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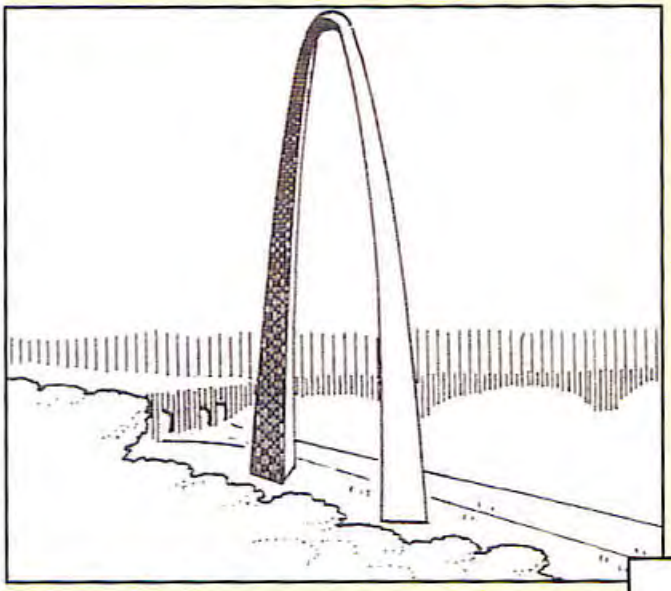
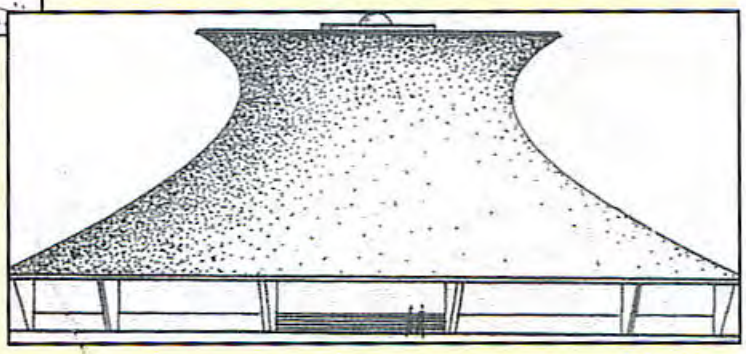


The locus of the centroids of each triangular cross section of the St. Louis Arch forms an inverted catenary curve.

What is the equation of this catenary?



A vertical cross section of the Planetarium at the St. Louis Science Center is a hyperbola.

What is its equation?

Problem Solving in the Primary Classroom

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When I was in second grade, the words *math* and *computation* were synonymous. Each day we completed a worksheet of 30-50 computation problems with one story problem at the bottom of the page. We called it the "dreaded story problem." Even our teacher called it that! On most days, her instructions were to just cross it off because it was too hard or complicated for us to do. On occasion our teacher would be in "a mood" and would require us to complete the problem. So, we would do what any second grader would do. Half of us would add the two numbers together and the other half would subtract the two numbers. Of course, half of us would get the problem right and the other half would get it wrong. That was in 1968. Unfortunately not a lot has changed since then. The only difference is that we have an exciting name like "Problem of the Day" for the story problem.

Most mathematics programs do not offer daily multiple opportunities to problem solve, and the problems are usually one-step and simplistic. My Action Research Thesis was written about the importance of teaching problem solving in the primary classroom. Through my research, I tried to locate and identify some of the highest quality materials available. Unfortunately, after conducting an extensive search of private sources, textbook companies and scouring materials at NCTM conferences, the only resources that I was able to find were simple Problem of the Day manuals. This became my inspiration to write a book that would meet this need.

Consider the following examples of story problems:

Example 1: Alexandra has 4 cats. Her aunt gives her 3 more cats. How many does she have now?

Example 2: Rich has 5 cookies. He eats 2 of the cookies. How many does he have left?
These are typical story problems found in most series today. While we are jumping up and down wondering why our kids aren't excited about solving these problems our students are thinking:

"Who in their right mind has four cats and if you did, why would you get three more?"

"What's wrong with Rich? Any normal kid would have eaten all five cookies!"

These kinds of story problems aren't relevant to children today. They are also too simplistic and can usually be solved by adding or subtracting the two numbers. Instead, we should be teaching our students multiple ways to solve complex and multi-step problems. As adults, we realize that there is a multitude of ways to solve real-life problems, and if we want our students to be future problem solvers, we need them to realize this as well.

I spend 15-20 minutes each day problem solving with my students. My children quickly learn that it is just as important to be able to tell me ***how*** they arrived at the answer as it is to get the correct answer. Therefore, every student must be able to explain his/her reasoning. After a student models his/her strategy, I challenge the rest of the class to come up with a different way to solve the problem. Modeling multiple methods of problem solving provides struggling students with clear examples they might use in the future. It also pushes more advanced students to look farther outside the box.

Samples of a scripted lesson from *When Do Dandelions Become Weeds?* (p. 49) follow whereby the teacher reads the script and draws what is written in bold (after responses from students) – just like the sample on the illustrated chalkboard.

In Figure 1, there are 15 items in my school box—pencils, erasers and crayons. If 4 are

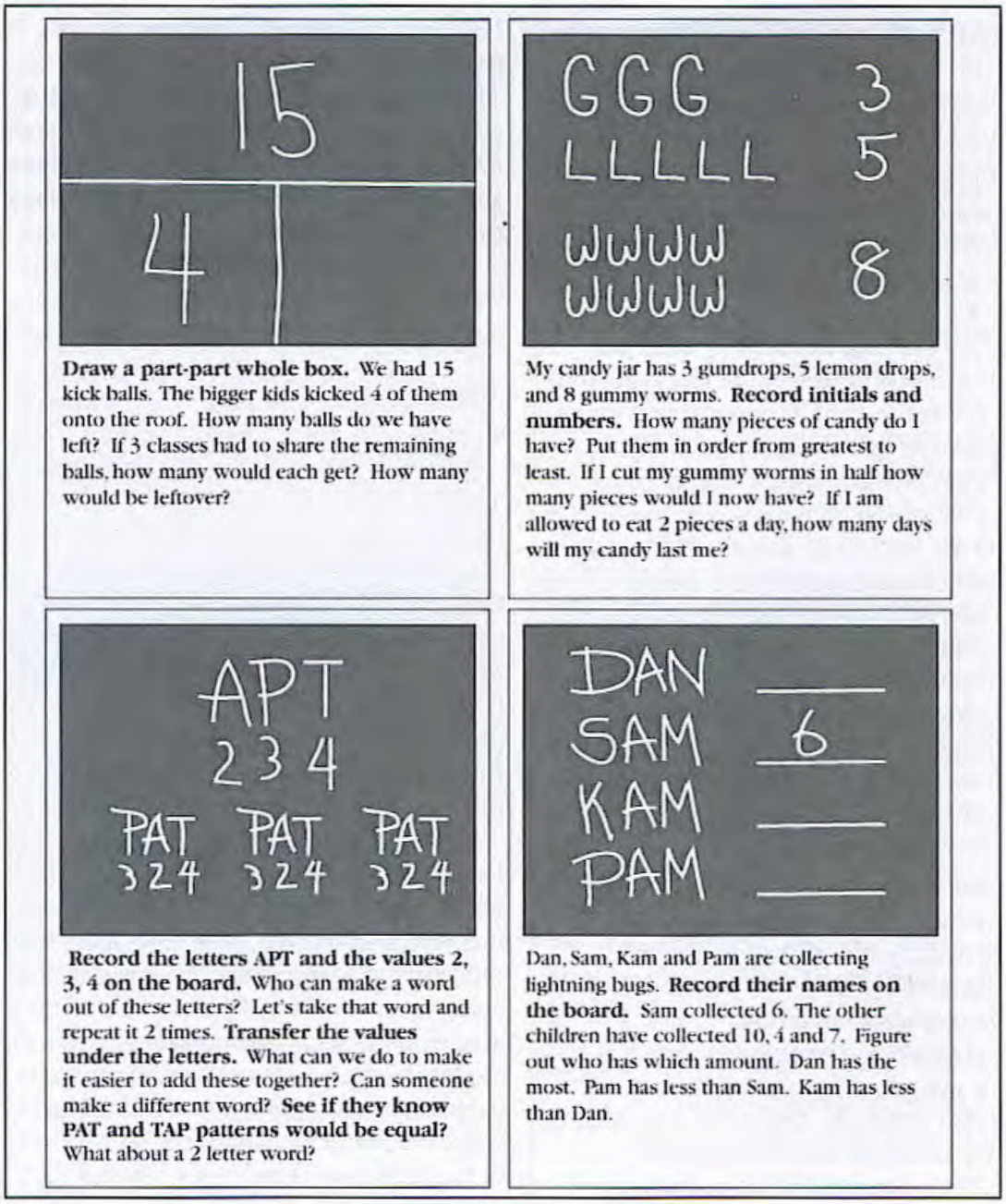

Figure 1 - Day 26, Part 2

pencils and 3 are erasers, how many are crayons?

The first student explains that he used a part, part, part-whole box. He put 15 in the whole and 4 and 3 in the parts. He then knew it was a subtraction problem and once he subtracted 4 and 3 from 15, he had solved for the number of crayons.

The second student explains that she counted up. "I knew I had to get to 15 items, so I added the 4 and 3 to get 7. I then used the number line to see how much I needed to add to 7 until I had 15." The third student shares that she drew a picture. "I drew the 4 pencils and 3 erasers and then kept drawing crayons until I had 15 items. Then I could count how many crayons I drew."

Clearly each of these three students is working at a different capability of problem solving. All three are going to get the correct answer if given

a question like this on a test. Your goal is to assist the student who worked much too hard drawing all of those pictures by showing her that there are easier ways to still get the correct answer.

In my class, we typically solve four different types of problems each day. While one Problem of the Day isn't nearly enough, time limitations and attention spans rarely allow me to work on more than four problems a day.

I use the scripted lessons with one response for each problem for the first month of school so that my students could be exposed to a variety of problem solving strategies. After that time, I am ready to accept multiple methods to solve each problem.

Once your students are experienced at identifying multiple ways to problem solve, it is time to move to more complex and multi-step problems. Look at the following samples:

Different Kinds of Homes

1. _____people live in an igloo. _____live in a cabin. How many people are living there? Are there more igloo or cabin people? How many more?

2. My apartment building has _____stories. If _____people live on each floor, how many people live in my apartment building?

3. It takes _____stilts to hold up one beach house. How many stilts would it take to hold up _____beach houses?

4. A ski lodge has _____floors. Each floor has one less room than the floor below. If the bottom floor has _____rooms, how many are on the top floor? How many rooms altogether?

The Little Red Hen

1. One bundle of wheat could be ground into _____cups of flour. How many cups could she get out of _____bundles of wheat?

2. Little Red can bake _____loaves each day. How many would that make in a week?

3. Little Red baked _____white, _____wheat, and _____cinnamon loaves. How many loaves is that? Put them in order from *most* to *least*. How many more does most have than least?

4. Little Red changes her mind and decides to share her bread equally with duck, dog and cat. If she cuts a loaf into _____pieces, how many will each get?

My problem solving topics center around: current holidays and sports; characters and events in stories we are reading in class; parts of our school day, etc. It is important to keep these topics of high interest to our students centered within our problem solving goals.

"Different Kinds of Homes" fits with a basal story and social studies unit where we study different kinds of homes around the world. Problem 1 requires work with number sense. Problem 2 and 3 teaches students multiplication through repeated addition. Problem 4 is a much more complex problem where students might have to draw a diagram or create a formula to solve.

The Little Red Hen features a childhood classic and requires students to work with number sense, multiple patterning, and fractions. Questions in problems 3 and 4 even provide discussion opportunities on what kind of bread do students think the Little Red Hen really did bake and who thinks that when she shared it was the right thing to do?

Notice that the number amounts are purposefully left blank for two reasons. First, you know your students best and can choose numbers that would be appropriate for the level of problem solving they are ready to complete. The second reason is that it gives you an opportunity to teach your students how basic problem solving skills will help them as their problems become more difficult and the numbers get larger. Take the second question from *The Little Red Hen* as

an example. If I taught this lesson early in the week, I might put a "2" in the blank. As we problem solve, my students would discover that using our doubles or counting by twos would be an easy way to get the answer. If I re-taught this lesson at the end of the week, I might put the number "8" in the blank. We could initially use our doubles to get started and then use a hundred -chart to add the doubles together. Another fun thing to do is to let students choose the numbers the next time you problem solve. When someone chooses 99 (thinking it will be funny) you can actually challenge students to find an easier way to solve the problem.

Problem solving is a lot of work for the teacher and for the students. You may begin this journey with the goal of raising student achievement in problem solving. While you will easily accomplish this goal, you will also discover that you and your students are now more experienced, successful, AND eager problem solvers. ■

Rena Pate has taught first grade for 21 years in Danville, Illinois and has her Master's in Teaching and Learning Mathematics. She has presented at several ICTM workshops, the NCTM Regional in New Orleans, and the Annual NCTM Conference in Indianapolis. She will be presenting at the NCTM Regional in St. Louis on Thursday, October 27.

Her book: *When Do Dandelions Become Weeds? A Guide to Teaching Problem Solving in the Primary Classroom* contains hundreds of problems ready for use in the classroom and is available from Amazon and Lulu.

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Wheel Watchers

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The *Wheel of Fortune* was created in 1975 by Merv Griffin as a daytime TV game show. Merv was already known as the creator of *Jeopardy*, which started eleven years earlier. Pat Sajak was hired as host of the *Wheel* in 1981. A night time syndicated version of the show started in 1983. Pat Sajak left the daytime show in 1989, but continued on as host of the evening show with Vanna White as the hostess.

At this point, I am going to assume that you are a "Wheel Watcher" and know how the game is played along with the rules and rewards. I have followed the evening show for a number of years. My interest lies in the way the game involves the basic ideas of mathematics, logic, strategy, and problem solving.

Contestants use well known facts of probability such as the following: some of the most likely consonants in the English language are *T, N, S, H, R, D,* and *L*; the most likely vowel is *E*; in a three-letter word starting with *T*, there is a good chance the second letter is *H*; in a three-letter word with *N* as the middle letter, there is a high probability the last letter is *D*; and so on. General knowledge about the puzzle topics, some basic logic involving the use of that knowledge, and a strategy for winning would seem to be helpful for a top level player. Of course, chance is involved in spinning the wheel and in selecting letters for the puzzle. Some players have very bad luck and hardly get a chance to play, and others are blessed with good fortune. The contestants selected are obviously intelligent people with considerable experience in watching the program.

After watching more than a few programs, the one contestant skill that I question is that of strategy. It seems to me that the trend, at least during the past several years, is to buy vowels early—before the most common consonants were selected. The opportunity to buy a vowel should help a player solve the puzzle. I believe