Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
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# A Mathematical Look at Connecticut's Geological Environmental

Curriculum Unit 95.05.10
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## Mathematical Concentration

The following statement by the Mathematical Science Education Board as recorded in *Everybody Counts* .

> "Effective teachers are those who can stimulated students to learn mathematics. Educational research offers compelling evidence that students learn mathematics well only when they construct their own mathematical understanding. To understand what they learn, they must enact for themselves verbs that permanent the mathematics curriculum: "examine," "represent," "transform," "solve," "apply," "prove," "communicate." This happens most readily when presentations, and in other ways takes charge of their own learning.

This curriculum may establish such a community of learners in the classroom. The actual mathematics in this curriculum is not as important as the instructional strategies such as communicating through writing or speaking, using manipulative, working in cooperative groups, and alternative forms of assessment.

Maps and scale drawings are used in everyday life and mathematics. This curriculum is for students to explore distance and angle measurement and the concept of reading and making maps. Students will be actively engaged in the process of learning as they work in group and individual settings. Students are asked to apply their learning is situations that will require an understanding of the concept of proportionality as it applies to measurement.

This method of instruction may be quite different than methods previously experienced by some students. The purpose of this curriculum is to introduce or reaffirm the instructional strategy and classroom practices used throughout this lesson. In other words, it sets the tone for this study of mathematics for the entire curriculum.

Please note that many of the activities in these lessons have more than one task. These multiple tasks provide flexibility for the teacher.

Although this is an introductory curriculum, you do not need to confine the tasks to the first lesson. You may reaffirm a certain instructional strategy or classroom practice at anytime during the activity. For example, you may wish to complete a cooperative learning activity after a vacation to reestablish the proper atmosphere for learning groups.

In this curriculum, students experience the concepts of scale, similarity, proportional reasoning, and basic

geometric constructions. They read and construct different kinds of maps and scale drawings, which call for multiple representations of geometric and numerical data. They become familiar with similar figures by observing patterns and making generalizations. They explore the idea of a path, both in the field and on paper, and estimate both linear and angular measurements in the process of creating paths. They bisect angles, copy angles, and construct triangles using a compass. The coherent mathematical idea underlying this curriculum is the study and application of proportional relationships.

The tasks required in this curriculum are accessible for all students. In order to have success in this unit, students should have had an introduction to distance and angle measure. The unit will flow more smoothly if the students have worked in cooperative groups, used a compass and protractor, communicated mathematical ideas through writing, speaking, and modeling and used technological tools such as calculators and computers. Some students may have had prior experiences in mathematics that they will find valuable in completing the lessons, such as making conjectures, designing maps, and preparing reports. If a significant number of students have not had these experiences, it may be necessary to take additional time to provide them.

Working in groups, students use pattern blocks to create a map of Faulkner's Island and mark a Wildlife refuge. They indicate the direction and number of units for each move. They look for the best location to locate the Reseate Tern nesting site.

Cooperative groups play an important role in this curriculum. Students interact and work in small groups throughout each of the lessons. Team building and working together are important skills students will need and use in life beyond school. For some students, working with others will be a new experience. Some care will need to be taken to help students develop the skill of collaboration and respect of the ideas of others. Working in pairs is often a good introduction to working with others. Later, pairs can join with other pairs to make groups of four.

When students are working in groups, sharing and listening to others becomes the key to successful mathematical decision making. Your role should be that of a facilitator. Your job includes careful listening and effective questioning to help students stay on or get themselves back on track. Each student should also have a role in the group such as recorder or materials manager so that he or she becomes responsible for his or her own learning. Student roles should change so that each group member has opportunity to fill each role.

Finally, it is important to discuss, either verbally or in writing, how the group has functioned. Questions such as "In what ways did your group work well together?", "Was everyone in the group given the effectiveness of the group and where improvements need to be made."

Assessment is a part of each lesson. It is important that students know up front the criteria on which they will be assessed, as well as how much time they will have to complete the task. Students should be graded on their products. Due dates should be set and expected to be met.

When student work is turned in, it should be assessed on its quality. Students may revise work not meeting acceptable standards. Generally, four categories of evaluation should be used Well Done, Acceptable, Revisions Needed, and Re-Start. You may want to allow students to create their own class assessment. These assessment can serve as an excellent self-assessment tool.

There is no set grading system you should use for this curriculum. The philosophy of this curriculum is to have students show their knowledge learned in the lessons by using different types of formal assessment. The

following are same examples of grading.

1. Students work in groups, using the mathematics they have learned to make a group presentation.
2. Each student produces a written product to show his or her knowledge of the material. This is the most important part of the assessment of the curriculum.

Homework is an important part or this curriculum. The homework assignments are not routine exercises imitating work done in class. Rather, they are activities that may take a number of days to complete. These assignments may be research oriented, project based, reflective and analytical in nature. Homework is design to extend the class work with meaningful mathematics. New and original ideas may be a product of these assignments. Homework is introduced in class, but the investigations require work outside of the classroom.

A journal is a written account that a student keeps to record what he or she had learned. Journal entries are conducive to thinking about why something has been done. They can be used to record and summarize key topics studied, the student's feelings toward mathematics, accomplishments or frustrations in solving a particular problem or studying a particular topic, or any other notes or comments the student wishes to make. Keeping a mathematical journal can be helpful in students' development of a reflective and introspective point of view. It also encourages students to have a more thoughtful attitude toward written work and should be instrumental in helping students learn more mathematics. Journals are also an excellent way for students to practice and improve their writing skills.

A portfolio is a representative sample of a student's work that is collected over a period of time. The selection of work samples for a portfolio should be done with an eye toward presenting a balanced portrait of a student's achievements. The pieces of work placed in a portfolio should have more significance than other work a student has done. They are chosen as illustrations of a student's best work at a particular point in time. Thus, the range of items selected shows a student's intellectual growth in mathematics over time.

You may wish to have all students include the products of group presentation, and written product in their portfolios. Students should also select the products of at least two additional lessons for inclusion. Bear in mind that the actual selection of the items by the students will tell you what pieces of work the students think are significant. In addition, students should reflect upon their selections by explaining why each particular work was chosen.

The following examples illustrate topics that would be appropriate for inclusion in a portfolio.

a solution to a difficult or non routine problem that shows originality of thought

a written report of an individual project or investigation

examples of problems or conjectures formulated by the student

mathematical art work, charts, or graphs

a student's contribution to a group report

a photo or sketch of physical models or manipulative

statements on mathematical disposition, such as motivation, curiosity, and self-confidence

a first and final draft of a piece of work that shows student growth

## EROSION

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To demonstrate how rain effects topsoil at Faulker's Island, in Connecticut

*Materials:*

Dirt, red powdered tempers paint, measuring spoon, teaspoon (5 ml), funnel, coffee filter paper, wide-mouthed jar, 1 qt (1 liter) measuring cup (250 ml), stirring spoon.

*Procedure:*

Add 1/4 teaspoon (1.25 ml) of red tempera paint to 1/4 cup (75 ml) of dirt. Mix

Set the funnel in the jar

Place the coffee filter inside the funnel

Pour the colored sand into the paper filter

Add 1/4 cup (75 ml) of water to the funnel

Observe the water dripping into the jar

Pour this water out of the jar and add another 1/4 (75 ml) of water to the funnel

*Results:*

The liquid dripping from the funnel is red.

The red paint represents nutrients in topsoil that is soluble in water. Nutrients dissolve in rain water and feed the plants growing in the soil. If the rain is too heavy, the water runs across the soil, taking the dissolved nutrients with it. Excessive rains can leave the topsoil lacking in necessary nutrients.

This lesson is user friendly and interactive. It keeps students involved by asking questions as a concept is being developed. In addition, these questions provide an ongoing assessment of students' understanding. When appropriate, this section may also contain one or more worked out examples to which students can refer when they on their own.

*Assessment:*

This lesson allow students to solve problems independently and to gauge their own understanding of the concepts learned in the lesson.

Open-ended problems require students to write clear, organized solutions to complex, multi-step problems. Students must explain how they arrive at conclusions and may receive full or partial credit based on the quality of their response.

## Island Models

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*Purpose:*

Islands are structures having a great variety of features. One of the best ways to show these features is by the use of a contour map. A contour map is a model of a given section of land that uses lines to show constant heights above sea level. These lines show the pattern of heights for an Island as it rises above sea level. First make a clay model of an Island rising out the ocean. Then you will construct a contour map from this model. Finally, you will compare the contour map with the original Island model.

*Procedure*

A. Materials: Modeling clay (four colors, nondrying), flour, plastic knife, pencil paper
B. Flatten a piece of clay of one color into a smooth, flat sheet about 1 cm thick and measuring about 10 cm an each side. Sprinkle some flour on the table where your are working to keep the clay from sticking to it. Flatten the other three colors into similar sheets. Stack the four sheets of clay one on top of the other. Sprinkle the surface of each sheet with some flour to keep it from sticking to the other.
C. Carefully curve the stack of sheets into an island. Keep the trimmings together by color, as best as you can, so the clay can be used again. Make one side of your island a steep cliff the opposite side should slope more gradually to the sea. Use your fingers to help shape the island to make it look natural.
D. Now place the island near the middle of a sheet of paper. Push a pencil, point down, through the center of the mountain and twist the pencil once or twice to make a mark on the paper underneath. Remove the pencil. Then lightly trace around the base of your island with the pencil. Peel off the bottom layer and place the remainder of the island inside the first drawing. Look down through the hole you made in the island to make sure it is lined up with the mark on the paper. Trace around the remainder of the island again. Repeat this procedure until all layers have been erosion traced. The flat peak of your island represents the top of the last layer. Place a dot on the paper to represent the flat peak of your island. You now have a contour map of your island.
E. Rebuild your clay island by putting the layers together as they were in the beginning. Using the clay model and the contour map of the model, answer the following questions in the manner directed by your teacher.

1. If each layer represented 50 meters in height, how high would the peak of your island be?
2. Looking at your contour map, what increase in height up the island does each line represent? This increase is called the contour interval.
3. On the map, how can you tell which side of the island has the most erosion?
4. On the map, how can you tell which side has the gradual slope to the sea?
5. What shape do the contour lines have which show the presence of a valley?

6. What shape do the contour lines have which show the presence of a ridge?

*Summary:*

In your own words, compare a contour map to the island features which the contour lines show.

Faulkner's Island, located 3 miles south of Guilford Connecticut, was formed by retreating glaciers. At present it has not been determined whether it was created during the retreat of the Wisconsin glacier or the earlier Illinois glacier. The island, approximately 40 feet high, is approximately 1400 feet long and 250 feet wide at its widest point. It is a drumlin composed of unconsolidated glacial sediments (Till) which are clearly seen along the steep sloping sides of the island. *Faulkner's Island Research Projec* t.

(figure availabe in print form)

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## Fantasy Island

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In this lesson, students draw an island to be used to be used as a game board. They identify directions and label landmarks. They select a random length to represent one unit of measure. North is designated as 0 degree on the protractor for the first move. Players are to move around the game board until all landmarks have been visited. A player moves by estimating the number of units and direction to one of the landmarks. A protractor is used to measure angles and a unit ruler designed for the game is used to measure lengths. The goal is to visit all the landmarks and return to the starting paint in the fewest number of moves. Students explain their strategies for choosing a large or small unit of measure and how the strategy would change if the unit of measure was greatly increased or decreased.

## Mathematical Overview

This lesson involves estimation, linear measurement, angle measurement, spatial visualization, and the use of number. Students estimate linear measurement from a scale on the map and the angle measurement of turns. They make ruler also indicates fractional parts of the unit being used. They plot the estimated distances and turns on the game board map.

## Lesson Summary

Students work in groups to design an island with at least six landmarks. They indicate a starting point on the map and a unit of linear measure with a key at the base of the map. The map is used as a game board. The game involves estimating linear measurement and angle of turn to trace a path around the island, visiting each of the landmarks, and returning to the starting point. The groups then analyze the strategies they used in preparing the map scale and in playing the game.

*Procedure*

1. Setup: Cooperative groups-Each group will need Group card, Rule Card, poster board, a coin, a straightedge, and a protractor.
2. Implementation: Introduce the lesson to the students. Point out that the rules for the game are on the Rule Card. Make sure students understand how to measure the angle of turn. You may want to suggest path. Point out that the direction the person face before turning is considered 0 degree ; the angle of turn is the turn they make to face the new direction. Some students may indicate the direction of the turn using words like “turn right 50 degree” while other may use compass directions, as in “turn southeast 50 degree.” Students work in their groups to create a map. Then they exchange maps with another group and play the game on the map. After playing the game, they analyze their strategies.

   You may want to ask students to repeat this lesson several times by changing the unit of linear measurement used. This requires students to adjust their estimates of lengths. You could also require them to visit the landmarks in the opposite order.
3. Processing the Lesson

   Lead a discussion about the lesson. A few questions may be useful in stimulating discussion.

   “What strategies for estimating lengths were most useful?”

   “Did a larger or smaller unit of measure change the strategy you used to play the game?”

   “What strategies did you use for estimating the angle of turn?”

   “How could you estimate direction changes for a real-life path?”

*Journal Prompts*

The following journal prompts may be used with this lesson.
"The mathematics I used in this lesson included. . ."
"Would a long or a short unit of measure result in more accurate estimates? Explain?

*Answers*

There is no single correct answer for this lesson. However, students should be able to make a convincing argument to support their conclusions.

## Rule Card

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*Rules of the Game*

The object of the game is to move around the game board until all landmarks have been visited. You may visit the landmarks in any order. The game ends when you return to the starting point. Here's how to play the game.

As a group, determine who will go first and the order the rest of the players will go. A player begins by estimating the number of unit and the direction of movement to reach a landmark. (To estimate how far to go, use the unit scale from the map. To indicate directions, use angle measures.)

Record your distance estimate and estimate of angle of turn. Then use a straightedge to draw a line in the direction of the turn from the starting point. On the first move, consider a move directly north to be a 0 degree move. On subsequent moves, consider the previous line of direction to be the 0 degree line from the end of the previous line.

You might want to imagine yourself walking the path. The angle of turn is the number of you would turn to face the new direction, for example, 45 degrees right.

You can make a special ruler for each game using the unit length from the map. After you have estimated the length and drawn a direction line, use the ruler to make the estimated length on the map.

Continue until you reach the landmark. Then repeat the process to get to the next land mark.

The player who visits all the landmarks and returns home in the fewest numbers of moves is the winner.

## Group Card

Imagine that your ship sank and you are marooned on an island.

Draw a map of your island on a piece of poster board.

Identify the directions north, south, east, and west on the map.

Use a coin to draw circles representing at least six landmarks on your island. Label the landmarks.

Draw a length at the bottom of the map to represent one unit of measure. Label the scale of the map.

Your map will be a game board. Mark a starting place somewhere on the map. The object of the game will be to move around the game board until all landmarks have been visited.

Play the game on your game board. Use the rules for the game that your teacher will give you.

When you have finished the game, complete the followings.

Describe your strategy for estimating the distance and angle of movement.

Explain your reason for choosing a large or small distance to represent one unit. Describe how using a much larger or much smaller unit of measure would change the strategy you used to play the game.

## Location Map

(figure availabe in print form)

## Group Investigation

**Mathematical Overview**

In this lesson, students explore angle measure and distance from one point to another. The use known measures like 360 degree and 90 degree and manipulates the pattern blocks in order to find the measure of angles in pattern block shapes. They will use reasoning like the following: since there are 360 degree in circle and six triangles can fit together to fill a circle at the center, each angle of the hexagon block must be 60 degree. They will use those measures to give instructions reading direction. They will note the relationships among the lengths of the sides of the blocks, and use the information for giving length instructions.

**Lesson Summary**

This lesson involves concepts from the entire curriculum and prepares students for work on the individual investigation. Using their knowledge of distance and angle measurement, they create a wildlife refuge for the endangered Roseate Tern on Faulkner Island. They exchange maps with another group and follow their design

of the wildlife refuge. They look for the best design. Each group writes a report of the investigation and makes an oral presentation to the class.

*Procedure*

1. Setup: Separate the class into cooperative groups. Each group should receive wildlife refuge Cards A and B, patter paper, and a set of pattern blocks. If pattern blocks are not available, have students to create paper blocks from Card C.
2. Implementation: Introduce the lesson to the groups. Students should first make Faulkner island by piecing together pattern blocks. They should then use graft paper to record the island they create. They may need to tape two or more sheers of graft papers together to record their island. Suggest that each group record its wildlife refuge location on a separate piece of paper.

Remind students that they are to determine the angle of turn without using a protractor. You may want to ask questions like the following.

"You know there are 360 degree in a circle. How can you use hexagon blocks together to find the number of degrees in an angle of one of the hexagons?"

After each group has completed their map and design, groups should exchange maps and follow the design to find the best location for the wildlife refuge. They should verify the location with the group that created the map.

Each group should then complete the lesson on Wildlife Refuge Card "B", analyzing the map, finding the best location, and explaining how they were able to determine the distance and angle measures. All group members should help prepare the group report.
3. Processing the lesson: Invite groups to present their reports. Discuss the methods the groups used to determine angle and distance measures, and the ratios they observed among the pattern blocks.

*Homework*

You may wish to have students work outside of the class on their reports.

*Journal Prompts*

The following journal prompts may be used with this lesson.

"What were the factors you had to consider in designing the wildlife refuge?

"What is one thing you learned about distance or angle measure from this lesson?"

*Answer*

There is no single correct answer for this lesson. However, students should be able to make a convincing argument to support their conclusions.

## Wildlife Refuge Cards A

Design your own Faulkner island using pattern blocks. Then trace the island on paper to make a map. Identify light tower, Erosion pins, Boat House, or other landmarks. Decide on a location for a wildlife refuge.

Write a set of at least eight clues finding the location of the wildlife refuge. Each clue should take the searcher to different location on your island, where he or she will find the next clue. Your first clue should tell the searcher where to begin. Indicate the direction and number or units for each move. The searcher's only tools will be the map and the clues-no protractors or rulers allowed!

Exchange island maps and clues with another group. Follow their clues to the wildlife refuge.

## Wildlife Refuge Card B

Describe the relationships among the angles and the sides of the pattern block pieces you used to create your island.

***YOUR REPORT***
Prepare a written group report on your wildlife refuge and your investigation of the pattern blocks.

Include how you measured lengths and angles, and any problems you experienced in following another group's clues.

Describe the best location for you wildlife refuge, and tell how you determined that location.

Calculate the ratio of the measures of the sides in each of the pattern blocks pieces.

Measure the interior angles of each pattern block piece. Calculate the ratio of the angle measures between pairs of pattern block pieces.

## Wildlife Refuge Card C

(figure availabe in print form)

## Wildlife Refuge Pattern Paper

(figure availabe in print form)

Take from Faulkner's Island Research Project Directed by George Gdovin out of Little Harbor Laboratory Vegetation Survey by Patrick Lynch

(figure availabe in print form)

Take from Falconer's Island Research Project Directed by George Gdovin out of Little Harbor Laboratory General Vegetation Survey 1984 by Ti Crossman

(figure availabe in print form)

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