Lab Framework

Text: CORD

Unit 23: Factoring

Short Description: Students are going to have a fixed length of string in order to build a pen for an animal. They will also construct a data table (manipulated variable is length and responding variable is area) and plot the data.

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Maximizing and Minimizing the Area of Rectangles Given a Fixed Perimeter

LAB PLAN

TEACHER: Teacher Prep/ Lesson Plan

- **Lab Objective**
  - Students will analyze and solve problems in which rectangles with identical perimeters are compared to maximize or minimize area.
  - Students will represent problem situations with models.
  - Students will analyze fixed perimeter problems using x,y coordinate graphing.
- **Statement of pre-requisite skills needed** (i.e., vocabulary, measurement techniques, formulas, etc.)

  Students will need to have a working understanding of appropriate expectations in a lab.
- **Vocabulary**
  - Area
  - Array
  - Factors
- **Materials List**
  - A fixed length of ribbon, or string (represents the fence)
  - Tiles, ceramic or paper
  - Inch tiles (tiles with 1 sq. in. area)
  - Graph paper
- **State Standards addressed**

  ### Reading
  - 1.2 Use vocabulary (word meaning) strategies to comprehend text.
  - 1.2.2 Apply strategies to comprehend words and ideas.
  - 1.3.2 Understand and apply content/academic vocabulary critical to the meaning of the text, including vocabularies relevant to different contexts, cultures, and communities.
  - 2.1.6 Apply comprehension-monitoring strategies for informational and technical materials, complex narratives, and expositions: monitor for meaning, create mental images, and generate and answer questions.
  - 3.3 Read for career applications

  ### Communications

- 1.1.1 Applies a variety of listening strategies to accommodate the listening situation.
- 1.3 Check for understanding by asking questions and paraphrasing
- 3.1.1 Apply appropriate reading strategies for interpreting technical and non-technical documents used in job-related settings.

Writing

- 1.1 Develop concept and design: develop a topic or theme; organize written thoughts with a clear beginning, middle, and end; use transitional sentences and
- phrases to connect related ideas; write coherently and effectively
- 1.2 Use style appropriate to the audience and purpose; use voice, word choice, and sentence fluency fro intended style and audience
- 1.3 Apply writing convention; know and apply correct spelling, grammar, sentence structure, punctuation, and capitalization
- 2.1 Write for different audiences
- 2.2 Write for different purposes, such as telling stories, presenting analytical responses to literature, persuading, conveying technical information, completing
- a team project, and explaining concepts and procedures

- **Leadership Skills**
  Coopertative group roles
- **SCAN Skills/Workplace Skills**
  - Mathematics: Use numbers, fractions, and percentages to solve problems; use tables, graphs, and charts; use computers to enter, retrieve, change, and communicate numerical information
  - Leadership: Communicate thoughts and feelings to justify a position; encourage or convince; make positive use of rules or values; demonstrate ability to have others believe in and trust you because of competence and honesty.
  - Teamwork: Contribute to group with ideas and effort; do own share of work; encourage team members; resolve differences for the benefit of the team; responsibly challenge existing procedures, policies, or authorities.
  - Self-Management: Assess one's own knowledge and skills accurately; set specific, realistic, personal goals; monitor progress toward goal.
  - Responsibility: Work hard to reach goals, even if task is unpleasant; do quality work; display high standard of attendance, honesty, energy, and optimism.
- **Set-up information**

  (1) Students will be given 3 paper rectangles with identical perimeters (such as 5 in. by 25 in., 10 in. by 20 in., and 15 in. by 15 in.) They will additionally be given 5 in. tiles (square tiles whose sides are each 25 sq. in.) Give the following instructions and questions:

  - Use your ruler to find the perimeter of each rectangle.
  - What do these rectangles have in common?
  - Which rectangle requires the most tiles to completely cover it?
  - Which rectangle requires the fewest tiles to completely cover it?

  (2) Next, the students will be presented with this problem, "You have a plot of land and a dog. Your dog has run away a couple of times and often runs on your neighbors' property. You decide to fence in a rectangular section of your land so that your dog doesn't run away but has room to play. You have 72 feet of fencing. You want each side of the rectangular "pen" to be a whole number in length. Your goal is to allow your dog the maximum amount of

space to run around and play. Design the rectangle that achieves this goal." The students will model this problem using a length of string or ribbon 72 cm. long. Students are to experiment with at least 5 different rectangles. They are to record the dimensions (bottom edge, side edge, perimeter, area) for each of their fence models. We will then discuss the fact that, geometrically speaking, we are maximizing area given fixed perimeter. (Students will work in pairs or in groups of four)

(3) Next, the students will be presented with these two problems:

(i) "You run a business that puts on banquets. For one small banquet, you need to seat 12 people. You construct your banquet tables from small square tables (which individually seat 1 person on each side). Each small table costs your company $1 per day (for rental or moving). Your banquet tables are always rectangular.

(a) What are the dimensions of the table that will seat these 12 people most cheaply?

(b) What are the dimensions of the table that would seat the 12 people in the most expensive way possible?

(ii) The same basic problem will be repeated for a banquet in which 24 people need to be seated.

For both of these problems, charts will be compiled in which the dimensions (bottom edge, side edge, perimeter, and area) are recorded for all possible perimeter of 12 and perimeter of 24 rectangles.

Fixed perimeter coordinate graphs will be completed recording the bottom edge and area ordered pairs (separate graphs for P = 12 and P = 24).

The shape of these graphs and the information they give will be discussed.

(The points can be connected to form parabolas. The area optimizing square and the two area minimizing rectangles will be evident on the parabolic curve.) (Students will work in pairs or groups of 4)

(4) Similar problems to the first 3 will be given. The students will be allowed to use models for some. For some problems they will not use models.

Use of the perimeter and area formulas will be discussed. Use of the calculator (the squaring key, for example) will be discussed.

Students may be asked to devise some of their own problems applying these concepts to realistic situations. (Students will work individually.)

- **Lab organization**(-Grouping/leadership opportunities/cooperative learning expectations; -**Timeline required)**
  One period
- **Teacher Assessment of student learning** (scoring guide, rubric)
  Assessment will be formative and summative.
- **Summary of learning** (to be finished after student completes lab)
  -discuss real world application of learning from lab
  -opportunity for students to share/present learning

- **Career Applications**

  Landscape architects
  Landscape architects design parks, playgrounds, and the outside areas around buildings using plants, flowers, trees, walkways, fountains, and water features for use and enjoyment. Some landscape residential yards that may need sprinkler systems for watering the grass and other plantings. Because the water in the arc of a sprinkler forms a parabola, quadratic equations can be used to determine the most efficient placement of sprinklers.

  Education: Bachelor's or master's degree in landscape architecture
  Pay: $45,800 - $77,600
  Growth: Faster than average; 16% increase over the next 10 years

  Civil engineers
  Civil engineers design roads, tunnels, bridges, dams, and buildings. Many of these structures contain arches in their design and need to be able to withstand any weather, including hurricanes, as well as other natural disasters like earthquakes. Engineers must examine the height and the length of the arches that form parabolas to ensure each arch has the strength necessary for the designed structure.

  Education: Bachelor's degree in engineering
  Pay: $59,000 - $94,500
  Growth: Faster than average; 18% increase over the next 10 years

LAB TITLE: Maximizing and Minimizing the Area of Rectangles Given a Fixed Perimeter

STUDENT INSTRUCTIONS:

- **Statement of problem addressed by lab**
  How can we use factors to maximize the area of a pen given a fixed perimeter?

- **Grouping instructions and roles**
  Working in your assigned groups and use your assigned roles

- **Procedures** – steps to follow/instructions
  Using your three rectangles:

  Use your ruler to find the perimeter of each rectangle.

  What do these rectangles have in common?

  Which rectangle requires the most tiles to completely cover it?

  Which rectangle requires the fewest tiles to completely cover it?

Part 2: You have a plot of land and a dog. Your dog has run away a couple of times and often runs on your neighbors' property. You decide to fence in a rectangular section of your land so that your dog doesn't run away but has room to play. You have 72 feet of fencing. You want each side of the rectangular "pen" to be a whole number in length. Your goal is to allow your dog the maximum amount of space to run around and play. Design the rectangle that achieves this goal."

Using 72 inches of string construct 5 different rectagles to represent a pen

Pen/ Rectangle	Length	Width	
1			
2			
3			
4			
5			
6			

In the shaded column, label the column *AREA* and calculate the are of all rectangles.

Follow- Up Questions:

1. You run a business that puts on banquets. For one small banquet, you need to seat 12 people. You construct your banquet tables from small square tables (which individually seat 1 person on each side). Each small table costs your company $1 per day (for rental or moving). Your banquet tables are always rectangular.

(a) What are the dimensions of the table that will seat these 12 people most cheaply?

(b) What are the dimensions of the table that would seat the 12 people in the most expensive way possible?