whole discuss their results.
10. Discuss whether it would be meaningful for the class as a whole to use all of the estimates produced so far to come up with an overall best estimate of the area. If they think it would be worthwhile, have them decide on such a best estimate.

Mathematics:

Basically, finding the areas of irregular figures amounts to approximating the figure with non-overlapping unit squares and counting the number of squares that it takes. This count gives the approximate number of square units that is the area.

To get a more accurate estimation of the area, use smaller squares of a known size and again count them.

Ultimately this process leads to the use of smaller and smaller squares and the notion of limit, one of the central ideas of calculus. However, without even mentioning calculus, the students can discuss whether using smaller and smaller squares should lead to more accurate estimations of the area.

Relationships to the Ohio Academic Content Standards, 2002:

Grades 5-7:

Number, Number Sense and Operations Standard
The student will be able to…

- Use a variety of strategies, including proportional reasoning, to estimate, compute, solve and explain solutions to problems involving integers, fractions, decimals and percents.

Measurement Standard
The student will be able to…

- Use problem solving techniques and technology as needed to solve problems involving length, weight, perimeter, area, volume, time and temperature.
- Identify appropriate tools and apply appropriate techniques for measuring angles, perimeter or circumference and area of triangles, quadrilaterals, circles and composite shapes, and surface area and volume of prisms and cylinders.

Geometry and Spatial Sense Standard
The student will be able to…

- Apply properties of equality and proportionality to solve problems involving congruent or similar figures; e.g., create a scale drawing.

Mathematical Processes Standard
The student will be able to…

- Communicate mathematical thinking to others and analyze the mathematical thinking and strategies of others.
- Relate mathematical ideas to one another and to other content areas; e.g., use area models for adding fractions, interpret graphs in reading, science and social studies.

Grades 8-10:

Measurement Standard
The student will be able to…

- Estimate and compute various attributes, including length, angle measure, area, surface area and volume, to a specified level of precision.

Geometry and Spatial Sense Standard
The student will be able to…

- Use coordinate geometry to represent and examine the properties of geometric figures.
- Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools, such as straightedge, compass and technology.

Mathematical Processes Standard

The student will be able to…

- Locate and interpret mathematical information accurately, and communicate ideas, processes and solutions in a complete and easily understood manner.
- Apply mathematical knowledge and skills routinely in other content areas and practical situations.

Relationships to the NCTM Principles and Standards, 2000:

Grades 6-8 and Grades 9-12:

Geometry Standard

Instructional programs from pre-kindergarten through grade 12 should enable all students to…

- Analyze characteristics and properties of two- and three-dimensional geometric shapes and develop mathematical arguments about geometric relationships.
- Specify locations and describe spatial relationships using coordinate geometry and other representational systems.

Measurement Standard

Instructional programs from pre-kindergarten through grade 12 should enable all students to…

- Understand measurable attributes of objects and the units, systems, and processes of measurement.
- Apply appropriate techniques, tools, and formulas to determine measurements.

Communication Standard

Instructional programs from pre-kindergarten through grade 12 should enable all students to…

- Organize and consolidate their mathematical thinking through communication.
- Communicate their mathematical thinking coherently and clearly to peers, teachers, and others.

Connections Standard

Instructional programs from pre-kindergarten through grade 12 should enable all students to…

- Recognize and apply mathematics in contexts outside of mathematics.