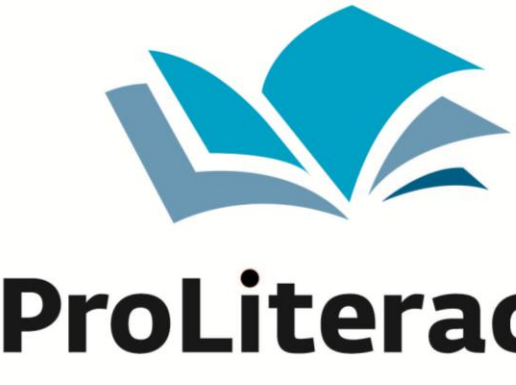

ProLiteracy®

From Stress to Success
Solving Math Word Problems

Presented by:
Todd Evans
tevans@proliteracy.org

Biographies, Surveys, and Other Writing Activities

Math biographies, surveys, and other writing activities can help students

- **Overcome the negative feelings they have toward math.** They can help students clearly see where their strengths and weaknesses are, and where they are already successful in solving math problems.
- **Become familiar with seeing math problems expressed in words.** This will make it easier for them to read and understand word problems.
- **Make connections between math concepts in the classroom and real world applications outside of the classroom.** This is important because word problems are drawn from real world applications.
- **See that they can transfer the problem solving skills they use every day to solving math word problems.**

Providing Context to Problems

Asking students to provide a context for the numbers in the math problems they solve can help students develop the problem solving skills they need to solve word problems.

Instructions

1. Assign math problems
2. Ask students to provide a context for the problems they solve
3. Ask students to share context when reviewing in class

Writing Word Problems

Having students write their own word problems helps students learn how word problems are constructed, develop their reasoning skills, and make connections between math concepts and the real world.

Instructions

1. Have students work in pairs.
2. Ask each student to make up a simple math problem and write it on a piece of paper, without the answer. Example: 10 ÷ 2 = 5
3. Ask students to exchange math problems with a partner.
4. Ask students to make up a context for their partner's math problem. For the example above, the context could be $10 divided between two people.
5. Once they have a context, ask students to write a word problem to go with the math problem. Example: Mrs. Johnson has two children. While at the mall, she wants to give each of them money so they can shop on their own. She looks in her purse and sees that she has $10. How much money will each child receive?
6. Ask each student pair to exchange their two word problems with another student pair.
7. Have students work in pairs to solve the new word problems.

Math Biography

Please answer the following questions as honestly and completely as possible. This will help the instructor understand more about your background in math.

1. Do you like math? Yes No
   If you circled NO in the above question, when did you start to dislike math?

2. With what kind of math problems do you feel most confident?

3. With what kind of math problems do you feel least confident?

4. What do you want to learn in math that could help you in your life?

Math Biography found in Teaching Math to Adolescents and Adults, prepared by Beth Ann Leaf and Linda Thistlethwaite; published by Central Illinois Adult Education Service Center, College of Education and Human Services, Western Illinois University.

Math Survey

When Do I Use Fractions, Decimals, Percents, and Ratios?

Each of the following situations involves a fraction, decimal, percent, or ratio. Check off any experiences you've had:

- ☐ Following a recipe
- ☐ Figuring out mileage
- ☐ Determining a sale price
- ☐ Using a measurement tool such as a ruler or tape measure
- ☐ Reading percents in newspaper headlines and articles
- ☐ Paying for something with coins
- ☐ Using the metric system for measurement

If you've done any of the things above, you've probably used fractions, decimals, percents, or ratios. Answer the questions below.

1. Describe the last time you used fractions when measuring something. For instance, you may have measured water for a recipe or used a ruler to measure the length or height of an object.

   _____

   _____

2. Where have you seen the word percent or the symbol %? Perhaps you've seen it in a sale advertisement or in a newspaper headline or article. Write the percent and what it was describing.

   _____

   _____

3. When is the last time you used a digital measurement? For instance, you may have used a digital scale at the grocery or hardware store. You may have weighed yourself on a digital scale. Or you may have used a car odometer or a digital thermometer. Describe what you used.

   _____

   _____

4. You use money every day. Have you ever thought of money as decimals? For example, $.01 is a penny, and $.10 is a dime. With a partner or a group, list other places that you see decimals. Use a newspaper, interview classmates, and ask your teacher for ideas.

   _____

   _____

Active Reading Strategies

Active reading strategies are any strategies that encourage students to interact with the word problem they are reading. They might include:

- Circling Numbers
- Underlining key phrases
- Rereading a problem
- Restating the problem in your own words
- Thinking of a similar problem
- Studying a graph or diagram before reading the problem
- Drawing a graph or diagram of the problem

Think Aloud Technique

The Think-Aloud technique is an excellent way for teachers to help students see the thinking process that goes into analyzing the problem, selecting the correct operations to use, and identifying when the operations are working and when they are not. In the Think-Aloud technique, the teacher periodically "thinks aloud" and describes the thought process he or she is using to work through the problem. Students can then observe how successful math students interact with and solve math problems.

Instructions

1. **Carefully select problem.** Select a problem that is challenging for students but that involves math operations they are already familiar with. You want students to concentrate on the critical thinking and problem-solving strategies you use to solve the problem without being distracted by new operations.
2. **Review the problem and select the strategies.** Analyze the problem to identify what students need to be able to do to solve it, and where they are likely to encounter difficulties. Identify three to five strategies to use in solving the problem that directly impact students' areas of weakness.
3. **Put problem into your own words.** This is the first step a good mathematician takes, but many students don't do this. Restate the problem in your own words, clearly identifying what you are being asked to find.
4. **Model the strategies you identified.** Model the strategies by stopping periodically and thinking aloud about the problem. It's important to rehearse when you'll use the strategies and what you'll say. Preparation will help you focus on the specific strategies and present them clearly. It is all right and even preferred to demonstrate the thinking process as not perfect. You can try strategies that are wrong, for example. Just explain why you tried them and how you realized they weren't correct. While you're using the Think-Aloud technique, have students follow along and write down the different strategies you try.

5. **Review and discuss the strategies that were used.** Have students identify why a specific strategy was useful. Ask students if they can think of other problems they have seen where that strategy would be useful. Ask them to think of other strategies that you might have used.
6. **Have students use the Think-Aloud technique.** You can do this in two ways. You can solve problems as a class, calling on different students to think aloud to the entire class. You can have students work in pairs and think aloud to each other while you go around the room and listen.

Brainteasers and Fermi Questions

Brainteasers and Fermi questions provide students with fun opportunities to practice their critical thinking and reasoning skills. You can have students work individually, in pairs, in small groups, or as the whole class to solve the problems. You can offer rewards for students who answer the question correctly or offer the most creative solution. The nice thing about these is that there are often more than one way to solve them, so student have an opportunity to see a variety of problem solving approaches. Below are some web resources for these activities.

Brainteasers

- **Brain Teasers-Daily Dose** (http://www.internet4classrooms.com/brain_teasers.htm)
  There are several categories of word problems. They are complex, but written for children. They can easily be rewritten with an adult context.
- **Math Warehouse – Math Riddles** (http://www.mathwarehouse.com/riddles/math-riddles.php)
  This site has a great collection of riddles that require students to manipulate numbers and information creatively.
- **A Collection of Quant Riddles With Answers** (http://puzzles.nigelcoldwell.co.uk/)
  The nice thing about this website is that he has categorized the riddles into not so hard, quite hard, and very hard.

Fermi Questions

A Fermi question is an estimation problem that teaches students reasoning and problem solving skills. They involve making estimations about problems that have limited information and seem impossible to answer. As students present their arguments for their approach to the problem, you can discuss the different approaches and which you think is the best approach. Below is an example of a Fermi Question.

How many piano tuners are there in Chicago? To solve the problem, you might make the following estimates

- There are approximately 5,000,000 people living in Chicago.
- On average, there are two persons in each household in Chicago.
- Roughly one household in twenty has a piano that is tuned regularly.
- Pianos that are tuned regularly are tuned on average about once per year.
- It takes a piano tuner about two hours to tune a piano, including travel time.
- Each piano tuner works eight hours in a day, five days in a week, and 50 weeks in a year.

From these assumptions, you can compute that the number of piano tunings in a single year in Chicago is

- (5,000,000 persons in Chicago) / (2 persons/household) × (1 piano/20 households) × (1 piano tuning per piano per year) = 125,000 piano tunings per year in Chicago
- We can similarly calculate that the average piano tuner performs
- (50 weeks/year)×(5 days/week)×(8 hours/day)/(1 piano tuning per 2 hours per piano tuner) = 1000 piano tunings per year per piano tuner
- Dividing gives
- (125,000 piano tuning per year in Chicago) / (1000 piano tunings per year per piano tuner) = 125 piano tuners in Chicago

For more Fermi Questions, visit

The Physics Teacher Online (http://scitation.aip.org/content/aapt/journal/tpt).
This Physics website publishes a monthly newsletter and in each newsletter is a Fermi question. You can find the answers to past Fermi questions in the newsletter archives.

Eliminating Barriers

Students can have many barriers to solving word problems. Some of these may even be self-inflicted, such as fear of word problems. There are several strategies you can use to help reduce or eliminate these barriers.

Introduce word problems early to students

Sometimes we teach (or published materials are organized) so that students learn content in discreet content areas and then we give them word problems that ask them to combine skills. For students who are afraid of math or intimidated by math, this leads to a constant barrage of new information and a sense that there is way too much for them to remember and understand. Introducing word problems early on, when the math content is not complex helps students take what they are already comfortable with and expand it into solving word problems. Continued exposure to math problems will increase students' comfort level, and by the time they get to more complex math content, they will not be intimidated by word problems.

Teach students to simplify word problems

Students who are not confident in their math abilities can be intimidated by problems that use unusual or complex numbers. Teach students to work a "simpler" version of the problem first, analyze what they did, then apply the same process to the more complex problem.

Use math aids to help fill in student knowledge gaps

Math aids are graphic organizers that can help students follow complex math processes and procedures. Students follow simple, one-step directions and enter the answer for that step before they move on to the next. The aid includes decision-making questions that help students determine which calculations they need to perform. Aids are a great way for students with gaps in their math skills to be able to work difficult problems and develop their critical thinking and problem solving skills without worrying about getting an incorrect answer because of their gap in skills. As they use the tables more and more, they will become comfortable with the operation and eventually will not need the support of the table.

Problem Solving Graphic Organizer

Step	Complete the Sentence
What am I trying to find?	I am trying to…
What is the information (with labels) in the problem? Identify information you think is necessary and information which you may not need.	The important information is… This information is not important because…
What operations will I use?	To solve the problem, I will…
Solve the problem	First I… Next I… Finally I
Check my answer. Did I answer the question? Does my answer make sense?	The answer is… I was asked to… This answer makes sense because…

Adding Mixed Numbers Math Aid

Problem						
1. Do the fractions have the same denominator? 1a. If no, find a common denominator and rewrite the numerators.	Yes	No	Yes	No	Yes	No
2. Find the sum of the fractions (not the whole numbers) 2a. Can you simplify the sum of the fractions? 2b. If yes, write the fraction in the simplest terms.	Yes	No	Yes	No	Yes	No
3. Is the sum of the fractions (2b) greater than or equal to 1? 3a. If yes, convert the fraction to a mixed number and write it here. 3b.Find the sum of the whole numbers in the original problem plus any whole number from 3a and write it here.	Yes	No	Yes	No	Yes	No
4. Combine the sum in 3b with the fraction from 3a.						