Reading Guide for "Math is Healthy" by Martha Merson *

Consider these questions before and after you read the essay "Math is Healthy" by Martha Merson. You are encouraged to take notes on your responses (e.g., in a reading journal). The ideas in this essay will be discussed during Session Three.

1. Martha Merson observes that "In spite of the importance and relevance of teaching math, many adult literacy teachers approach the subject reluctantly... Teaching beyond the boundaries of one's comfort or knowledge level is stressful" (p.1). How is Merson's observation consistent with your own teaching experiences and feelings about math instruction?

2. Identify some ways that the author believes that an adult literacy teacher can support their students' math skill development, even if the teacher is not specifically trained to teach math.

3. What message do you think the author tries to convey with her sub-title "Uniting Math and Health: Mix Equal Parts" (p.3)?

4. Reflect on the nine recommendations Merson offers for maximizing math instruction in the context of health literacy skills. Think of an example that illustrates how you might apply one of Merson's recommendations in your own classroom. Do any of the recommendations seem especially difficult? If so, why?

5. The author recommends that teachers make use of students' "common sense to increase their facility with school math" (p.3). Think of an example in which a student's "common sense" (i.e., everyday mathematical thinking) about chronic disease management could be used to facilitate the development of math skills in the classroom.

6. Choose one of the math skills mentioned in Merson's essay (e.g., problem-solving, measuring time, reasoning, reading scales).

   - Why would someone with a chronic disease need to master this skill?
   - What do you think your students would find easy or difficult to learn with respect to this math skill if they needed to manage a chronic disease?
   - How might you go about addressing this skill in your teaching (even if you are not a math teacher)?

7. What aspect of Martha Merson's article was most relevant to you as you think about how to address math skills related to chronic disease management in your own ABE/ESOL classroom?

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* Merson, M. (2004). *Math is Healthy*. Paper prepared for the Health and Adult Learning and Literacy (HALL) Study. Cambridge, MA: National Center for the Study of Adult Learning and Literacy.

Math is Healthy

An essay by Martha Merson

The scene: A few friends gather for dinner at a restaurant. After dinner, the check comes and inevitably, someone backs away, saying, "I am no good at math."

Cut to an adult basic education program where an adult student confronts a math text and says with equal emphasis, "I am no good at math."

Adults often express insecurity about math. Yet the same people who feel unsure of their math skills have numbers that act as their personal benchmarks, for example, the height and weight of a child. They can handle division situations such as splitting an amount fairly between two children, and they can often calculate hourly wages and sometimes time and a half as well. If teachers look and listen, they can easily find evidence that their students 1) do math and 2) have strategies to manage real life situations that demand mathematics.

Why teach math in the classroom then?

1) Some adults want to perform well on tests and pursue formal education for which they need higher math skills.

   Students' out of school math skills and experience do not always translate to classroom or test situations. Building a bridge between adults' common sense and their strategies in-school situations is key to promoting progress in reaching goals such as higher education, passing tests like the GED or work-related tests for promotions.

2) Adults face high-stakes decisions that call for complex math problem solving. When a real-world problem is unfamiliar or slightly more sophisticated than what adults are accustomed to, the strategies they have developed to handle specific real-world tasks may not translate to the new situation.

   Adults confront high-stakes decisions regarding their health benefits and life insurance options, not to mention payment plans and credit card debt. Caretakers make decisions about when to rush to the nearest emergency room based on their reading and interpretation of blood sugar levels, peak flow meter results, or thermometer readings. Experience with math in the classroom can lead to greater confidence with problem solving thereby helping adults avoid negative financial and health repercussions.

In spite of the importance and relevance of teaching math, many adult literacy teachers approach the subject reluctantly. Literacy or language teachers have training, experience and passion for reading and language, and not necessarily for exploring math concepts and skills like word problems, algebraic thinking, or percents. Teaching beyond the boundaries of one's comfort or knowledge level is stressful.

However, adult education teachers can assist students in refining their math skills, ***not*** by teaching the how-to of every calculation, but by:

1) Scaffolding reasoning skills
2) Teaching students how to question themselves and others
3) Modeling how to make informed guesses
4) Teaching students how to capitalize on the strategies students already possess
5) Setting the tone for exploration and inquiry

Pre-GED teacher Martha Gray frequently tells her students, "We're learners together. We help each other out by explaining how we see the situations and what our process is. "

Uniting Health and Math: A Little Background

In published standards (1989, 1995) the National Council of the Teachers of Mathematics has stressed that students need skill-based instruction in concert with the ability to communicate, problem solve, reason, estimate, and make connections to other areas, like health. Many financial and economic issues require sophisticated math skills. Health topics usher in mathematics issues as well. Because health is both universal and personal, it works well as a context for making math meaningful. The mathematics involved can be related to concrete topics like time and measurement or more complex topics like risk and probability. Adult educators are uniquely positioned to carry out this type of curriculum. They understand that adults come to class with expertise based on life experience as well as immediate, pressing needs related to real world problems.

Literacy and language teachers who begin to delve into mathematics with their students will find that many of their teaching strategies carry over to mathematics. Excellent math classes are less about the teaching of specific steps and more about posing an open-ended question, such as "What did you notice? In what range do you expect the answer to fall? What do you predict will affect the rate of change?"

Habits related to daily activities like exercise, sleep patterns or eating have formed over years and years; adults are unlikely to change after one conversation. Similarly, habits of mathematical thinking based on a lifetime of experience may not shift immediately. Educators who teach health topics tend to be realistic about the process of changing health behaviors. An equal amount of patience may be called for when teaching math. Assimilating new steps or strategies can take encountering, processing, and repeating the information multiple times in multiple ways. For example, while counting out the number of hours between medication doses, a student might revert to counting the hours by one's as opposed to counting by two or adding six hours and adjusting for the 24-hour day or simply dividing the number of times into the 24-hour day.

Most standards and frameworks documents include general ideas rather than specifics for teaching lessons. The National Science Foundation recognized the need for a curriculum geared to adults and young adults and funded Extending Mathematical Power to Adults (EMPower, 2000-2004), a research and curriculum project to design and pilot reform math curriculum in pre-GED type classes (for ESOL and ABE students).

As EMPower's research associate, I have closely observed adults doing mathematics in their classrooms. The team of researchers and authors has also collected and analyzed student work. When we gather around samples of student work, we ask ourselves: *What do students know and understand? What questions do I have about the work I see? What might I do next as an instructor?* The result of this scrutiny is that field-test teachers and EMPower authors have found several approaches which deepen mathematical thinking, communication, and reasoning.

In this article, I share some of the insights, hunches, and recommendations gleaned from this work. I offer tips for how to handle math topics that tend to surface in health discussions, particularly misconceptions about percents, number, and data, and offer a sample lesson plan teachers with minimal math background can adapt, expand and take into the classroom.

Uniting Math and Health: Mix Equal Parts

By exploring some of the mathematical issues inherent in health topics, teachers have a chance to:

- Acknowledge and exploit students' common sense to increase their facility with school math, thereby strengthening both
- Teach how to use tools like gauges (temperature), calculators, web-based calculators
- Increase document literacy (interpreting of charts, graphs, and forms)
- Gain a deeper understanding of how students make sense of quantities, including percents associated with (representing) risk or raw numbers
- Increase students' reasoning, ability to articulate patterns, generalize and predict

Below are nine recommendations for maximizing math instruction in the context of health and literacy.

(1) Pose a real life problem.

Researchers have shown that on the job, people tend to stick to the meaning of the situations. This guides their thinking and keeps them from making the exasperating errors teachers tend to see in classwork. If school math could take advantage of the sense that adults bring to the math in their daily lives and workplaces, then students could make quicker progress toward their school related goals. Staying close to the meaning of the situation makes EMPower curriculum writers carefully consider the structure and content of math classes. The problems have to ring true. Here are some sample questions to pose:

> What does the 4 mean in the temperature reading of 100.4? How worried are you if your child's temperature is 100.4?
>
> The doctor says this therapy works in 50% of the cases. How do you interpret that? What would it mean if 100 people get the surgery this month? What about 600 people?

Keep the math linked to a sensible context so that students can always come back to the question, look again at their solutions and ask themselves: does this make sense?

(2) Offer multiple strategies
Brainstorm possible strategies before you hone in on one. Create a bridge to students' real world experience. Invite students to bring those strategies into the classroom. An example:

> With information from a nutrition label in hand or posted:
> 4 cookies 62g
> Calories 220
> Calories from fat 20
>
> How would you figure out the nutrition information for one cookie? What is another way?

Encourage students to show their ways using pictures of cookies or a number line that shows the numeric information for four cookies, two cookies, and finally one cookie. Students may guess and check, break the numbers down, or add up.

> "If you want to find someone's pulse for a minute, how do you do it?" Sure, you can place your finger on the pulse at the wrist for one minute. That absolutely works. Does anyone have another way?"

If students do not offer multiple strategies, or a strategy you see as efficient and one they could get some mileage out of, model how you approach the problem.

"Here is how I do it: I watch the clock for 15 seconds while I count the pulses. Then what could I do to find the pulse rate for one minute?"

Give students a chance to practice each other's strategies or the one you offered. "Okay, let's work in pairs and get a pulse for each person." (Note: Remind students to avoid using the thumb to track pulse; it has a strong pulse point of its own that can interfere.)

(3) Use manipulative or countable objects to make an abstract idea more concrete.

Although adult education programs may have math manipulatives like blocks or Cuisenaire rods on their shelves, sometimes students resist using manipulatives. Over the counter manipulatives (available through Cuisenaire or Dale Seymour) like blocks, may look childish and are thus off-putting. However, manipulatives give students a physical model to which they can relate the abstract numbers. For example:

> Pam is taking three pills every day. When will she finish her 50th pill? Use pennies to represent the pills. Group them by day then count how many days go by until the 50th pill is reached.

Manipulatives are especially helpful in understanding ratios with relatively small numbers. For example:

> If you can buy 2 pints of blueberries for $5.00, how much do 10 pints cost? Use pennies to show pints and toothpicks for dollars.
>
> | | | | |
> |---|---|---|---|
> | OO | OO OO | OO OO OO | etc. |
> | iiiii | iiiii iiiii | iiiii iiiii iiiii | |

It is key to introduce manipulatives well. I have seen teachers explain that children learn by playing and that play is something adults can benefit from as well. Central to dispelling the stigma of manipulatives is to make sure everyone has them, not just the one or two students who are struggling. If the manipulatives are easily accessible, anyone can reach for them at any time to make an explanation clearer.

Teachers absolutely do not have to spend a lot of money to have manipulatives: post-it notes, paperclips, a jar of pennies, a stopwatch, clock, thermometer, all come in handy. Learners hold onto information that they absorbed from kinesthetic experiences as well as through verbal and auditory channels.

(4) Use benchmark numbers

Even adults who memorized their times tables do not rely exclusively on them to do mental math or estimation. Adults report using strategies such as breaking down numbers, rounding, adjusting, and doubling. With a strong sense of 10's, 5's, and 1's, adults can solve a very wide range of problems.

Similarly, for understanding data, a grounded sense of half, quarters, and thirds allows for mental comparisons. For example, students in one class generated a set of data based on the foods they eat most frequently. They organized the data and wrote statements based on it. One group described the starch category, "4/9 of the starch group is rice". This statement is accurate, yet not typical of the way most statistics are reported. The teacher asked, "Is this more than, less than, or equal to a half?"

Strategies involving breaking numbers apart and putting them back together can make intimidating-looking problems manageable mental math. For example,

> *MJ makes $800 for a 70-hour work week.*
> *Kiki makes $10.25/hour for a 35-hour work week.*
> *Who makes more per hour?*
> *What do you do first?*
> *Compare what you did with a co-worker or friend.*

(5) Address component parts [measurement units]

Be aware that students often relate to quantities as if they are all whole numbers represented by countable objects. This model works if you are handling gelcaps or counting fingers. The first one is one, but if you are counting parts of a day or using a measurement tool, you start counting with the first *space*. Students may benefit from practicing with a ruler and may require help finding zero on it because rulers rarely have "0" clearly marked.

Students' written work may look as if it is filled with comprehension errors particularly when word problems involve time. In EMPower pilot classes, I have observed students struggle with problems that require converting between seconds and minutes or minutes and hours. In the two problems below, the math concepts called upon are similar. Students found the first problem was not at all difficult, but the second was a huge challenge.

> Alberto puts aside $5 a day for his mother. How many weeks will it take him to save up $140 for his mother?
>
> Velma watches 5 hours of television every day. Each hour includes 10 minutes of commercials. How many days until Velma has watched 10 hours worth of commercials?

In both problems, students take a given amount and repeatedly add or multiply that amount until they find the given target amount. But in the first problem, the unit starts as $5 and the unit for the target amount is also given in dollars. Whereas in the second problem students need to work with 10 minute increments, but the target amount is hours. When the teacher asked how many 10 minutes chunks in an hour, students seemed not at all certain.

The fact that in the U.S. we don't use a twenty-four hour clock complicates matters further. Unless they are associated with the military, it is unlikely that students will ever see the 13th hour written as 13:00, but rather must visualize 1 p.m. as the 13th hour. The use of diagrams and sketches can clarify calculations. Diagrams and pictures help the teacher determine whether a mistake or question is conceptual (e.g., not understanding whether to multiply or add) or if the difficulty is based on measurement/counting. One student calculated 100 minutes in an hour instead of 60 minutes in an hour, so her answer for Velma's TV time came out wrong though she understood well how to approach the problem.

If a problem becomes confusing, use the same premise, but simplify the numbers. EMPower students are strongly encouraged to rely on their benchmarks. If they can figure out the problem with easy to manipulate numbers like half, four, and twenty-four or if they can re-state the problem using money, they may be able to get themselves back on track.

(6) Ask about the story in a graph, table, or chart.
Certain kinds of formats presenting information and numerical data are more likely to be familiar to students than others. A traditional graph with the numbers starting at the bottom left corner with zero and getting larger as they go up is not a particularly familiar format to adults with little formal education. On the contrary, adults tend to be very comfortable with columns of numbers that start small at the top and get larger. People organize numbers and total them in this format. Many adults are familiar with multiplication tables that start in the left corner with zero times zero. Women might recognize the format as similar to the charts on the backs of many pantyhose packages. Parents might recognize average height and weight charts from their children's visits to the clinic. However, when students encounter graphs, they may need time to orient themselves because the numbers do the opposite of what they expect. The numbers typically start small at the bottom left instead of at the top left.

Posing a specific question about information in a chart or graph quickly sets up a dynamic where students are right or wrong. In this situation, students' comprehension is evaluated solely on interpreting a graph for a purpose determined by a teacher or test. Such questions do not motivate students to independently engage with a graph. Multiple-choice formats do nothing to promote a real need to know or drive to understand.

Teaching for understanding involves fostering observation skills. Ask students to list all that they notice in the first 20 seconds of looking at a table or graph. Over time, they will learn to look for key words, key numbers, and features of the format. Then ask what story the graph tells. Help students tell a coherent story based on the graph. Students looking at a graph of the cost of prescription drugs might say, "At the beginning the price went up, then it leveled off, then it went sharply up."

Once students have identified the overall trend, they can focus on specific data points. Follow up by asking, who would care about this data or what decisions could this graph help you make? Teachers can also ask critical thinking questions, such as:

> *What information appears to be missing?*
> *What other way could the information be presented?*

Encourage students to pose their own questions about the graph.

(7) Give students opportunities to generate their own graphs.
EMPower has one unit dedicated to data and graphs. The unit gives students many opportunities to organize data as well as to make their own graphs. To see where information in a graph comes from, students generate a set of data, sort the data into different categories, and then present and describe the categories. In a follow-up activity, the task asks students to organize data about illnesses a group of adults experienced. Determining categories and titles has proved a challenge in a few classes. After working with the data, students in one class suggested categories such as: "Illnesses you can see" and "Illnesses you cannot see." Another's categories included bones, skin, stomach and chest. Many illnesses did not fall into these categories, and students mis-categorized others. Categorizing is one aspect of organizing information. It is a skill that can and should be honed across the curriculum because it is central to determining relevant information for making decisions. Without the skill of organizing information, adults are needlessly distracted by bits of information.

Once students have categorized information, a next step they can take is to represent the information using a bar graph, pie graph, or frequency graph. In a small ESOL/pre-External Diploma Program, the teacher asked the students to draw a pie graph to show how many women and men were in the room. At the time, five women were present and no men were present. As an author and observer, I predicted that they would finish their first circle graphs quickly. I tried to think ahead about another situation for them to represent on a circle graph. Three students put their circle graphs on the board. To my surprise, the first one showed two equal slices; one slice labeled Women (5), the other labeled Men (0). Hoping students could learn from each other, we asked a couple students to show their circle graphs. One student had divided her circle into two. She wrote women (5) next to the first slice and men (0) next to the second slice. Both students explained that there were no men currently present, but some might come, hence there was space on the pie chart for them.

Why is this significant? The expectations any of us brings to a text (including graph or chart) shape what we see. The fact that students expect that they might encounter an empty place, that the graph might save a space for something that is yet to occur indicates to me that they may expect more truth from a circle graph than the data will actually deliver. Absent categories fall out of certain kinds of graphic representations.

(8) Consider that written or oral skills may mask math strengths or difficulties.
Often students write what they mean but say it wrong or the reverse, say their thoughts correctly, but then record them incorrectly. For example, a teacher was reviewing homework in one class I observed. The student who volunteered had the answer on her paper, but when she read it aloud, she said the answer incorrectly. I called the teacher over to look at the student's written work. Continuing to work back and forth helps students with strengths and deficiencies in different areas begin to build off one to augment the other. Pay particular attention to students whose symbolic writing will confuse them later. A slanted plus sign could cause an error if it is read as a times sign.

The work on paper may be recorded correctly, indicating the student does have some idea, but has trouble expressing that verbally or has simply misspoken in the heat of the moment. For students who find all math intimidating, especially equations with parentheses or letters standing for words, working with the equation and the rule stated in English can diffuse the fear.

(9) Play out students' suggestions to their logical conclusions.
It is easy to accept the right answer and to move on. For example, you the teacher pose a question. What is the number of seconds in a minute? You hear some right answers and a couple wrong answers. Instead of accepting the right answer and moving on, try this. Record all the answers. Then ask representatives to explain their thinking.

Alternatively, take the wrong answer and play it out to its conclusion. If a student claims that 2 divided by 20 is the same as 20 divided by 2, ask what would happen if there were $2.00 divided among 20 students. Will the amount each student gets be equal to the amount if $20 is divided by two students? Follow students' thinking by asking, "If this is the case, then this is the case? Does this make sense?" If students can correct their own thinking, they will remember better for the next time.

Uniting Health and Math: Ways to Nourish Discussion
Once a teacher has posed life problems, offered multiple strategies, used manipulatives, addressed component parts, and played out students' suggestions

to their logical conclusions, here are some ideas for how to sustain the momentum of a math discussion.

Facilitating math discussions takes a little practice. You may not have time to turn every question into a rich, nuanced conversation, but when you want to, here are some rules of thumb that EMPower teachers use to enliven discussion.

The goals of math discussion/conversation are to:

1) Reveal students' thinking. What are their ideas? How do they see the problem? What strategies do they gravitate toward?
2) Encourage students to talk with each other, to share strategies
3) Give multiple students a chance to practice their reasoning
4) Give students opportunities to articulate their logic

Call for a vote

Rationale: Students have to commit. They will remember the outcome longer if they have had to commit to one answer or another because that is an active stance toward the question, not a neutral and passive stance.

Pose a question.
Often you will hear more than one answer.
Choose an answer to focus on that is NOT correct.
Ask how many agree or disagree.

Make the numbers/pictures/data visible

Rationale: The conversations can get abstract. Students will glaze over. Those whose learning style is not strongly auditory will flounder. Patterns are most easily noticed when the work is organized. Help students by setting up charts for their work.

Keep the focus

Rationale: It is useful to have the opportunity to express one's ideas aloud, but often students have the experience of not really being heard. It takes work to listen through an accent or to piece together a circuitously explained idea. Nevertheless, there are rewards for listeners and speakers in sticking with an explanation.

Have students re-state each other's words:

Can someone recap what Sam just said?
Ask someone else, *How did your classmate say he or she knew?*

Have meta-level conversations

Rationale: In every class (not to mention in life), there is a lot to pay attention to. Help students prioritize, rehearse, and therefore remember the most important points.

Take time to engage students in metacognitive thinking about the math:

How is this like/unlike anything you have seen in class/seen in your life before?
What about this seems important to know/remember?
How would you summarize what we just did?
What's the rule?

Conclusion

By exploring some of the mathematical issues inherent in health topics, e.g., timing medication, understanding nutrition label information, reading gauges like temperature or peak-flow meters, students will benefit inside and outside the classroom. With math-related health instruction, they will increase their accuracy and confidence when they encounter unfriendly numbers, math in graphs, measurement, or other types of problems. With the type of problem-posing approach used by EMPower, students can increase their ability to explain their reasoning, articulate patterns, generalize and predict. Instruction that illustrates the connections between health and math gives students the opportunity to more deeply understand both health topics and math topics and thereby to improve their health and the quality of the decisions they make in health and other arenas.

About the Author

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About the Sample Lesson Plan

Lesson 3: Body at Work, Tables and Rules *

The lesson plan included here is part of Seeking Patterns, Building Rules: Algebraic Thinking, one unit in the EMPower curriculum authored by Tricia Donovan, Mary Jane Schmitt with Myriam Steinback and Martha Merson. Lesson 3 “Body at Work, Tables and Rules from Seeking Patterns” captivated and challenged students. By design, the lesson’s main focus is generalizing a rule from a pattern and articulating how the pattern visible in tables relates to each other. For the purpose of EMPower lessons, the context of average maximum heart rate motivates students to compare average pulse rates across the life span.

Average maximum heart rates are used as benchmarks to which maximum heart rates for individuals can be compared. They can reveal whether or not a person is doing better or worse than would be expected at that age. Lifestyle decisions may proceed from such determinations. Questions such as “Do you need to increase your exercise times or the difficulty (of the routines)” can be addressed.

Note the structure of the lesson, the open-ended questions, and following the activity write-up, the two sections Looking Closely, for ongoing assessment ideas, and Lesson 3 Commentary, with facilitation ideas and math background information.

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FACILITATING LESSON 3

Body at Work—Tables and Rules

What is your heart rate at rest?

Synopsis

This is the first of a set of three lessons in which students explore, extend, and compare patterns about the human body. This lesson emphasizes connecting rules with tables of real data, and using tables and rules to solve related problems.

1. Students take their pulses at rest for 15 seconds, make a class table of the data, and state a rule for finding the number of beats per minute.
2. Individuals develop a personal table, a general statement, and an algebraic equation to determine the number of times their own hearts beat in any number of minutes.
3. Student pairs complete four tables with information about the number of calories burned over time for different exercises. They write a rule in words and algebraic symbols for each table.
4. Summary discussion centers on strategies for relating tables and rules, and using the table or rule to help solve problems.

Objectives

- Describe the pattern in a situation with a verbal and symbolic rule
- Connect patterns in tables with generalized rules
- Solve problems using the patterns represented in table data and rules

Materials/Prep

- Calculators
- Clock or watches with second hands
- Colored markers
- Graph paper
- Newsprint or transparencies
- Rulers

For *Activity 2*, prepare transparencies or newsprint copies of the four "Calories Burned" tables (*Student Book*, pp. 37–39).

Heads Up!

Use the board or set up newsprint copies of the data for the whole class to see so they can compare the various representations (table, verbal rule, and algebraic equation).

Opening Discussion

Explain that this lesson again focuses on noticing patterns and stating a rule to solve a problem, but that this time the data concern students themselves.

Begin with a common pattern for everyone—heart rate, or pulse. Say:

Start by thinking about a pattern that everyone has—a heart rate, or pulse.

How does a nurse or a workout trainer usually take a pulse?

Students will most likely mention that nurses and trainers check pulse rates on the wrist. If no one mentions that a pulse is usually taken for 10 or 15 seconds, explain that this method saves time.

Activity 1: Heart Rates at Rest

Part 1

Ask everyone to take his or her pulse for 15 seconds, and post the results in a table for all to see. The results might look something like this:

Name	Beats per 15 Sec.	Beats per Minute
Jonna	20	
Ron	17	
Denise	18	

Then ask:

How can you predict the number of times your heart will beat in a minute?

After students copy the information in the table onto their charts (*Student Book*, p. 34), they are ready to fill in their predictions for the pulse rate for a baby and a feverish adult.

Ask:

How did you figure out those two new listings? Did anyone do it a different way?

What is the rule for finding the total number of heartbeats in one minute?

Write down people's *verbal* rules verbatim on the board. In one class, for example, students dictated:

Rule in Words
To find the heartbeats in a minute, multiply the heartbeats in 15 seconds by 4.
Heartbeats in 15 seconds times four equals heartbeats in one minute.
Times it by two, two times.
Add the 15-second number four times.

Check for agreement on the ways the rules are expressed. While you will be working toward using precise language, use the students' words and notation for now.

Ask for volunteers to translate the verbal rules to algebraic notation. You might prompt by saying that "F" stands for the number of beats in 15 seconds and "M" for the number of beats per minute. In one class, the students wrote:

Rule in Words	Algebraic Notation
To find the heartbeats in a minute, multiply the heartbeats in 15 seconds by 4. →	$M = F \times 4$ $M = 4F$
Heartbeats in 15 seconds times four equals heartbeats in one minute. →	$F \times 4 = M$
Times it by two, two times. →	$F \times 2 \times 2$
Add the 15-second number four times. →	$F + F + F + F = M$

Check for agreement on the way the algebraic expressions are written, and use this opportunity to ask people to relate the various algebraic expressions:

How can you show with words or by sketching that your algebraic expressions mean the same thing?

Part 2

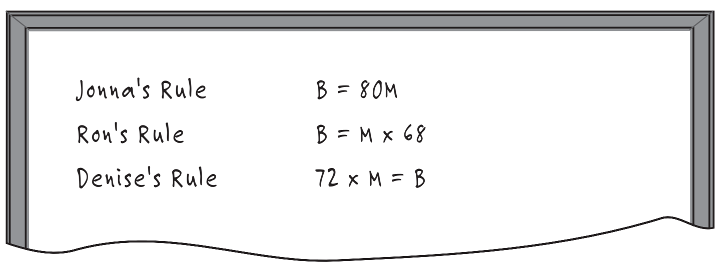
Students now focus on their own heart rates. They complete their personal heart rate table (*Student Book*, p. 35). Starting with their one-minute pulse rates, they determine the number of times their hearts beat in other time periods, such as in 5 minutes, 10 minutes, an hour (60 minutes), or a day (1,440 minutes). Ask student pairs to compare tables with each other. When everyone has a personal table completed, suggest:

Think of the table you completed as an In-Out table. Is there a rule you can write that tells how you get from the number of minutes to the total number of heartbeats?

Call upon three volunteers to record their tables and rules in words and in algebraic notation on the board. Focus on one person at a time. Draw attention to the connections between each table, its verbal rule, and its algebraic rule, asking:

Show how your rule and table are related.

Does the rule work for every instance in the table?



Students should use table data to verify that a rule works.

Select a fourth student's algebraic equation to write on the board, and pose the question:

Whose rule might this be? How do you know?

Then instruct:

Use the rule to predict the number of times this person's heart will beat in a day.

Ask the originator of the rule to verify the prediction.

Activity 2: How Many Calories Am I Burning?

Explain that the next activity will provide a chance to think more about how bodies work and how patterns and rules can be used to predict future outcomes or solve problems.

Form pairs or small groups of students. Direct attention to *How Many Calories Am I Burning?* (*Student Book*, p. 37). Let pairs work for a while, and then ask for volunteers to fill in the newsprint tables you prepared earlier.

How did you know which numbers to use to fill in the tables?

What pattern did you see in Table 1? Table 2? Table 3? Table 4?

How did those patterns show up in your rules?

Ask a few volunteers to write verbal and symbolic rules for each table on the newsprint and to connect those rules with the table data.

Heads Up!

The tables show that jogging burns 10 cal./min.; cleaning house burns 5 cal./min.; running up stairs burns 20 cal./min.; and watching TV burns 1 cal./min. Rule for jogging, $y = 10x$; cleaning house, $y = 5x$; sitting, $y = x$; and running up stairs, $y = 20x$.

Next, focus attention on how people used the tables and rules to solve Problem 1:

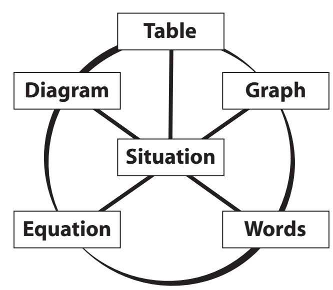
How long do you have to watch TV to burn the same number of calories as you would in a half-hour of jogging? How do you know?

If we substitute those times (30 minutes of jogging and 300 minutes of TV watching) into these rules, what will happen?

Did anyone use his or her rules to solve this problem? How?

Substitute the number of minutes for each of those activities into the symbolic rules to show that the calorie totals are equal. If no one used his or her rules to solve the problem originally, work on that now.

Summary Discussion



Much happens in this lesson. Take time to review what has been learned by asking:

How did you use the tables and/or algebraic equations to solve problems about heart rates and calories burned?

How can you tell that a table and a rule are related?

Also, provide an opportunity for students to share concerns and achievements by asking:

What was hard and what was easy for you today? What questions do you still have?

Finally, suggest students take a few moments to write in *Reflections* (*Student Book*, p. 159).

Practice

Say It in Words and Fill in the Tables, p. 41
For practice translating common abbreviations for rates into tables and connecting those to situations.

Driving at 50 Miles per Hour, p. 42
For practice looking at the rule in a table that involves distances and times.

Symbol Sense Practice

Equations ⟷ *Words,* p. 44
Asks students to translate algebraic expressions to words and vice versa.

Substituting for x, p. 45
For practice evaluating expressions.

Extension

A Friendly Reunion, p. 46
Extends this lesson to a more complicated situation that involves times, distances, and speed. A follow up to *Driving at 50 Miles per Hour*.

Test Practice

Test Practice, p. 48

Looking Closely

Observe whether students are able to

Describe the pattern in a situation with a verbal and symbolic rule

One issue that impedes rule description occurs when students rely on numerical relationships that surface in the columns, rather than looking across the rows. For instance, if the figure for calories burned for 15 minutes is given, students may realize they can double that figure to arrive at the calories burned in 30 minutes. However, this will not help them find the rule for this situation. To do that, they must look across the rows. Remind them that while these tables reflect particular levels of activity, they operate like In-Out tables. Pushing to the 100th case often forces the need to define the rule as well.

Work on getting the verbal rule as precise as possible, and use mathematical terms like "multiply it by 10." The *Symbol Sense Practice* (*Student Book*, p. 44), provides opportunities to translate equations into words and helps students become familiar with the language-symbol connection. More explicit work with rules and equations takes place in *Lesson 7*.

Do students find it hard or easy to work with letters representing the variables? For the most part, let students define the variables in their own ways. However, sometimes it is useful to make a suggestion. Make sure students understand that the variable represents the *number* of heartbeats or the *number* of total calories and that these numbers vary according to the particulars of the situation.

How well do students connect the verbal rule to the equation? One way to help students translate verbal rules into notation is to write out the verbal rule, formulated as specifically as possible, across the board or on a piece of paper. Then work with the student to connect the words with symbols and numbers, using arrows.

To find the number of **beats per minute** | Multiply the **15–second number** | by **4**

$$b \quad = \quad f \times 4$$

Connect patterns in tables with generalized rules

Do students see that the multiplier (the coefficient) in the equation is the number that they multiply time-related variables by to get figures for heartbeats or calories burned? Make that connection explicit by setting up a third column in the table between the time column and the heartbeats or calories-burned column. Ask students to write in this space what they did to get new numbers. Then ask:

Where is that number in your rule?

Minutes Jogging (m)	$10m = C$	Calories Burned (C)
1	x 10 =	10
15	x 10 =	150
30	x 10 =	300
45	x 10 =	450

Asking students to check rules by substituting table values into the equations or the verbal rules further strengthens the connections.

Solve problems using the patterns represented in table data and rules

Do students show how a solution is supported by the table data and the rule? Although some of the problems can be solved with simple computational arithmetic, ask students to connect this information to the table and rule as well.

Spend time showing how the table data for TV-viewing might be extended to reach 300 minutes without making every 15-minute entry. Match the calories-burned figure for TV-viewing to the jogging-for-30-minutes entry. Likewise, demonstrate how the rules could be used to solve the problem:

Jogging – $C = 10m$, so $C = 10(30)$ or $C = 300$

Watching TV (sitting) $C = 1m$. We know we want to burn 300 calories, so $C = 300$, and $300 = 1(m)$. What number multiplied by 1 equals 300?

Always use students' rules, and ask students to demonstrate how they might use them to solve the problem first. If they do not know how, then demonstrate. Do not worry if students seem baffled by this process. They are just getting used to equations and will have more time to solve problems with them in the lessons ahead.

WHAT TO LOOK FOR IN *LESSON 3*	WHO STANDS OUT? (LIST STUDENTS' INITIALS)			NOTES FOR NEXT STEPS
	STRONG	ADEQUATE	NEEDS WORK	
Representations Diagrams • Creates a diagram to represent the number of heartbeats in 15 seconds related to the number of beats in a minute Tables • Recognizes vertical and horizontal patterns • Identifies relationship between *x*- and *y*-values • Predicts missing values correctly Rules • Accurately describes relationship between *x*- and *y*-values in words • Accurately writes relationship between *x*- and *y*-values as algebraic equations • Uses algebraic notation conventions for all four operations				
Connections • Uses table data to arrive at rule in words • Recognizes how table data connect to symbolic rules				

LESSON 3 COMMENTARY

Rationale

Tables and rules continue to be the focus in this lesson, but students extend their knowledge by connecting tables and rules to real situations. Connecting tables to rules and using each to solve problems involving bodily data demonstrates that the pattern description skills learned earlier can prove meaningful in our daily lives.

Math Background

Rates: References to rates are endemic to our culture. We talk of miles per gallon, miles per hour, interest rates, heart rates, etc. all the time. However, understanding the mathematical relationships involved in rates is often difficult. Most commonly used rates involve change over time or distance. The dependence of one variable on the other—of miles per gallon of gas or interest paid for a number of months or years—can be confusing to anyone whose sense of proportion is shaky. This is because rates involve two variables, either of which can influence the magnitude of the other. As proportional relationships, common rates can be represented as linear relationships on graphs, which will be dealt with in the next lesson. Proportional relationships are not the main focus of this lesson, but inform much of the work.

Symbol Sense Focus: How much you decide to focus on symbol sense depends on the needs of the class. During the lesson, you might choose to highlight any or all of the following:

- Ways to write about rate: 60 mph, 60 mi./hr., 60 miles per hour, 60 miles in 1 hour.
- Ways that rates can look different when extended but be constant: 60 beats in 1 min. is the same rate as 600 beats in 10 min.; 60 beats/min. = 600 beats/10 min.
- Ways to write multiplication without a multiplication sign:

  $C = 5m$ reads C equals 5 multiplied by m; $5m = 5(m)$.
- Relationships that use multiplication to find a total—for instance, total calories burned—can be reformulated as division rules to find one of the units multiplied, e.g., minutes exercised:

  $C = m(10)$ for dancing and $\frac{C}{10} = m$ or $\frac{C}{m} = 10$

Context

Heart Rates: Differences in heart rates interest students. Normally the heart beats 60–80 beats per minute (bpm), although it can beat up to 200 or more bpm during intense exercise periods. Exercise is not the only stimulus that can raise a person's heart rate, however. Drugs, such as caffeine and nicotine; hormones, like epinephrine and those produced by the thyroid; and mental conditions, like anxiety, can all raise a person's heart rate. High body temperatures, like those experienced during a fever, can also increase the heart rate to make you feel like your heart is racing. Low body temperatures decrease the heart rate, as does being in good physical condition.

Calories: A calorie is a unit of energy equal to the amount of heat energy it takes to raise the temperature of one gram of water one degree Celsius. The calorie amounts listed on food packages are actually kilocalories. When a package reads that two slices of bread have 150 calories, it means "food" calories, or kilocalories. In scientific terms, it really has 1,000 times that many calories, or 150,000.

For more information, go to http://fitness.howstuffworks.com/calorie.htm.

At http://www.caloriesperhour.com you can calculate calories burned for any of dozens of activities. The site charts the calories burned based on height, weight, gender, age, etc.

At http://www.nutristrategy.com you can find tables of calories burned for various activities.

Facilitation

Numeracy Connection: You and your students might look for tables outside the classroom, perhaps sent with a bill, in an advertisement, or in the newspaper. For each table, you might ask:

What patterns do you notice?

Does there seem to be a rule?

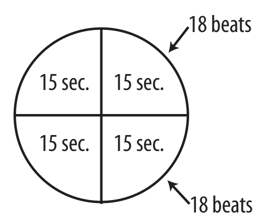
Is there a rule to predict what comes next in the table?

Students use a table to organize heartbeats in 15 seconds and the corresponding pulse in a minute. Make sure everyone reads the column headings and understands what they mean.

Some students have trouble knowing where to look for the pattern. Remind them that these tables are similar to In-Out tables.

Making the Lesson Easier

Conduct the two activities as separate lessons. Spend more time on the heart rates exercise and the relationship between the number of beats and number of seconds.



Using objects to model these relationships can help demonstrate their equivalency. Ask students to diagram or represent the relationship between time and beats by having pennies represent seconds and large paper clips represent heartbeats. Someone can lay out a penny for each of 15 seconds while another person takes his or her pulse. Then lay out the paper clips for the heartbeats. Look to see how the clips and pennies relate. Is there is a one-to-one correspondence? Ask students how many paper clips or heartbeats there are for each second. Place the pennies in an arc from 12 o'clock to 3 o'clock, and ask students how many groups of 15 pennies would be needed to fill a whole clock. Ask them to figure out how many heartbeats would then be represented.

Making the Lesson Harder

If most students are comfortable with algebraic notation, spend a little more time being more precise about the notation, comparing and relating the multiplication form with the division.

If $C = 50m$, then $m = \frac{C}{50}$.

Ask students:

Why do we multiply to find the number of calories burned, but divide to find the number of minutes doing the exercise?

LESSON 3 IN ACTION

The unit's early lessons are launched with a situation itself (e.g., taking pulses) and two-variable tables of numbers. Students are asked to seek patterns and to write a rule that explains how to find the second variable, when the first is known. They are strongly encouraged to say or write the rule in everyday language before they write it in algebraic symbols because, as one student we videotaped said, "I understand it more when I try to write it down in words."

Pulse Rate Activity

When we look closely at how students verbally express rules, we see a variety of responses. Most responses have in common the communication of a mathematical pattern, but they vary in degree of precision. Here are examples from pilot classes.

Some of the language is very precise:

"The nurse takes the pulse for 15 seconds and whatever number she gets, she times it by four."

"The pulse rate for 15 sec. x 4."

"Take pulse for 15 seconds and multiply by 4."

"Multiplies beats for 15 sec. by 4."

"Multiply beats/15 seconds by 4."

Some of the language is less complete and less precise, but you can understand what the student means.

"Multiply by 4" (several students wrote this).

"x4."

"She multiplies 15 seconds by 4 to get the answer."

"Multiply by pulse rate x 4 = ____."

"Multiply the number of ♫'s by 4."

"Times by 4."

"15 seconds x 4 = _____."

"Multiply the beats by 4."

Some students did not generalize:

"18 beat to 15 sec."

Ask yourself: What kind of instruction will move students toward more precise language?

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In one class with both General Educational Development (GED) and pre-GED students, there was one student who did not know that there are 60 seconds in a minute. He guessed there were 100. Not knowing this basic fact made it hard for him to grasp the multiplication in the opening heart-rate exercise. It was not clear to him that you would multiply the number of beats in 15 seconds by four because 4×15 did not equal 100. This young man wrote at the end of class that he enjoyed working on the problems, but experienced some confusion when doing problems with heartbeats and minutes. In fact, he posted his heart rate as 15 beats in 15 seconds, which made us wonder if he counted seconds, not heartbeats. He couldn't distinguish between the two variables and see them as distinct, yet related.

Calories Burned Activity

When working on the calorie charts, the level of computational ability separated those who completed the table quickly from those who took more time. Fortunately, people helped one another.

In a pre-GED class with a wide skill range, some people divided and multiplied with ease; others figured out situations calling for multiplication and division by using adding or doubling techniques. Even with calculators available, the computation was a workout for some.

At the close of one class, students were asked how the class went for them. One student said, "I learned more about burning calories. It went fast and was fun."

Compilation of data from several pilot classes

LESSON 3

Body at Work—Tables and Rules

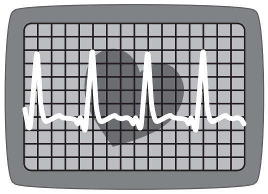
What is your heart rate at rest?

Scientists, business people, and health professionals often use tables to organize information to look for patterns. These patterns sometimes involve *rates*, such as pay rates, interest rates, or growth rates.

This lesson gives you a chance to look for patterns of heartbeat rates and rates at which you burn calories during different activities. You will use tables to organize the information and detect the patterns. By the end of the lesson, you will be able to use the tables to describe patterns as rules both in words and in algebraic notation.

Activity 1: Heart Rates at Rest

Part 1



Everyone's heart throbs in a fairly rhythmic pattern. We check that pattern when we take a pulse by counting the number of heartbeats in a minute. Usually, when nurses take your pulse, they do so for less than a minute, often for 15 seconds. Take the pulses of several people for 15 seconds. Record the information in the table below. Then figure the number of heartbeats per minute for each person.

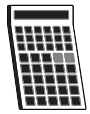
Name	Beats per 15 Seconds	Beats per Minute
A baby	30	
A feverish adult	35	

Write the rule you used for finding the number of heartbeats per minute when you knew the number of beats in 15 seconds.

Rule in words:

Rule as an algebraic equation:

Part 2



Now complete your *personal* heart-rate-at-rest table. Enter your pulse (number of heartbeats in one minute) in the first row. Then fill in the missing values based on the same rate.

Personal Heart Rate Table

Time in Minutes (*M*)	My Total Number of Heartbeats (*B*)
1	
5	
10	
30	
60 (an hour)	
1,440 (a day)	

1. Write a rule for finding the total number of times your heart *beats* if you know the number of *minutes* it has been beating.

Rule in words:

Rule as an algebraic equation:

Always remember to check a rule by entering the numbers in the table. A rule has to work with *all* the entries.

2. Write a rule for finding the number of *minutes* your heart beats if you know the total number of *heartbeats*.

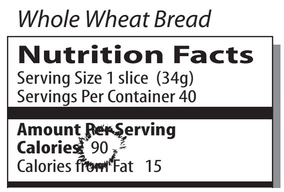
Rule in words:

Rule as an algebraic equation:

3. About how long would it take for your heart to beat 1,000,000 times? How do you know?

Activity 2: How Many Calories Am I Burning?

Many people pay close attention to calories these days. There are two ways to think about calories:



We put calories into our bodies in the form of food.

We burn calories at different rates, depending on what we do and how much time we spend doing it.

In the following activity, you will consider various activities and their rates for burning calories.

- Look for a pattern in the table, and fill in the missing information. In each table, the rate for burning calories remains constant.
- Write a rule that can be used to determine the total calories burned in any number of minutes for each type of activity.

For the following tables, numbers are approximate, based upon an imaginary 5′8″, 190 lb. woman (source: http://www.caloriesperhour.com).

Minutes Jogging	Calories Burned
1	
15	150
30	
45	450
60	
100	

What patterns do you see?

The rule in words for finding calories burned while jogging:

The rule as an algebraic equation:

When writing the rule in algebraic notation, be clear about what each letter stands for. Let the reader know the letter you are using to represent calories and the letter you are using to represent minutes.

Minutes Cleaning House	Calories Burned
1	
15	75
30	
45	
60	300
100	

What patterns do you see?

The rule in words for finding calories burned while cleaning house:

The rule as an algebraic equation:

Minutes Running Up Stairs	Calories Burned
1	
15	300
30	600
45	
60	
100	

What patterns do you see?

The rule in words for finding calories burned while running up stairs:

The rule as an algebraic equation:

Minutes Sitting (Reading or Watching TV)	**Calories Burned**
1	
15	
30	30
45	
60	60
100	

What patterns do you see?

The rule in words for finding calories burned while sitting:

The rule as an algebraic equation:

Use the information from the four calorie-burning tables you have just completed to answer the following questions:

1. How long would you have to watch TV to burn the same number of calories as you would in a half-hour of jogging?

    a. How can you use the tables to arrive at the solution?

    b. How can you use the equations to arrive at the solution?

2. You have to burn 3,500 calories to lose a pound of fat. Invent three exercise plans for burning a pound of fat. Combine all three activities in each plan you create.

Three Ways to Burn a Pound of Fat (3,500 calories)

	Jogging		Cleaning House		Running Up Stairs		Total	
	Min.	Cal.	Min.	Cal.	Min.	Cal.	Min.	Cal.
Plan 1	180		100					3,500
Plan 2								3,500
Plan 3								3,500

Write a rule that tells, in general, how to make a plan to burn 3,500 calories. What do you add? What do you multiply?

Practice: Say It in Words and Fill in the Tables

The expressions below relate to rates of measurement that are fairly common in everyday life.

1. Write in words what each one says.
2. Fill in a table with some entries based on that rate.
3. Describe a situation where you might use that rate.

Example: 60 mph

In words: This means you travel 60 miles in one hour.

A table:

Miles	Hours
60	1
120	2
240	4
480	8

A possible situation: Driving a car on the highway

1. $0.15/minute

In words:

A table:

A possible situation:

2. 2,500 calories/day

In words:

A table:

A possible situation:

Practice: Driving at 50 Miles per Hour

1. A woman is driving 50 miles per hour. What does that mean?

2. Does she have to drive for one entire hour to go 50 miles per hour? Explain.

3. How far does she go in

a. 1 hour? _______

b. 2 hours? _______

c. Half an hour? _______

d. 10 hours? _______

4. How long does it take her to go

a. 50 miles? _______

b. 100 miles? _______

c. 25 miles? _______

d. 500 miles? _______

5. Explain your strategies for figuring out the answers to Problems 3 and 4.

6. Put the values from Problems 3 and 4 in the table below. Be sure all your times and distances are in the same units of measurement.

Driving at 50 mph

Time (t)	Distance (d)

7. Circle all of the equations that correspond to your table:

$t = 50d$ $\quad$ $d = 50t$ $\quad$ $t = \frac{d}{50}$

$d = \frac{50}{t}$ $\quad$ $d = \frac{t}{50}$ $\quad$ $t = \frac{50}{d}$

Symbol Sense Practice: Equations ⟷ Words

Every algebraic equation can be translated into a simple sentence. Some examples are listed below:

Algebraic Equation		A Simple Sentence
$7x = y$	⟷	Multiply seven by x to find y.
$6x - 2 = y$	⟷	Six times x minus two equals y.
$y = x/4$	⟷	y equals x divided by four.

Translate each algebraic equation below into a simple sentence.

1. $x + 9 = y$ ______________________

2. $10x + 20 = y$ ______________________

3. $\frac{x}{8} + 15 = y$ ______________________

4. $y = \frac{1}{2}x + 1$ ______________________

Now write an algebraic equation for each sentence.

5. ______________________ *y* equals five multiplied by *x*.

6. ______________________ Double *x* to find *y*.

7. ______________________ Multiple *x* by ten, then add five to equal *y*.

8. ______________________ Find *y* by subtracting four from *x*.

Make up two of your own equations and matching sentences.

9. ______________________ ______________________

10. ______________________ ______________________

Symbol Sense Practice: Substituting for *x*

In math, a rule of order is to perform multiplication before addition, no matter where they occur. So …

$$5 + 2(100) = 5 + 200$$
$$5 + 2(100) \neq 7(100)$$

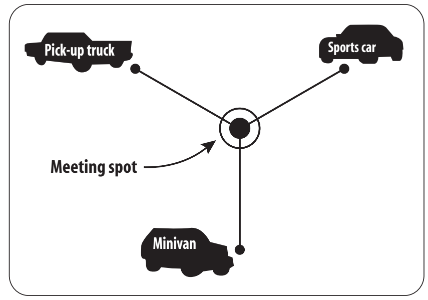
In the following equations, solve for y in three cases: when $x = 0$, when $x = 10$, and when $x = 100$. When you have addition and multiplication in the same equation, perform the multiplication first *unless* there are parentheses. If there are parentheses, do the math inside them first.

Substitution Values for *x*

Original Equations	$x = 0$	$x = 10$	$x = 100$
1. $y = 2x + 35$	$y =$	$y =$	$y =$
2. $y = 15 + 3x$	$y =$	$y =$	$y =$
3. $y = 5 + 7x$	$y =$	$y =$	$y =$
4. $y = 2(x + 2)$	$y =$	$y =$	$y =$
5. $y = (0.25 + 0.75)x$	$y =$	$y =$	$y =$
6. $y = 1{,}000 + 25x$	$y =$	$y =$	$y =$
7. $y = \frac{x}{2} + 90$	$y =$	$y =$	$y =$

Extension: A Friendly Reunion

1. Three friends who live quite a distance from one another planned a reunion. They picked a central meeting spot that seemed fair, 180 miles away from each person. Each of the friends has a car, but the cars are not in the same working condition. The sports car driver can drive at an average speed of 90 mph. The minivan driver figures she can go 60 mph, and the driver with the old pick-up truck will only be able to drive at 45 mph. (Highway speed limits are ignored in this problem).



a. Fill in three tables, one for each driver. Show at least five entries for time and distance.

Pick-up Truck

Time (in hours)	Distance (in miles)
1	
2	
3	

Sports Car

Time (in hours)	Distance (in miles)
1	
2	
3	

Minivan

Time (in hours)	Distance (in miles)
1	
2	
3	

b. If they want to meet at noon, what is the latest time each driver should plan to leave home? Use your tables and the sketch to support your answer.

2. What if some things went wrong? The three drivers all started out from their homes as planned, but halfway there, the sports car driver discovered she forgot her purse and had to go back home to get it. The minivan driver had to detour because of road construction, which meant she had to go 60 miles out of her way. The driver of the old pick-up truck had no problems. How did this affect their meeting time? Use your tables and the sketch to support your conclusion about when each person actually arrived under these new circumstances.

Test Practice

Use this table for Problems 1 and 2.

Cost of Item	Sales Tax
$20	$1.00
$30	$1.50
$40	$2.00
$50	$2.50

1. Which of the following could be the rule to find the sales tax when you know the cost of an item?

(1) Subtract $19 from the item cost.

(2) Divide the cost of the item in half.

(3) Divide the cost of the item by ten.

(4) Multiply the cost of the item by 10.

(5) Divide the cost of the item by 20.

2. Which of the following could be the rule to find the cost of the item when you know the sales tax? Let "*C*" stand for item cost and let "*t*" stand for the sales tax amount.

(1) $C = \frac{t}{20}$

(2) $C = 20(t)$

(3) $C = \frac{t}{2}$

(4) $C = 2(t)$

(5) $C = 0.5(t)$

Use the following sequence for Problems 3 and 4.

6, 11, 16, 21, …

3. What is the eighth number in the sequence?

(1) 26

(2) 41

(3) 46

(4) 51

(5) 56

4. What digit would the 75th number in the sequence end in?

(1) 0

(2) 1

(3) 5

(4) 6

(5) 7

5. Look at the pattern in the table below. What reasonable conclusion can you make based on the information?

NutriStrategy = Calories Burned During Exercise

Activity (1 hour)	130 lb.	155 lb.	190 lb.
Running, wheeling, general	177	211	259
Sailing, boat/board, windsurfing, general	177	211	259
Sailing, in completition	295	352	431
Scrubbing floors, on hands and knees	325	387	474
Shoveling snow, by hand	354	422	518
Shuffleboard, lawn bowling	177	211	259
Sitting–playing with child(ren)–light	148	176	216
Skateboarding	295	352	431
Skating, Ice, 9 mph or less	325	387	474
Skating, Ice, general	413	493	604
Skating, Ice, rapidly, > 9 mph	531	633	776
Skating, Ice, speed, competitive	885	1056	1294
Skating, roller	413	493	604
Ski jumping (climb up carrying skis)	413	493	604
Ski machine , general	561	669	819
Skiing, cross-country, > 8 mph, racing	826	985	1208
Skiing, cross-country, moderate effort	472	563	690
Skiing, cross-country, slow or light effort	413	493	604
Skiing, cross-country, uphill, maximum effort	974	1161	1423
Skiing, cross-country, vigorous effort	531	633	776

Source: http://www.nutristrategy.com/activitylist4.htm

(**1**) The less you weigh, the more calories you burn doing the same amount of exercise.

(**2**) For any amount of exercise, the number of calories you burn increases as your weight increases.

(**3**) The older you are, the harder it is to lose weight.

(**4**) If you double your speed, you double your calories burned.

(**5**) The number of calories burned does not depend upon your weight.

6. Continue this pattern: What is the *fifth* number?

100, 50, 25, ______, ______, ______

Not Just a Number: Critical Numeracy for Adults

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by Sandra Kerka
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"It is difficult to understand why so many people must struggle with concepts that are actually simpler than most of the ideas they deal with every day. It is far easier to calculate a percentage than it is to drive a car." (Dewdney 1993, p. 1) To many people, the words "math" and "simple" do not belong in the same sentence. Math has such an aura of difficulty around it that even people who are quite competent in other areas of life are not ashamed to admit they can't "do" math. Innumeracy is more socially acceptable and tolerated than illiteracy (Dewdney 1993; Withnall 1995). Rather than discussing specific ways to teach math to adults, this *Digest* looks at emerging perspectives on numeracy and their social, cultural, and political implications as a context for new ways of thinking about adult numeracy instruction.

What Is Numeracy?

Numeracy involves the functional, social, and cultural dimensions of mathematics. Numeracy is the type of math skills needed to function in everyday life, in the home, workplace, and community (Withnall 1995). Although not always recognized as such, math is used in many everyday situations-cooking, shopping, crafts, financial transactions, traveling, using VCRs and microwave ovens, interpreting information in the media, taking medications. Different people need different sets of math skills, and their numeracy needs change in response to changes in life circumstances, such as buying a car or house or learning a new hobby (Gal 1993; Withnall 1995). Like literacy, numeracy "is not a fixed entity to be earned and possessed once and for all" (Steen 1990, p. 214), nor a skill one either has or doesn't have. Instead, people's skills are situated along a continuum of different purposes for and levels of accomplishment with numbers.

Beyond daily living skills, numeracy is now being defined as knowledge that empowers citizens for life in *their* particular society (Bishop et al. 1993). Thus, numeracy has economic, social, and political consequences for individuals, organizations, and society. Low levels of numeracy limit access to education, training, and jobs; on the job, it can hinder performance and productivity. Lack of numeracy skills can cause overdependence on experts and professionals and uncritical acceptance of charlatans and the claims of pseudoscience (Dewdney 1993). Inability to interpret numerical information can be costly financially; it can limit full citizen participation and make people vulnerable to political or economic manipulation. Like people with low levels of literacy, those lacking numeracy skills sometimes manage to avoid using math, relying on social support networks and coping tricks adapted to their environment (Steen 1990).

Math Myths . . . and Real-Life Numeracy

Why do people avoid math, and why does such a seemingly abstract subject arouse such high emotions? Many myths cloud the perception of math and numeracy (Bishop et al. 1993; Gal 1992; Willis 1992); the realities are discussed in this section.

*Numeracy is culturally based and socially constructed.*The math mystique is fed by stereotypes suggesting that white males and Asians are innately better at math and that math originated in Western civilization (Zaslavsky 1994). However, a new field-ethnomathematics-is emerging to refute these ideas. Researchers in this field are demonstrating that all cultures have math and use it (like language) as a system for making meaning of the world (*Numeracy in Focus*1995). Math principles and numeracy practices are not universal. Like literacy, numeracy is a set of cultural practices that reflect the particular values of the social, cultural, and historical context (Joram, Resnick, and Gabriele 1994). From the mental math of bazaar merchants to the navigational practices of South Pacific islanders to the astronomical calculations of ancient Mayans, "an enormous range of mathematical techniques and ideas have been developed in all parts of the world" (Bishop et al. 1993, p. 6). Some math activities are widely practiced across cultures-counting, measuring, locating, designing, playing (gambling, guessing), and explaining-but there are cultural differences in these "universal" activities (ibid.). Academic math may look the same in many societies because a competitive economic and political ethic demands a competitive math curriculum and dominant cultures may have imposed their math forms on other societies (ibid.).

Math reflects a particular way of thinking. Why is a computer program considered "real" math and the calculations in knitting a sock are not (Zaslavsky 1994)? Why do people think that math requires special intelligence or a "math mind"? As a particular way of thinking about the world, the math of a particular culture or group can be used as a gatekeeper to restrict access to professions, disproportionately keeping out nondominant groups such as women and minorities (Willis 1992). The behavior and attitudes of the dominant group become the norm against which others are measured. Those whose ways of thinking are attuned to this kind of math succeed where it is used in school and work. Those who think in other ways may be considered lacking in math ability, prompting Willis to ask whether math anxiety is innate or culturally induced. Because math (and numeracy) relates to specific cultural contexts, different cultural groups have different mathematical strengths. Although academic math is used to regulate access to higher education and occupations, academic aptitudes and skills are not necessarily those needed on the job or in life (Gal 1992).

Numeracy reflects cultural values. Math is often seen as abstract and neutral. In reality, it is a discourse-a way of talking or thinking-that people use to give meaning to the world and therefore it reflects a particular world view (*Numeracy in Focus* 1995). For example, consumer education typically uses math to teach about credit, budgeting, and money management. Implicit in these uses of math are the assumptions of a market economy about value for money, investment, and consumption-a hidden curriculum whose values are not shared by all cultures (ibid.).

Numeracy is not just about numbers. Numeracy is a socially based activity that requires the ability to integrate math and communication skills (Withnall 1995). It is intricately linked to language: words are the tools for translating numerical code and giving it meaning. Words can have everyday meanings as well as math meanings: for example, "and" is a conjunction, but in math it can also mean "plus." Some words are math specific: numerator, multiplicand, divisor. Interpretation of these words can cause confusion for people with low literacy levels or those attempting to become numerate in a second language.

Math evolves and changes. Despite the myth that mathematical principles are fixed for all time, new discoveries and theories about math continue to emerge. The uses of math in the world evolve as societal needs change. For example, computers are changing the need for some kinds of math skills and creating the need for others (Bishop et al. 1993).

Numeracy is about procedural, practical knowledge. This type of knowledge is perceived as less important or prestigious than abstract, theoretical knowledge. Practical, everyday math is considered the "lower end" of the mathematical hierarchy.

Numeracy involves different ways of solving problems. There is not just *one* way to get the *one* right answer. "The students found it helpful to discuss the sort of strategies they use in their real lives. The reinforcement of these strategies not being wrong gave them a lot of confidence. The students were convinced that there was only one way to carry out a process in maths" (Halliday and Marr 1995, p. 75). In traditional teaching, the teacher/authority hands down knowledge to blank-slate students who memorize multiplication tables and formulas and mechanically apply rules to solve problems. However, real-world problems are not as cut and dried as textbook math (Zaslavsky 1994). Intuition, mnemonics, tricks, and other "home-grown" problem-solving methods can complement abstract, formal approaches (ibid.).

Implications for Adult Education

Numeracy has an uncertain place in adult basic education. Instructors (often volunteers) are not always prepared to teach math and may even share some of their students' anxieties about it. Adult math instruction often focuses on preparation for the General Educational Development Test, which is based on high school math and perhaps "cannot serve as a complete road map for what adult numeracy provision should encompass" (Gal 1992, p. 22). The concepts of numeracy and math explored in this digest suggest that numeracy instruction should be based on the belief that *everyone*can do math and everyone uses numeracy practices that may go unrecognized. Taking a broad view of numeracy, educators take learners' existing reasoning skills, experience, and literacy and language abilities as the context for what learners need to learn (ibid.).

Literacy and numeracy should be linked and contextualized. Math is better understood if learned in familiar contexts that may provide cues to enhance problem solving. Familiar contexts may make math more accessible for those who have been alienated from it (*Numeracy in Focus* 1995). Having learners keep journals develops language and math skills together, helps them verbalize their thought processes, and enables them to express emotional reactions and feelings about math (Halliday and Marr 1995). Contextualized math applies a constructivist approach to learning, in which people relate new knowledge to what they already know, construct their own understanding, and make new meanings. This approach can help learners recognize the math characteristics of everyday situations (Gal 1992).

Contextualized math can also help those learners with different ways of thinking. Individual learning style preferences should be considered in numeracy instruction (Zaslavsky 1994).

Adult educators should also consider their philosophical approach to education as well as numeracy. Critical numeracy means that learners empowered with functional skills can participate fully in civic life, skeptically interpret advertising and government statistics, and take political and social action. In opposition to the perspective that blames innumerate people for their own difficulties, educators can use language, literacy, and numeracy as vehicles for examining how society positions people and treats them differently (Shore et al. 1993).

Teaching from the perspective of adult education as a tool for social justice, instructors seek to change the system in which math serves as a barrier and to "equip people with the knowledge and tools that will enable them to examine and criticize the economic, political, and social realities of their lives" (Zaslavsky1994, p. 217). An inclusive approach to instruction recognizes the different power relations in the way math and numeracy are viewed and used and seeks to give people a voice and more control over life circumstances (Shore et al. 1993). At the same time, educators can also empower learners with the numeracy skills needed to function in the technological society and workplace. As more learners acquire those skills, the cultural practices that are numeracy as well as the way math serves society can be changed.

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Digest
National Center for ESL Literacy Education

Numeracy in the Adult ESL Classroom

by Tom Ciancone
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Numeracy is the ability to cope confidently with the mathematical demands of everyday life in the home, workplace, and community (Cockcroft, 1982; Withnall, 1995). The tools of mathematics provide adults with the resources to express facts and opinions and to analyze situations. Knowing how to calculate percentages, for example, is necessary for discount shopping and for figuring sales tax. For many adults, expressing and using the abstract concepts of mathematics is not an easy task, in part, because numeracy needs change as one's life circumstances change. However, like literacy, numeracy is not a case of one's either being proficient or not, rather individuals' skills are "situated along a continuum of different purposes and levels of accomplishment with numbers" (Kerka, 1995, p.1).

This digest examines numeracy for adults learning English as a second language (ESL) as well as for those who teach them. It focuses on learners with low literacy skills and provides curriculum ideas and resources for use in the classroom. While many suggestions are based on the author's experiences in teaching adult immigrants in Canada, they are applicable to adult ESL instruction in other English-speaking countries.

Assessing Numeracy Needs

Adult ESL Learners
In developing a methodology for numeracy instruction, an instructor must consider not only the nature of mathematics learning, but also the nature of adult learners. Determining appropriate instructional methods depends both on learners' mathematical skills and on their attitude toward mathematics. For the ESL learner, proficiency in English will be an additional factor. Although mathematical concepts may be generalizable to many languages and cultures, these concepts must be learned and expressed through particular languages. Whereas "2 + 2 = 4" may be widely understood, the English expression "two plus two equals four" is not. Thus a learner's difficulties in numeracy may be due in part to a lack of proficiency in English.

Decisions regarding topics to be covered should be based on a needs assessment that takes into account both what the learners *want* to do and what they *can* do. Needs may be assessed in a number of ways, from asking about learners' experience in school mathematics to having them try math problems related to a skill they want to learn, e.g., calculating whether it is to their economical advantage to buy a monthly bus pass. To ensure that the class is meeting learners' needs, the instructor should continually monitor their progress and encourage self-assessment.

It is also important to be aware of differences in the use of mathematical symbols in learners' native languages and differences in methods of computation that result from their previous schooling. For example, there is variation in the world's languages in the use of the comma and the decimal point for writing numbers greater than a thousand and numbers as decimals. If a postal carrier earns $32,578.50 in Canada or the United States, most persons from non-English-speaking countries would write the salary as $32.578,50 -- i.e., with the point and comma reversed.

Another common difference is the method of writing out long division computations. For a class party, if 16 people wish to share equally the bill for some pizzas that cost $42.40, there are at least three different ways to do the division:

```
  2.65

16  42.40

42.40  16

   2.65

42.40 : 16 = 2.65
```

Writing `42.40 16` instead of `16 42.40` is not backwards; rather it is simply another way of symbolizing the operation of long division. Because there are often multiple ways to solve problems, it is best to observe how learners approach them and build on that. However, adult ESL learners may ask to learn the *new* way so that they may help their children in school.

Adult ESL and Literacy Instructors
In addition to addressing learner needs, instructors need to consider their own attitudes about numeracy (Kallenbach, 1994; Leonelli & Schwendeman, 1994; Stoudt, 1994). Many ESL and adult literacy educators may not be comfortable with math and may teach math skills as discrete and isolated rather than "relevant, contextualized, and essentially linked to overall literacy" (Stoudt, 1994, p.11).

Educators in the United States are beginning to form local and national groups to improve their own and others' math teaching practice. In 1992, 22 adult basic education (ABE), ESL, adult secondary education (ASE), general education development (GED), and workplace education practitioners in Massachusetts collaborated to form the ABE Math team. Using the standards from the National Council of Teachers of Mathematics as a model, they developed 12 math standards for teaching adults (Leonelli & Schwendeman, 1994) that stressed the importance of learning through discovery rather than through rote study of textbooks, the value of understanding over memorization, and the usefulness of such generally undervalued skills as estimating totals (Kallenbach, 1994).

In 1994, in Arlington, Virginia, 110 adult educators from 30 states met for a three-day working conference on adult mathematical literacy. Their recommendations included the following:

- Class math activities should be collaborative, involve problem-solving, and help learners develop reasoning skills.
- Diagnostic assessment tools need to be developed to inform all stakeholders‹learners, instructors, evaluators, and program funders.
- Support for professional development for teachers is needed (Gal & Schmitt, 1995).

Guidelines for Teaching Numeracy
To facilitate numeracy learning in an ESL literacy program, Ciancone and Jay (1991), Kallenbach (1994), Leonelli and Schwendeman (1994), and Lucas, Dondertman, and Ciancone (1991) offer the following suggestions:

- Encourage looking for patterns rather than finding the right answer.
- Stress the possibility that there may be many ways to solve the same problem.
- Encourage peer-group collaboration. The best way to clarify one's own understanding of a concept is to explain it to someone else.
- Encourage learners to write journals about the math skills they are learning and their feelings about learning math. Using the language of mathematics reinforces both the mathematical concepts and proficiency in English.
- Although numeracy is an everyday coping skill, mathematical concepts can be quite abstract; the more concrete and visual the explanation, the more easily understood the abstract concept.
- Each numeracy lesson should provide a balance between skill building and functional needs. A lesson may begin with a problem (e.g., a mistake on a paycheck) that provides a context for learning new skills (such as subtracting decimals), or the lesson may start with a skill (e.g., adding decimals) followed by practical applications (such as adding sales tax to a fast food bill).
- Include math in literacy instruction from the beginning. Even learners who have almost no proficiency in English need to learn numbers for such basic activities as shopping and riding the bus.

Some Numeracy Activities
As learners develop language skills, they can also develop skills such as estimating, measuring, and analyzing data. Activities for numeracy learning can range from recognizing numbers to calculating percentages, from reading a bus schedule to baking a cake. The two activities described below have been useful for helping beginning numeracy learners understand number systems.

Place-Value Chart
The place-value chart reinforces the essential mathematical concept of place value while helping ESL learners to read large numbers. It is a series of adjacent columns with headings that designate their value. From right to left the headings are "Ones," "Tens,"

"Hundreds," "Thousands," and so on as high as "Billions," if needed. The chart can be used in a variety of ways. The instructor can simply dictate numbers and ask the learners to write them in the correct columns on the chart. Or this exercise can be combined with questions, such as, "How many days are there in a year?" or "What is the population of Ontario?" If a class is reading a newspaper article that involves large numbers (e.g., corporate profits), the instructor can have learners underline numbers and then copy them onto the place-value chart. The chart can also be used when writing numbers in words, as required in writing checks.

A related activity is to make a large money chart. The headings on this chart are (from right to left) "Pennies," Dimes, "Ones," Tens," and "Hundreds, with the decimal point between the "Ones" and "Dimes." The columns are large enough to allow placement of real money or facsimiles on the chart. The money chart is an excellent tool for learners who have difficulty with carrying and borrowing in addition and subtraction.

Metric Measurement
A unit on metric measurement can include topics of length, distance, area, volume, and weight to teach functional language skills related to dimensions and mathematical skills involving decimals. The following activity presupposes a preliminary understanding of metric units, a reasonable expectation of learners educated outside the United States. U.S. measurements can also be used, or an activity can be done comparing the two systems of measurement.

The learners work in pairs, each pair with one meter stick or ruler, or both. A dialogue such as the following occurs in which learners take turns estimating the length or size of something in the classroom:

A: How long is the table?
B: It's about 2 meters long.
A: Let's measure it.

The learners measure the table and record the exact measurement. Then the second learner might ask, " How high is the ceiling?" and so on. From here more complex dialogues can be developed.

This activity provides a starting point for learning decimals. For example, learners may measure the width of a piece of paper as 21.6 cm with the ruler and see that 21.6 cm is just over halfway between 21 cm and 22 cm. In fact, 0.6 cm is six-tenths of one whole centimeter. Using the ruler as a concrete aid, the teacher can introduce the concept of decimal before the learners have mastered fractions.

Conclusion Numeracy includes a range of skills that are necessary for initial survival in a new country and for functioning as a fully literate person. In programs for adults learning English as a second language, both the mathematical skills and the language for these skills need to be integrated into the curriculum in order to prepare the learners to be successful. Instructors interested in integrating numeracy-related activities into their classes should evaluate their own perspectives on numeracy and advocate for training and professional development to improve their math teaching practice.

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Fieldnotes for ABLE Staff
2004 Edition

ABSTRACT

How adults learn basic math

by Ellen McDevitt

Most adult math practitioners are not math teachers, but reading teachers who have inherited the math classes. Or they are volunteer tutors whose own math anxiety might equal that of their learners'. Both groups might find themselves wondering how best to teach adults and might be finding that the methods by which they learned are not working as well as expected with adult learners. This article provides insights on how adults learn math and offers suggestions that practitioners can use to increase their learners' success.

Ellen McDevitt has worked in adult education for more than 20 years. She is a founding member and current president of the Adult Numeracy Network, former editor of The Math Practitioner *newsletter, and owner of a training consulting firm, FourthRiver Associates.*

Able
State Leadership
Activity

ARTICLE BEGINS NEXT PAGE

How adults learn basic math

by Ellen McDevitt

You can count on me." "Count me in." "A day late and a dollar short." "Penny wise and pound foolish." Our language is rich with references to numbers and math. Isn't it interesting, then, that so many of us are afraid of math? Isn't it even more interesting that so many of our learners actually believe that they never use math, as if all the numbers and number concepts they encounter in daily life don't exist? But we do use numbers every day and we need to be able to use them as needed. So how do we learn the math we need? The answer to that question is found in the principles of adult learning theory and in the practices of the math classes we know from childhood.

Adults learn math: under protest, with a great deal of anxiety, more easily when it has meaning for them right now, when they can apply it, when they can use their own learning style, and when they have examples to learn from.

'When am I gonna use this stuff?'

We've all heard our learners ask some version of that question. They frequently save the math subtest of the GED until last, postponing the inevitable in the hope that either it will all make sense in some miraculous cosmic math osmosis or that the GED gods will absolve them of the need to do it! Sometimes learners can't get beyond their fear of math and they drop out of sight, sacrificing their goal of getting a GED. Most learners try, under protest and with a great deal of fear, to understand concepts that have eluded them most of their lives. They don't see the relevance of the math they've learned in class to anything in real life because they don't have any familiar contexts on which to "hook" their understanding.

So my first suggestion for improving that scenario is that adults should learn basic math in an environment that is as different as possible from the one they remember so unhappily from their school days. For one thing, adults don't have a lot of time to spend in learning, so you and they have to make the time count. If you teach math the way you were probably taught, you are using a model that is based on the idea of 180 class days for young children who have little else to occupy their days. If adults didn't get it under those circumstances, they are not likely to get it under the time constraints of adult literacy programs.

Also, the lecture model of teaching works well for those who learn by hearing, but not as well for those with other learning needs. According to Dunn (1994), less than 30 percent of adults learn aurally. Further, underachievers "tend to be tactile/kinesthetic learners … often are peer motivated or motivated only when interested in what they are learning." If we accept that many of our learners are underachievers, we can make the case for restructuring our teaching. A suggestion, then, is to include the use of manipulatives, group work, and other hands-on activities in learning experiences.

Another suggestion is to ask a different question than: "How do adults learn basic math?" When you read that question, what do you think of? I think of multiplication tables and

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theorems and computation. The more productive question might be: "Why do adults want to learn basic math?" As soon as we reframe the question, we do two things: We acknowledge the learner's goal, validating it as a context for instruction, and we shift the emphasis from mere number operations, implied by the term *math,* to the rich tapestry of experience and understanding known as *numeracy*.

Teaching in context

In a typical classroom, the instructor provides both the content and the context of the instruction, with every learner being fed the same number stew. But contexts—why a learner wants to learn math—differ from learner to learner. Effective instruction takes advantage of those contexts to help learners recognize the characteristics of generalized math instruction in their own lives.

My next suggestion is that you use learners' goals to identify contexts for instruction. By using familiar contexts to frame our instruction, we might make math more understandable to those who haven't been able to "get it" in the past, and we might help the transference of learning. For a long time we have taught skills in general terms and have assumed that they will transfer to the more specific situations in which adults need to use them. In reality, transference has not been well established for the learners in our math classes. Another suggestion, then, is that you use the following strategies to help a learner transfer knowledge:

- Use the skill in several contexts;
- Teach when to use a skill, not just how to use it;
- Teach for understanding; and
- Teach through patterns (NIFL, 2000).

Teaching in context also gives instructors the freedom to work beyond the ubiquitous workbooks. By asking why the learner wants to learn math we get some idea of other ways for an adult to learn. The instructor no longer has to be the source of all knowledge but can ask the learner to supply authentic materials to supplement the standard materials. The National Institute for Literacy's Equipped for the Future (EFF) initiative asks learners to select a role that is important to them—worker, parent, or citizen—and uses that context as the "hook" for instruction.

You don't have to use the EFF roles, but you can still find the "hook" with your learner. In doing so, you increase the likelihood that your learner will learn and retain the knowledge. Multiplication for a carpenter, for example, looks very different from multiplication for a cook. The basic operations are the same, but the applications are different. Why make up "real-life" contexts when the genuine article is at your fingertips? Use building blueprints; work orders; lumber dimensions; or metric weights, cups, and gallons when teaching multiplication, measurement, volume, or geometry. Another suggestion is that you use authentic materials, supplied by the learner if possible, to enhance your instruction and increase the learner's understanding.

Beyond the test

One of the shortcomings of traditional math instruction is that students learn enough to pass a test, but then they can't remember how to do the math when they need it to help a child with simple geometry or figure whether the car salesman is ripping them off. Dr. Kathy

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Safford of St. Peter's College in New Jersey calls it "Magic Slate Math." Do you remember the magic slates of childhood? You wrote on them with a stylus, then all was erased as you lifted the cover sheet, so you could write more. That's the end result of learning only what you need to learn to pass a test. It's erased from memory when the test is over.

The Third International Math and Science Survey (TIMSS) tested more than half a million students from 40 countries. American students scored below the international average on math and science literacy—a position that put us in company with students from Hungary, the Russian Federation, Italy, Lithuania, Cyprus, and South Africa. Part of the assessment dealt with performance expectations, defined as knowing, using routine procedures, investigating and problem-solving, mathematical reasoning, and communicating.

According to Willard R. Daggett, American students are the most tested but least evaluated students in the world. We do very well in testing content knowledge, but do little to assess whether students can use their knowledge in a variety of real-world situations. And according to the TIMSS, we don't do very well when it comes to using the math we learn so well for tests.

Of course, both the TIMSS and Daggett are referring to learners in the K–12 system, but many students who can't make it there eventually find our programs, and we inherit the performance shortfall. The traditional method of teaching math to adults does little to improve the situation. Our learners want to know only what they have to know to take the test, so we oblige them and send them on their way, with the result that they still do not remember the math when they need it. So another suggestion is that you teach math as problem-solving, so that learners will develop an understanding of the math processes that will enable them to figure out what they don't know. When learners can do that, they're on the way to being numerate.

Numeracy is making sense of math

If we begin by asking why the learner wants to learn math, we not only establish a new context, but we also begin to reframe our instruction as numeracy rather than simple math. Just as literacy is more than letters, numeracy is more than numbers. Numeracy has been defined as the kinds of math skills needed to function in everyday life; not one fixed set of skills, but a continuum of skills that an adult draws from to meet different needs. And it's numeracy that we want for our learners, not just math. It's because they haven't been educated in numeracy that our learners don't get the connections between what they learn in class—school math—and what they use every day—real-life math.

For example, in real life, math problems are complicated. They use real numbers that can be messy, and there is rarely only "one way" to the answer. Yet our classrooms rely on the "I'll teach you the rule, and you'll practice this skill over and over until you get it" method of instruction, which perpetuates the gap in understanding. This reliance on algorithms creates a situation in which learners believe they have to memorize the rules if they're going to be good at math. When they can't remember the rules, they give up, because they never learned how to actually engage in problem solving. Sometimes I think the start of a solution is as simple as shifting our thinking from "How will I teach this?" to "How will they learn this?" In shifting from teaching to learning, we place the emphasis where it should be—on what the learners need to be able to do.

So another suggestion is that you conduct your classes to encourage development of

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problem-solving skills that will be useful beyond the classroom walls. Encourage learners to wonder why things are, to practice solving problems even where they're not familiar with or aware of procedures, to solve problems in a variety of different settings, and to use what is familiar to them to explain what is not. Problem solving might not be a short-term process, because learners engage in math at multiple levels. So learners don't work on multiplication and then practice it over and over again on different problems. Instead, they might learn about multiplication and then have a real-life learning situation that will take several class sessions to solve.

At the April 2001 Making Math Real Institute held in Pittsburgh, the final activity asked teams of practitioners to create a math learning activity based on what they had learned during the institute. One team set up a learning activity that would use a grocery shopping trip that the student makes every week as the context for demonstrating an understanding of map reading, operations with whole numbers and decimals, the use of time and scheduling, budgeting and the use of money, and making good decisions. Such a learning activity will provide mental models for the learners to use when they need to solve problems in similar situations. The National Council of Teachers of Mathematics (NCTM) in the *Professional Standards for Teaching Mathematics* (NCTM 1991) offers suggestions for incorporating problem solving in math class.

Adults who are numerate have a full toolkit of problem-solving strategies they can draw from in different situations. So another suggestion is that you help learners identify different problem-solving strategies and encourage them to use different strategies as needed. One good idea is to keep a class strategy list posted on the wall or bulletin board. As learners identify strategies, write them on the list for everyone to see. The goal is for learners to understand that not all strategies work all the time, but that success comes from knowing which strategy to select and when. As learners experience success, they begin to *believe that they can be successful* in other math situations. And when that happens, well, your work is done.

What it boils down to

In summary, here is a list of suggestions for helping adults learn math:

1. Don't teach the way you were taught.
2. Use manipulatives, hands-on activities, group work, and other varied modalities for delivering instruction.
3. Ask, "Why do you want to learn math?" in order to discover the learner's goals and to establish a context for instruction.
4. To enhance the transfer of knowledge, provide practice in using the skill in several contexts; when to use a skill, not just how to use it; recognizing patterns; and understanding.
5. Use authentic materials, supplied by the learner if possible, to supplement your instruction.
6. Teach math as problem-solving to increase understanding.
7. Help learners identify problem-solving strategies they can use in different situations.
8. Shift the emphasis from teaching to learning.

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