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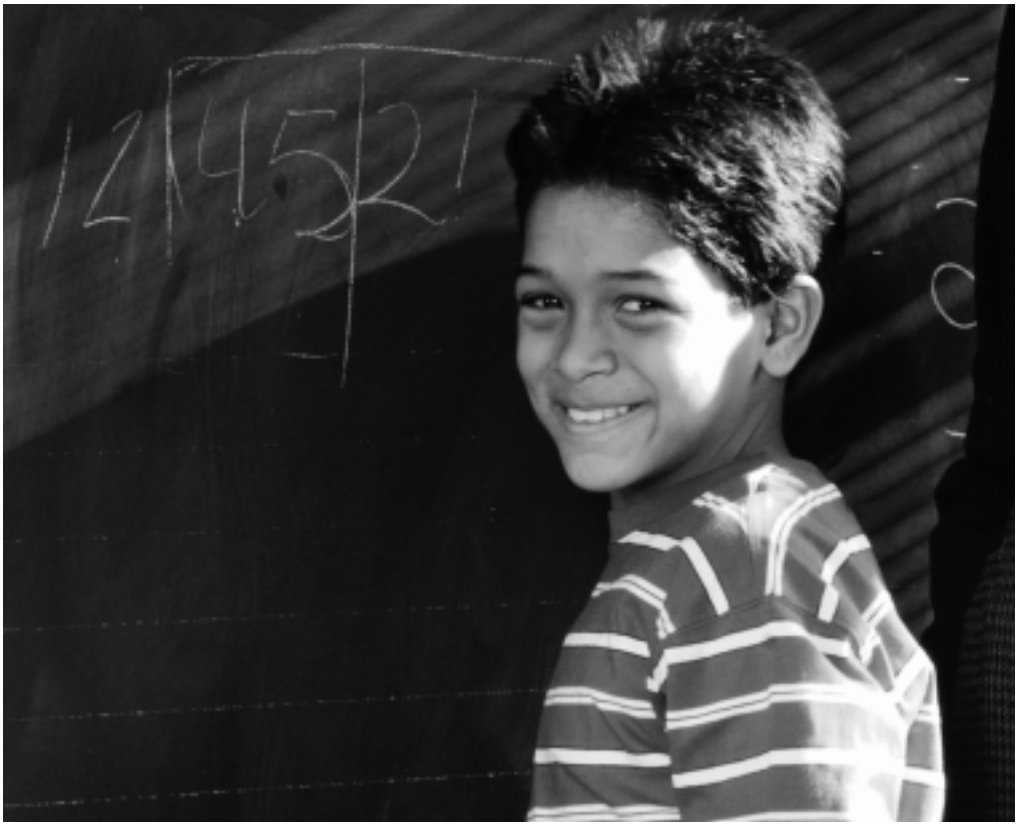
Promoting Mathematics (By Any and All Means)



1. Introduction

New standards for mathematics require students to do much more than be able to perform mathematical calculations in isolation. There is now a much a broader view of what "mathematics" encompasses, including the application of mathematics in other disciplines such as science, the humanities, and social sciences; identifying problems that can be solved using mathematics; mathematical reasoning; and using mathematical tools such as graphs to communicate ideas. In addition, students must be able to demonstrate their understanding of math in a variety of ways, such as creating tables and charts, as well as writing descriptions of processes they have used to solve a problem.

In contrast to math taught as computation, the more recent understanding of achievement in math necessitates much more application of computation in a variety of situations, as well as communication and cooperation among students. Our earlier view of math as a universal system relatively independent of language has been replaced by the view that math, like other content subjects, has a specialized vocabulary, common grammatical patterns and rules for constructing arguments.

These new definitions of mathematical literacy impact all of our students who must learn "to speak math," that is, learn a specialized vocabulary, particular grammatical constructions, as well as learn to defend solutions to problems. Many students, including LEP students who are still acquiring academic English, need explicit and detailed practice in how to understand word problems, use strategies to find solutions, and communicate their solutions mathematically and in writing. All students benefit from hands-on, cooperative math projects that grow out of real-world situations and have multiple paths toward solutions.

2. Cultural differences in math symbols or in problem-solving procedures

In some Spanish-speaking countries, a period is used to separate multiples of a thousand, and a comma is used in decimals. The opposite is the case in the United States. For example:

"five thousand, four hundred and thirty seven" is represented as 5.437 in some Spanish-speaking countries but as 5,437 in the United States

"four and one half" is represented as 4,5 in Spanish, but as 4.5 in the United States

The operation of division is represented as $4\overline{)32}^{\,8}$ in the United States, but as $32 \mid 4$ (8) in some Spanish-speaking countries.

Cultural differences in math curriculum

In the United States, the units of measurement (pounds, feet, inches) are unfamiliar to students who have learned the metric system. In addition, U.S. schools devote extensive practice to fractions, in part because of our system of measurement. U.S. teachers often refer to "half a foot"; international teachers may refer to "5 millimeters" rather than "half a centimeter."

3. Instructional suggestions for teaching math to LEP students

The lessons and suggestions that are included in this section of the *Help! Kit* exemplify a multifaceted approach to teaching math to all students, based on the goals of the National Council of Teachers of Mathematics (NCTM):

1. **Learn the value of math.** Students should learn the relationships and applications of mathematics in academic subjects such as science, social science, and the humanities, and the applications of math in everyday life.

2. **Become confident in one's own math ability.** Students should learn to use math to solve real-world problems.

3. **Become math problem-solvers.** Students should learn to solve complex problems that require sustained effort over a period of time, and tackle problems that require cooperation with others to solve.

4. **Learn to communicate mathematically.** Students should learn to use math symbols and tools (such as equations or graphs) to communicate mathematical ideas in writing and in discussion.

5. **Learn to reason mathematically.** Students should learn to make predictions, gather evidence, and build an argument to support their conclusions.

The example lessons in this section demonstrate the NCTM goals in that the lessons involve hands-on projects, manipulatives, the solving of word problems, and practice with the language of math.

Hands-on projects

To achieve these goals, students should learn through hands-on, cooperative activities and discussion based on real-world situations. Involve groups of students in researching questions of importance to the school community, for example, doing a user survey of cafeteria menus. Students survey peers to create graphs of favorite foods, together with a written and oral report of the results of their survey. This information is then shared with cafeteria staff.

Manipulatives

In the classroom, make a variety of objects and purchased math manipulatives available so that students can gradually come to understand abstractions. For example, allow students to play with the concept of place value through physically grouping beans or counters into groups of 10s and 1s to represent numbers such as 34.

4. Math-specific language and problem solving

Explicitly practice math language, such as "table," "area," or "operation," distinguishing the mathematical definitions of these terms from their use in everyday language. Provide extensive practice with the steps of problem solving following the examples presented in the sample lessons below. Have students work in groups to solve and then discuss problems, and then have them create their own word problems. Practice with grammatical constructions found in academic or formal writing such as comparatives or sentences with "if..then" clauses. Ask LEP students who have learned other methods for solving problems in their home countries to demonstrate those methods.

5. Problem solving

The steps in solving a mathematical problem are all important. Skip one and you miss part of the solution. The following are steps for teaching problem solving to LEP students that would be good in solving any math problem.

How to teach problem-solving steps to LEP students

1. **Understand the question**. Teach students to understand the problem through elaboration and imagery. Then rewrite the question as a statement.

2. **Find the needed information**. Help students to use selective attention (e.g., disregard irrelevant data or number distractors to find needed information).

3. **Choose a plan**. Have students identify the operation and what the problem calls for, then choose a plan, (e.g., write a number sentence, identify parts of the problem, work with a peer, make a table, make a list).

4. **Solve the problem**. Students write out the steps of the problem and solve it, using cooperation to review the steps they have taken.

5. **Check the answer**. Students use a variety of approaches to verify their answer.

6. Adapted math lessons for ESOL students

A. ESOL Adapted Math Lesson

Grade 1

Materials:

index cards for each student
one-hole punch for each student
a pencil for each student
overhead projector

Lesson Objectives:

Students will demonstrate an understanding of basic addition facts.

Procedure (5 minutes):

1. Teacher provides each student with a hand-held hole punch and an index card.

2. Teacher models using her own hole punch and index card.

3. Using TPR, teacher introduces and reinforces basic vocabulary. Teacher says,
   "Look at my hole punch." (She holds up the hole punch.)
   "Show me your hole punch." "Hold up your hole punch." (Students hold up hole punches.)
   "Look at my index card." (She holds up her index card.)
   "Show me your index card." "Hold up your index card". (Students hold up index cards.)
   "Show me your hole punch." (She waits, then models by holding up her hole punch.)
   "Show me your index card." (She waits, then models by holding up her index card.)

4. Still using TPR, the teacher continues.
   "Watch me punch three holes in my card." (While the teacher punches, she counts.)
   "One, two, three."

5. Teacher places her punched card on the overhead. The light will shine through the punched holes. She points to the holes and counts, "One, two, three holes."

6. Teacher says,
   "Punch three holes in your card." (Using another card, teacher models while students punch their cards.)

7. Teacher says,
   "Count the holes with me. Count the holes in your card." (She points to the overhead holes.) "One, two, three holes."

8. Teacher moves the punched card on the overhead to the left half of the screen. On the right half of the screen where the light is not covered, she writes the numeral "3" next to the three holes as she again counts to three.

9. "Look at the three holes in my card. Look at the three holes in your card." (Points and models.)

10. "Watch me punch two holes in my card. Watch me punch two holes under the three holes." (Teacher removes card from overhead and punches two holes in her card under the three holes she previously punched. She replaces the card on the overhead and covers the three holes previously punched with another card so only the two just-punched holes show through.)

11. "Look at the two holes in my card; one, two holes." (Points and counts.)
    "Punch two holes in your card." (Models and counts.)

12. Teacher moves the card to the left of the overhead screen and counts the two holes showing through on the overhead. Teacher writes the numeral "2" to the right of the two holes under the three holes.

13. Teacher removes the index card covering the three holes. She counts,
"One, two, three, holes..." (She points to the numeral "3".)
"...plus..." (She adds an addition sign to the left of the numeral "2".)
"...one, two holes." (She points to the numeral "2".)
"Three plus two..." (She points to each as she says it.)
"Count all the holes with me. One, two, three, four, five." (Points and counts; repeats.)

14. "Three plus two equals (points to each as she says it then writes the equals lines under the "2" to form the equation) FIVE!" (She writes the numeral "5" under the equation on the right side of the screen.)

15. "Pick up your pencil. Count with me." (Students pick up pencils.)

16. Teacher covers equation on right of screen. Teacher covers two bottom holes, leaving only the three holes showing through.

    "One, two, three. Write the number 3 on your card." (Teacher uncovers the numeral "3" on the right of the overhead. Then the teacher repeats the last command and models by writing the numeral "3" on her card. She shows what she has written on the card to the class. Students write on their cards.)

    "Three plus..." (She uncovers the addition sign and writes one on her card. Students write on their cards.)

    (Teacher uncovers the two holes)
    "One, two..." (She writes "2" in her equation and uncovers the "2" on the screen. Students write on their cards.)

    "...equals...." (She uncovers the equals sign and writes one on her card. Students write on their cards.)

    "...five." (Uncovers, writes and models. Students write.)

17. Students now have a card with three holes punched in a line with two holes punched under them and the simple addition fact 3+2=5 written on it. Follow the procedures to explore two other simple addition facts: 6+3=9 and 4+3=7.

(Total lesson time: 20 minutes.)

Follow-Up Lesson

Teacher reviews, following the above procedures for one equation, then repeats, reducing modeling following the model outlined below:

1. Teacher says, "Six...plus...three."

2. Students punch one line of six holes followed by one line of three holes.

3. Teacher puts punched card on the overhead and says,

    "Six..." (points to and counts six holes)
    "...plus three..." (points to and counts three holes)
    "...equals...one, two, three, four, five, six, seven, eight, NINE!" (points and counts)

    Students will join in counting aloud at their own pace depending on their levels of language proficiency. They should be encouraged to join in when they are ready, but not forced.

4. Teacher and students write equation.

Lesson adapted from Lynda Franco, Region XIV Comprehensive Center/Center for Applied Linguistics.

B. ESOL Adapted Math Lesson

Grade 2
Basic Bar Graph Activity

Materials

- an apple, an orange, and a banana (other fruit pieces may be added or substituted)
- survey sheet (sample follows) for each student and an overhead copy for the teacher
- worksheet (sample follows) for each student and an overhead copy for the teacher
- a pencil for each child
- colored markers or crayons for each child
- an overhead and markers

Objectives

- The students will survey the class orally to gather information.
- The students will compile information gathered into a bar graph.
- The students will explain (in writing or orally) the meaning of the data displayed on their bar graphs.

Procedure

This lesson is a practice lesson that follows an introductory lesson about bar graphs. The students have looked at bar graphs in a previous lesson and discussed the meaning of the information displayed in those graphs. In this lesson, the students will gather information and create their own bar graphs for display and interpretation.

1. The teacher shows the class the apple, orange, and banana. The teacher names each fruit as she picks it up and shows it to the class.

2. To elicit oral answers, the teacher asks individual students if they like the fruits:

   Teacher: "Adela, look at this apple. Do you like apples?"

   Adela: "Yes, I like apples." (Teacher accepts any comprehensible answer such as "Yes." or "Yes, I like." and continues by modeling.)
   Teacher: "Yes, I like apples, too. Adela likes apples."

   (Teacher repeats with another student and continues with the remaining two fruits.)

3. The teacher makes a statement.

   Teacher: "I like apples best. Francisco, which fruit do you like best?"
   Francisco: (for example) "I like bananas best." (Teacher accepts any comprehensible answer)
   Teacher: "Francisco likes bananas best. I like apples best."

   Teacher repeats, asking a few more students their preference of the three fruits, and models acceptable answers.

4. Teacher tells the class that today they will be gathering information and making a bar graph to display what they find out. The teacher asks the class to listen to a question, but to think of their answer only. They will have a chance to say their answer soon. Here is the question:

   "Which is your favorite fruit?"

5. Teacher provides each student with a copy of a survey sheet. (See Sample on p. 89.) The survey sheet has the name of each child in the class listed with the teacher's name at the top. (Providing sheets with the names in different orders will assist greatly in this activity.)

6. The teacher displays a copy of the survey sheet on the overhead. The teacher asks herself:

   "Which is your favorite fruit?"

She provides the answer, "My favorite fruit is an apple."
Teacher checks the "apple" column next to her name.

7. Teacher directs the students to get up and go around the room asking every student in the class, "Which is your favorite fruit." Teacher reminds each student to give the same answer every time he or she is asked the question. Teacher monitors group activity, directs students to check the correct box and include all students and completes the activity herself, checking on her overhead copy.

8. When everyone has been asked, the students return to their seats. The teacher displays her overhead copy, covering it so only the information in one column at a time shows.

9. Teacher directs, "Count how many people say the apple is their favorite fruit." Teacher counts down the column and writes the number at the bottom in the "total" box. Teacher directs students to do the same on their papers.

10. Teacher uncovers the next column. Teacher directs, "Count how many people say the banana is their favorite fruit." This time the teacher directs students to count and write on their papers first. Then she counts her column and writes the numbers at the bottom.

11. Teacher uncovers the last column and follows procedures above to have students total the column.

12. Teacher asks questions using "pair share" strategy. (Put students in pairs and have them discuss the answer to the questions before calling on a student to answer.)
"Which fruit do students like best?"
"Which fruit do students like least?"
"How many students like apples best?"
"How many students like oranges best?"

13. Teacher provides graphing sheet and markers or crayons. Teacher displays her graphing sheet on the overhead.

14. Teacher asks:

"How many students like apples best?"
(students answer)

15. Teacher counts UP from the bottom of the "apple" column on the worksheet to the number the class found. She draws a line at the top of that number box. Then she colors in the column (using any choice of color) up to that number to form a bar. Teacher directs students to do the same.

16. Teacher asks, "How many students like bananas best?"
(students answer)

17. Teacher directs students to make the bar for the banana column. Then she does the same on her overhead copy.

18. Repeat procedure for the remaining orange column.

Each student now has a completed bar graph of the information gathered in the activity. Teacher asks a student to review the steps followed to complete this activity. (This may be followed up by a written explanation at the teacher's discretion.)

19. Teacher asks, "What do our graphs show us?" (Students respond in pairs, writing their ideas on a separate piece of paper.)

The teacher then asks pairs to answer the question. Teacher writes ideas on the board. For example:
More students like apples than bananas.
Students like apples best.

Lesson adapted from Lynda Franco, Region XIV Comprehensive Center/Center for Applied Linguistics.

Follow-Up Activity

The activity following this lesson should repeat the same procedures with five different fruits (for example, a mango, a kiwi, a peach, a cherry, and a grapefruit). This time the students will need less modeling and can get to the information gathering sooner. Display the graphs created along with the explanations of the meanings of the data.

Students should be asked to create their own title for their graphs. They can also be asked to create their own graph sheet if provided with rulers.

Sample Survey Sheet

	Which is Your Favorite?		
	Apple	Banana	Orange
Teacher's name			
Ana			
Josefa			
Chabeli			
Carlos			
Luis			
Marisol			
Kim			
Quan			
Antonio			
Alexa			
Barney			
Total			

Sample Graphing Sheet

Our Favorite Fruits

C. The Fence

You Will Need

About 25 toothpicks. (Paper clips, beans, crayons, wooden blocks, etc., will work as long as all pieces are the same size.)

The Problem

Your school is planning to build a new sandbox for the playground. A low fence needs to be built around the sandbox to keep the sand in. The builders need to know how much fence material to buy. The principal knows you like math and has asked you to help with the project.

The sandbox will be a rectangle.

A rectangle looks like this:

It will be 6 feet long and 4 feet wide.

How many feet of material will be needed to build the fence around the sandbox?

Pretend that each toothpick is one foot long.

Make a rectangle with your toothpicks that is 6 feet long and 4 feet wide.

Count the number of "feet" there are around the outside of the rectangle.

How many feet of material did you use to build your fence?

If you used 20 feet of materials, you built a perfect fence.

Reach for the Stars

How many sides are 6 feet long? How many sides are 4 feet long?

Can you solve the problem without counting toothpicks?

On the Job

All kinds of jobs require measuring and counting skills: carpenters, electricians, and engineers need these skills to build houses, office buildings, and schools. Farmers need to be able to measure the land for their crops. A seamstress or tailor needs to be able to measure cloth.

Count on Me was supported, in part, by the National Science Foundation.

C-1. La Cerca

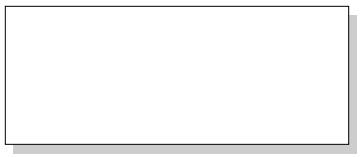
Udin. Ecesitará

Aproximadamente 25 palillos de diente. (Tanto los sujetapapeles, frijoles, lápices de pastel, bloques de madera, etc., funcionarán mientras todas las piezas sean iguales de largo.)

Su escuela está planeando construir una nueva caja de arena para el campo de juego. Se necesita construir una cerca baja alrededor de la caja de arena para mantener la arena adentro. Los constructores necesitan saber cuánto material tienen que comprar para la cerca. El director sabe que a Ud. le gustan las matemáticas y le ha pedido que ayude con el proyecto.

La caja de arena será rectangular.

Este esun rectángulo:



La caja se medirá 6 pies de largo y 4 pies de ancho.

¿Cuántos pies de materiales se necesitarán para construir la cerca alrededor de la caja de arena?

Suponga que cada palillo de diente es un pie de largo.

Haga un rectángulo con sus palillos de diente que sea 6 pies de largo y 4 pies de ancho.

Cuente el número de "pies" que hay alrededor de la parte de afuera del rectángulo.

¿Cuántos pies de material usó para construir la cerca?

Si usó 20 pies de material, construyó una cerca perfecta.

Alcance las Estrellas

¿Cuántos lados son 6 pies de largo? ¿Cuántos lados son 4 pies de largo?

¿Puede Ud. solucionar el problema sin contar los palillos de diente?

En El Trabajo

Gran cantidad de trabajos requieren medidas y habilidades de contar: carpinteros, electricistas, e ingenieros necesitan estas habilidades para construir casas, edificios de oficinas y escuelas. Los agricultores tienen que ser capaces de medir la tierra para sus cosechas. La costurera o el sastre necesita poder medir la tela.

D. Guess What!

You Will Need

Uncooked pasta in 3 colors, paper, pencil, a bag you can't see through.

Game One: For Younger Children

You will need several pieces of pasta in 2 different colors.

Player one puts 7 pasta pieces in a bag. The pieces can be any combination of the 2 colors: 0 & 7, 1& 6, 2 & 5, 3 & 4.

Player two dips his or her hand into the bag and, without looking, pulls out one piece of pasta. *Player two* then records the draw and replaces the piece of pasta in the bag.

Player one shakes the bag.

After 4 rounds of pulling, recording, and replacing, **player two** makes one guess about the combination in the bag. If the guess is wrong, **player two** plays 3 more rounds and guesses again.

If still not successful, **player two** pulls 2 more rounds and guesses again.

This game can be varied by changing the total number of pasta pieces and the possible combinations.

Game Two For Older Children

You will need several pieces of pasta in 3 different colors.

Player one puts 12 pasta pieces in a bag. The pieces can be any combination of colors such as 0,3,9; 4,4,4; 2,5,5; etc. There are many more possibilities.

The rest of the game is played in the same way as for game one.

On the Job

Probability is the chance that a certain thing will happen depending on the conditions. A weather forecaster uses probability to predict the chance for rain. A dietician uses probability to predict how much of a certain food to prepare for your school cafeteria. A store owner uses probability to figure out how much stock to order.

Count on Me was supported, in part, by the National Science Foundation.

D-1. ¡Adivine Que!

Ud. Necesitará

Pasta cruda (fideos, macaronis) en tres colores, papel para sacar notas, un lápiz, y una bolsa de papel opaco para esconder los pedacitos de pasta.

Primer Juego: Para niños menores

Ud. necesitará muchos pedacitos de pasta de dos colores diferentes.

El primer jugador pone 7 pedacitos de la pasta en la bolsa. Los pedacitos pueden ser de cualquier combinación de los dos colores: 0 & 7, 1 & 6, 2 & 5, 3 & 4.

El segundo jugador mete su mano adentro de la bolsa y, sin mirar saca un pedacito de pasta. Entonces *el segundo jugador* toma nota del pedacito que se sacó y vuelve a poner el pedacito de pasta en la bolsa.

El primer jugador sacude la bolsa.

Después de cuatro vueltas sacando, tomando notas, y reponiendo, *el segundo jugador* trata de adivinar la combinación en la bolsa. Si no acierta, *el segundo jugador* juega tres vueltas más y trata de adivinar otra vez.

Si todavía no tiene éxito, *el segundo jugador* saca 2 vueltas más y trata de adivinar otra vez.

Este juego se puede variar cambiando el total de pedacitos de la pasta y las posibles combinaciones.

Segundo Juego: Para niños mayores

Ud. necesitará muchos pedacitos de pasta en tres colores diferentes.

El primer jugador pone 12 pedacitos de pasta en la bolsa. Los pedacitos pueden ser de cualquier combinación de colores, tales como 0,3,9: 4,4,4: 2, 5,5: etc. Hay muchas más posibilidades.
El resto del juego se juega de la misma manera que el primer juego.

En El Trabajo

La probabilidad es la casualidad de que cierta cosa pasará dependiendo de las condiciones. Un pronosticador del clima utiliza la probabilidad para predecir la casualidad de lluvia. Un dietético usa la probabilidad para predecir cuánta cantidad de cierta comida debe preparar para la cafetería de su escuela. El dueño de una tienda usa la probabilidad para calcular qué cantidad de mercancía ordenar.

E. Shape Town

Language Focus: The city; shapes
Critical/creative thinking component
Application skills: estimating how many beans will fit on and around a shape
Analysis skills: comparing the frequency of shapes seen in the environment
Content area: Math
Materials: One copy of "Shape Town" blackline master for each student; different shapes cut from construction paper; beans; one copy of "Most Often Seen" blackline master for each student.

Part 1: Shape Town

Stimuli Directions: Distribute copies of blackline master "Shapetown." Call students' attention to the illustration by displaying it on the overhead projector. Use the illustration and stimuli given below to introduce the primary activity. Select stimuli according to the linguistic level of the group.

Preproduction Stimuli

Prompt nonverbal, active participation.

Show me an oval-shaped house. (Lead action.)

Open one of the diamond-shaped windows. (Point to window and pantomime opening it.)

Push one of the circular shopping carts from the grocery store. (Point to cart and pantomime pushing it.)

Pull out some of the mail from the mail bag shaped like a hexagon. (Point to mailbag and pantomime pulling out a letter.)

Trace the perimeter of a square stop sign. (Point to stop sign and use your finger to trace.)

Early Production Stimuli

Prompt one- or two-word responses.

Is the diamond-shaped window (point) open or closed?

Are the rectangular tires (point) on a car or an airplane?

Is the circular mail (point) near the post office or the bank?

Is the traffic signal (point) shaped like a circle or a triangle?

Is the stop sign (point) shaped like a rectangle or a square?

Speech Emergence Stimuli

Prompt short answers to literal questions.

What shape are the homes? (Trace the outline of a home with your finger.)

What shape are the tires? (Trace the outline of a tire with your finger.)

Where are the circular shopping carts? (Point to the front of the grocery store.)

What is shaped like a hexagon? (Trace the outline of a tree or the mailbag.)

What is shaped like a square? (Trace the outline of the stop sign.)

Intermediate Fluency Stimuli

Prompt detailed answers to higher-level thinking questions.

What might be different about living in an oval-shaped house?

Why do you think our shopping carts are rectangular instead of circular?

What shapes would you use to construct a traffic signal? Why?

How are a triangle and a square alike? How are they different?

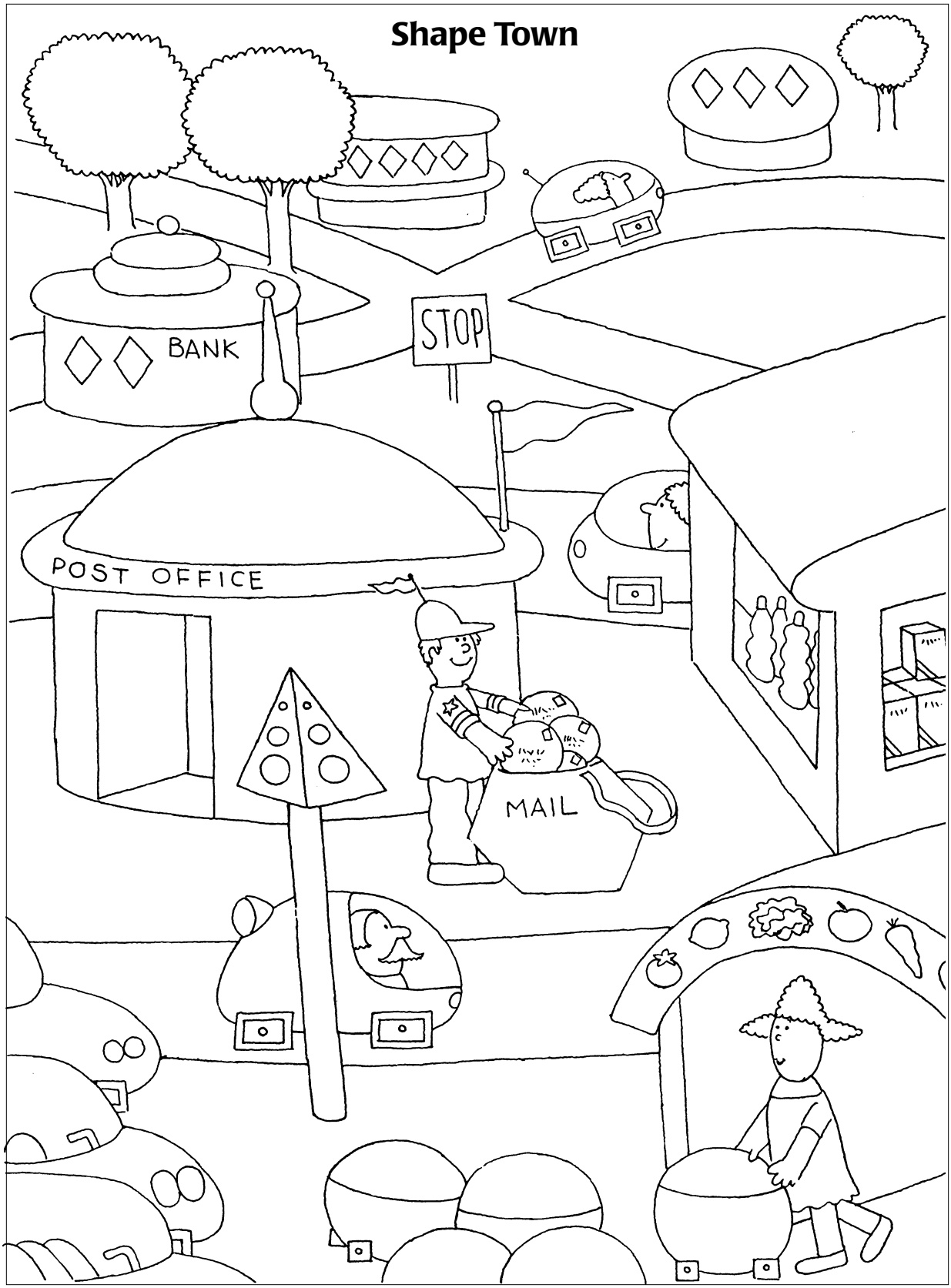
Do you think that shapes were invented or that they just naturally appeared in the environment? Why?

Most Often Seen

Look at the shapes.

Rank the shapes by how often you see them in a day. Give the shape you see most often the number 1.

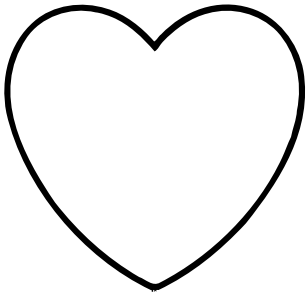
Shape Town



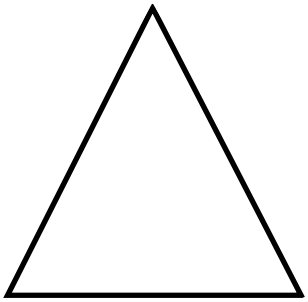
Most Often Seen

Look at these shapes.
Rank the shapes by how often you see them in a day.
Give the shape you see most often the number 1.

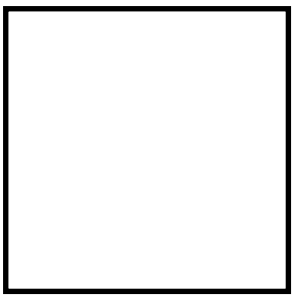
Lesson adapted from *Curious and Creative: Critical Thinking and Language Development*, 1993, Nancy Sokol Green, Addison-Wesley.



Heart _____

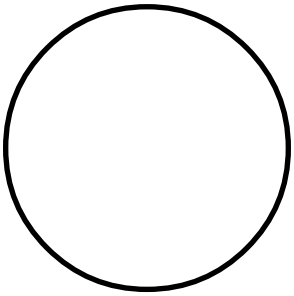


Triangle _____

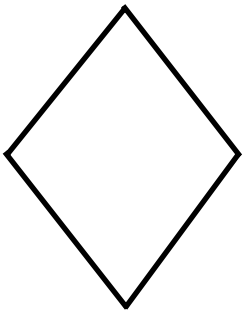


Square _____

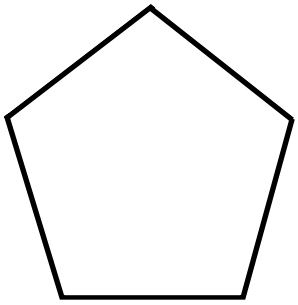
Rectangle _____



Circle _____



Diamond ____



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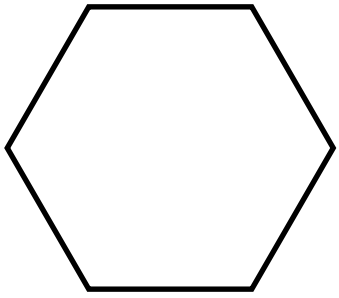

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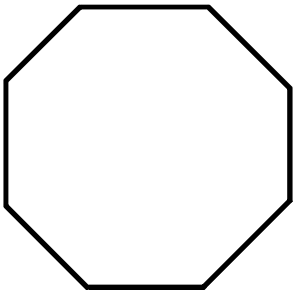

Octagon ____

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