Introduction

Teachers will not take up attractive sounding ideas, albeit based on extensive research, if these are presented as general principles which leave entirely to them the task of translating them into everyday practice—their classroom lives are too busy and too fragile for this to be possible for all but an outstanding few.

What they need is a variety of living examples of implementation, by teachers with whom they can identify and from whom they can both derive conviction and confidence that they can do better, and see concrete examples of what doing better means in practice.

—Paul J. Black and Dylan Wiliam

Active Learning

Recent research about the adolescent brain validates the educational practices collectively known as *active learning*. Here, *active* refers to brain activity. Learning is active when a large part of the brain is engaged and the use of multiple senses is required. The traditional classroom actions of listening, reading, and writing are only part of active learning. In addition, active learning involves speaking, kinesthetic movement, social interaction, and mental manipulations such as visualizing and imagining.

Active learning attempts to involve the whole brain, which makes it the best approach for teaching big ideas and concepts. When students learn actively in a systematic way, the dendrites in their brains—the branched projections of neurons—make stronger and more extensive connections, resulting in deeper understanding and longer retention.

How can teachers use active learning techniques to make mathematics more meaningful for students? *Active Algebra* is intended to present a living, working example. The lessons in *Active Algebra* are designed to build connections across large areas of the brain, draw upon ideas and skills already within the brain, give the brain a workout at all levels.

The mental math exercises stretch students' short-term memory and recall. Student presentations and group or pair tasks promote verbal communication of mathematical ideas; this verbalization clarifies and anchors ideas within the brain. Writing uses a different part of the brain to anchor ideas; every student

is required to communicate solutions and record ideas in a personal notebook. Some of the lessons use physical movement to illustrate abstractions. In Lesson 3, students walk a course at a steady pace. In Lesson 5, students move their arms to show different slopes. Note that it's important to distinguish between movement to teach a concept and movement to practice skills. Many teachers use physical games, such as classroom soccer and row relays, to teach skills. These games can work well but the physical movement required by them is not directly related to the concept being studied—the movement does not help the student understand the ideas. (To read further about brain research and its connection to teaching and learning, see Chapter 6, "Brain Research and Teaching Mathematics.")

Overview

Chapters (Section I)

Active Algebra opens with seven chapters that serve to guide and support teachers' mathematics teaching when using the *Active Algebra* lessons.

Linear Relations Lessons and Assessments (Section II)

The core of *Active Algebra* consists of a ten-lesson unit for students that focuses on understanding linear functions numerically, graphically, and symbolically. Each lesson consists of a set of five mental math problems ("Mental Math Startup"), three or four Core Problems to do in class, and three or four Additional Problems for homework or in-class work. All problems are formatted so teachers can easily print (see included CD) or photocopy and hand them out to students.

The *Active Algebra* lesson sequence includes both real-life and abstract mathematical situations. The lessons engage students in performing mental arithmetic, writing solutions in individual notebooks, making presentations, working in pairs or groups to accomplish tasks, using graphing calculators for exploration, and creating posters for display. Student assessments are included with the lessons. The first quiz (Quiz A) comes after Lesson 3; the second quiz (Quiz B) comes after Lesson 7. The final assessment of the *Active Algebra* lessons consists of two items: a Linear Equation Poster that students create with partners, and a written exam (Lesson 10) that each student completes individually. (For more information on assessments and grading, see Chapter 1, "Mathematics Classroom Logistics.")

Answers and Teaching Insights (Section III)

Answers for all problems are provided in Section III. This section also includes teaching insights and "From the Classroom" vignettes for each lesson.

Active Algebra Prerequisite Knowledge

The mathematics in the lessons is appropriate for seventh-, eighth-, ninth-, or tenth-grade students who have had some experience solving linear equations and who have done a little work with graphing linear functions in the form $y = mx + b$. *Active Algebra* works especially well for students who have engaged in, or completed, a year of pre-algebra or algebra. The Mental Math arithmetic involves work with fractions, decimals, and percents normally introduced before sixth grade.

Active Algebra: The Teacher's Role

In rote teaching, the teacher's main job is to explain how to do the problems. In active teaching, it's just the opposite: The teacher's job is to get the students to

explain how to do the problems. The teacher's role in the ten lessons in this resource is to choose and assign appropriate tasks for students, answer questions and give encouragement to groups and individuals as they work, give feedback on presentations, keep records of individual student progress, and maintain a classroom atmosphere conducive to learning.

Students feel more connected to a subject when the teacher interacts with each student every day at a personal level. Teachers can accomplish many of these interactions while students are busy working in groups. If you use a grading system similar to the one recommended in Chapter 1, you will automatically have a scheduled opportunity for personal interaction with each of your students while you are walking around during class, giving points for completed assignments.

What happens when a problem is assigned that no student can do? It's best not to give in and explain the problem—that's the easy way out and, if done frequently, causes students' thinking to shut down. After all, they know they can just wait and get the answer from the teacher.

If students truly find a problem impossible to do, the teacher has several options besides simply doing the problem for the students, including to:

- **ask students questions that clarify the task;**
- **get other students involved who may be on the right track;**
- **assign a similar problem modified so that students can solve it (and then reassign the original problem); and/or**
- **put the problem on hold—give it more time.**

Active Algebra: The Students' Role

Using the lessons in this resource, students are expected to work alone and with others to solve problems, make presentations, keep their personal notebooks updated, produce an end-of-unit poster, and complete two quizzes and an end-of-unit exam. Students are expected to respect each others' ideas and use appropriate social skills.

About the "From the Classroom" Vignettes

All of the "From the Classroom" vignettes, such as the one on the following page, describe real incidents that happened in my classroom. Only the names have been changed to protect the innocent. As you read these vignettes, you may recall similar experiences from your own classroom. Perhaps you have dealt successfully with the situations in ways other than mine. If you recognize yourself in a vignette and are willing to share your approach with other teachers, please email me at dan@meaningfulmath.com. I'll post your ideas on my website, *meaningfulmath.com*.