



## Mathematics at the Mall

**T**he "Investigations" department recognizes the importance of children's exploring mathematics and, therefore, presents teachers with explorations that will immerse children in doing mathematics as well as enhance their mathematics instruction. These tasks are designed to evolve as they are conducted. They invoke problem solving, communication, connections, and reasoning. To ensure their usability, these ideas have been used in a variety of classroom settings.

A mathematical investigation may be defined as a collection of problem-solving tasks that—

- has multidimensional content;
- is open-ended, permitting several acceptable solutions;
- is an exploration requiring a full period or several classes to complete;
- is centered on a context-based theme or event; and
- is often embedded in a focus question.

In addition, a mathematical investigation involves a number of processes, which include—

- researching outside sources to gather information;
- collecting data through such means as surveying, observing, or measuring;
- collaborating with peers in small learning groups; and

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*This section is designed for teachers who wish to give students new insights into familiar topics in grades K–6. This material can be reproduced by classroom teachers for use in their own classes without requesting permission from the National Council of Teachers of Mathematics. Readers are encouraged to send manuscripts appropriate for this section to the editor, Marty Hopkins, 246 Palmer Avenue, Winter Park, FL 32789.*

- using multiple strategies for reaching solutions and conclusions.

This month's investigations for grades 3–5 and 4–6 involve number sense in and around the shopping mall and are adapted from the *Numbers Alive!* project (Long and Fennell 1996) funded by the National Science Foundation. The activities deal with size and space: "Parking at the Mall" concerns the amount of space provided for parking, and "Shops at the Mall" explores the amount of leased space found in the mall. Both investigations involve estimation, measurement, and applications involving percent.

### Introductory Information

The shopping mall is about as American as baseball and apple pie. Did you know that the United States has more shopping centers than movie theaters? Enclosed malls number more than cities, four-year colleges, or television stations.

### Preparing for the Investigations

To assess prior knowledge, begin by asking students to describe their experiences at malls. Tell them that these investigations will involve their own experiences that are a bit different from walking in the mall, visiting stores, and spending money. Rather, these activities focus on space—space for parking and space for leasing shops in the mall.

### Parking at the Mall

#### Levels 3–5

#### Objectives

The student will—

line a percent of an amount, estimate quantities by using whole numbers, draw a drawing to estimate area, and present data presented in a table.

## Materials

Students will need—

one copy of the reproducible page “Parking at the Mall,”  
one hundred-grid or one-inch graph paper,  
one two-inch ruler,  
one centimeter paper,  
one string,  
one piece of chalk,  
one measuring tape, and  
one calculator (optional).

## Background Information

Students that although some exceptions can be made, the International Council of Shopping Centers recommends that parking spaces be nine feet wide and twelve feet deep. However, parking spaces for the handicapped must be fifteen feet by fifteen feet. Parking regulations require that three percent of every one hundred, or 3 percent, of the area in any parking lot must be set aside for the use of challenged visitors (Kowinski 1985).

## Structuring the Investigation

Write the word *area* on the chalkboard. Ask students what it means. Why are area measures usually given in square units, such as square inches, square feet, and so on? Divide the class into groups of four, and give each group some butcher paper and four twelve-inch rulers. Challenge each group to use its rulers to make on the butcher paper a shape with an area of one square foot. Encourage the discussion and demonstration of their responses. How do students know that their shapes measure one square foot? Why are they called a “square foot”? After confirming that each shape has the correct area, ask students to cut out their designs. Challenge students to use all their cutouts to create a shape on the floor of the classroom. What is the area of their shape? How do they know? What would it mean if that the area of a driveway is five hundred square feet? What might the driveway look like? Use string or chalk and a measuring tape to measure and mark a nine-foot-by-twelve-foot parking space. Ask the groups to describe in any way they would like, the area where a car would be

parked, such as by paces, by people lying down in it, and so on. Ask each group to share its description with the class. Use another string or chalk mark to “stretch” the parking space to meet the fifteen-foot-by-twenty-foot specifications of the space for the handicapped. Ask the groups to describe how much larger this space is than a regular space. (I can lie down in the additional space, etc.) Are the spaces for the handicapped twice the size of a regular space? Half again as big? How do you know? How could we find out? Discuss why such spaces are larger and why they are located closest to mall entrances.

3. Next ask each group to estimate the area of the handicapped-parking space. Younger students might pace off their parking space to determine an estimated area, others may describe the area as the estimated number of people who could lie down in the space, and some might use the square feet they made in activity 1. Older students may use the formula for finding the area of a rectangle to estimate in square feet. Compare and contrast the strategies used as well as estimates. After discussing the estimates, ask each group to find the actual area of the parking space for the handicapped. Again, discuss the strategies and answers. Compare each group’s estimate with the actual measure. Ask students to explain any differences. Challenge the groups to estimate the area of regular space on the basis of the size of the space for the handicapped. Remind the groups that a regular space is six feet narrower and eight feet shorter than a handicapped space.
4. Encourage students to discuss when they have seen percents in their everyday lives. If it is not offered, ask how many of them have received a grade of 80 percent, eaten 50 percent of a candy bar, or paid 5 percent sales tax. Ask the students what they think these numbers mean. After the discussion, if it has not already been mentioned, tell the children that “per cent” means “of 100.” Ask why they think “cent” might mean “hundred.” Ask them to think of other words with “cent” in them and to explain what they mean (e.g., cents in a dollar, century, centipede). Monetary discussions will inevitably occur at this point. What percent of a dollar is three pennies? How do they know? What does 50 percent of a candy bar mean? (If you could divide the candy bar into one hundred pieces, you would have fifty of them.) Provide a blank one hundred grid and ask students to shade in one block. Ask them to tell what percent of the paper is shaded (1 percent). Encourage them to explain their thinking. How many blocks of 100 would need to be

Ask students why they think “cent” might mean “hundred”

shaded to represent 3 percent? One hundred percent? Fifty percent? How do they know?

Next ask the students to imagine a large grid with 1000 blocks. For younger children, place the children in groups of ten, and use all ten of their 100 grids rather than require them to visualize a 1000 grid. How many blocks would be needed to show 1 percent? Or 3 percent? Or 100 percent and 50 percent of this larger grid? (10, 30, 1000, 500, respectively.) Encourage students to share their strategies. Some students may merely determine that the grid is 10 times larger, so the answers would be 10 times bigger; others might use their prior knowledge that 100 percent of anything is all of it and 50 percent is half to find 1000 and 500, find a 10-times-larger pattern in those two answers, and use the pattern to determine the number of blocks in 1 percent and 3 percent. Groups using the ten 100 grids will most likely count each time and finally realize that 1 percent of each of the 10 grids is the same as 1 percent of the total. Allow adequate time for this exploration, and have students compare and contrast their strategies.

5. Organize the children into groups of three or four. Distribute a "Parking at the Mall" reproducible page to each student. Read the first problem with the students, and ask how this problem is different from the last activity. (Five thousand spaces would be on the grid paper instead of 1000.) How would that difference affect their responses? After the students have completed the first two problems on the reproducible page, draw the class together and encourage each group to discuss its results and strategies.
6. Ask students to look at item 3 on the reproducible page. After its completion, encourage each group to share its response and reasoning with the class. In what ways are the responses similar? What information is not given that would have made the problem easier? (The number of people arriving in each car.)

## Extending the Investigation

1. Encourage your students to collect some parking-lot data. Ask them first to estimate and then later to determine the number of parking spaces provided at your school and at a local shopping center or mall. How many parking spaces for the handicapped are provided? Estimate and measure to see whether parking spaces at the school or mall are of the size suggested by the International Council of Shopping Centers. Do the spaces reserved for handicapped parking meet the recommended percent?

2. Students can collect some parking-lot data of their own to see whether their estimates in problem 3 on the reproducible page are meaningful. They can design a research project to determine the average number of people per car in a mall's parking lot. They may wish to consider such variables as time of day; day of the week; and area in the parking lot, such as near a theater. Each student could spend a predetermined amount of time at the mall recording the number of people emerging from each car. All data would then be compiled to determine the average number of people per car. Estimates for item 3 on the reproducible page could then be adjusted, if necessary.
3. Present the following problem:

A new mall is a rectangular two-story structure with an entrance on each side. Use a piece of graph paper to design the parking area so that you can provide 5000 parking spaces in the least amount of space. Create your parking areas so that no mall visitor has to walk more than thirty car spaces to get to a mall entrance.

Distribute graph paper to each group. After reading the problem together, identify variables that must be considered in their design, such as driving space, safe walking space, both handicapped and regular parking spaces, and entrances on each side. Ask the students whether the shape and size of the mall will be important to the design of the parking areas. Why or why not? After all plans have been drawn, encourage students to make group presentations to the class. The plans can be compared with, and contrasted against, the criteria provided.

## Shops at the Mall

### Levels 4-6

#### Objectives

The students will—

- estimate using percent,
- compute using percent,
- create a scale drawing, and
- solve problems involving percent and scale drawings.

#### Materials

Each student will need—

- a copy of the reproducible page "Shops at the Mall,"
- one-hundred-grid or one-inch graph paper

centimeter graph paper, and a calculator (optional).

## Preparing for the Investigation

Begin by generating a class list of stores typically found in a shopping center or mall. Challenge students to categorize stores into general categories, such as women's clothing, food, service, and so on. Ask students which types of stores seem to be most prevalent and least prevalent at a mall.

Discuss the word *lease*. What does it mean? (For rent or hire.) Why is it important to shopping center or mall operators? The International Council of Shopping Centers recommends that malls allocate a certain percent of the total square footage of leasable retail space using the following guidelines: women's clothing, 25 percent; men's clothing, 10 percent; food, 15 percent; service (beauty salons, eye-glass centers, etc.), 5 percent; shoes, 10 percent; jewelry, 3 percent; family items (learning centers, etc.), 7 percent; and gifts, 17 percent (Kowinski 1985). Note that the International Council only recommends space allotments and does not recommend specific allocations for all 100 percent of the space within a mall. Why?

Encourage students to conduct some research at the mall or shopping center closest to where they live. For a homework assignment, ask them to list all the stores in the mall and to place each into one of the International Council's categories listed in the foregoing. Draw their attention to the fact that the recommendations were made in 1985. How have malls changed since then? What problems might those changes pose for students in their task?

When all lists have been compiled, ask students to share their data and justify the placement of specific stores within each category. Where did they place stores like The Gap? The Disney Store? A bank? A pharmacy? A video store? Ask them to find the total number of stores at the mall, the number of stores in each category, and the percent of each type of store listed. (Review the meaning of percent—per 100—and do activity 4 under "Structuring the Investigation" in the preceding investigation of "Parking at the Mall.") How does the local mall's space allocation compare with the International Council's recommendations?

## Structuring the Investigation

Tell the students that they can lease space within a new mall. Distribute the reproducible page "Shops at the Mall" to each student. After students have completed the first two items,

encourage them to share their results and strategies. Some may use proportional reasoning, calculate with fractions, or use calculators.

2. Organize students into groups of three or four for the final activity. Distribute graph paper to each group to use when creating the scale drawing of the mall. Before beginning the activity, discuss the criteria for mall design in item 3 on the reproducible page. After all drawings are complete, encourage each group to share its plan along with a justification for each element. The plans should be compared with, and contrasted against, the criteria provided as well as the International Council's recommendations.

## Extending the Investigation

1. Ask the class how to determine which stores are the most popular or which stores sell the most merchandise. Allow them to develop a plan for collecting data that could help answer their question. Ask the class to consider surveying store managers or mall shoppers or observing mall traffic.
2. Students may want to investigate where they spend most of their time or money at the mall. Encourage students to identify possible ways to collect information that would answer their questions, design a study that controls for the variables identified, and collect and analyze the data collected. They might wish to include students in the local middle school so that they can compare the spending habits of upper elementary students with those of middle school students.
3. The cost of leasing space might be of interest to students. How is the cost determined? How do such factors as rent and placement in the mall affect the store manager's decision to locate in a mall? Invite the manager of your local shopping mall to help students explore these issues.
4. A related but different question involves profit. Do stores that sell the most merchandise make the most money? The most profit? Explain the differences between a store's costs, sales, and profit. Are these items related to size? Do the biggest stores make the most profit? Again, the manager of a local shopping mall may be helpful.

**Encourage students to conduct research at the mall closest to where they live**

## Concluding Comments

In preparing for the *Numbers Alive!* project (Long and Fennell 1996), hundreds of students were surveyed regarding their favorite places to go and things to do. The shopping mall was the most frequently selected site. As a culture, we experience

the local shopping center or mall in a variety of ways: we shop; we visit; we walk. Mathematics is at the core of many of these choices. It is appropriate to help students visualize numbers, particularly large numbers, in a context that will be familiar and constantly reinforced.

### Bibliography

- Kowinski, William Severini. *The Malling of America*. New York: Morrow and Co., 1985.
- Long, Gail Porter, and Francis (Skip) Fennell. *Numbers Alive!* Parsippany, N. J.: Silver Burdett Ginn, 1996.
- The Washington Post*. "Downtown Endures in Twin Cities' Retail War," Sunday, 4 June 1995, A3. ▲

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# Parking at the Mall

Name \_\_\_\_\_

## Parking Lot Recommendations

|                        | <u>Dimensions</u>        | <u>Percent of Spaces</u> |
|------------------------|--------------------------|--------------------------|
| Regular parking spaces | 9 feet $\times$ 12 feet  |                          |
| Handicapped spaces     | 15 feet $\times$ 20 feet | 3                        |

1. The new shopping mall advertised that parking space is available for 5000 cars. Estimate how many spaces at the new mall would be needed for handicapped parking.

Estimate \_\_\_\_\_ Explain your thinking. \_\_\_\_\_

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How many spaces at the new shopping mall would actually be needed for handicapped parking?

Actual spaces \_\_\_\_\_ How do you know? \_\_\_\_\_

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How many other parking spaces would be available? \_\_\_\_\_ How do you know? \_\_\_\_\_

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A large sale was scheduled at the mall, and the parking lot was full. Estimate the number of shoppers in the mall. Tell how you determined your estimate.

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