February 2005
Volume 1, Issue 1

APS Mathematics Teacher

A Newsletter for Secondary Mathematics Teachers
in Albuquerque Public Schools

Never Say Anything a Kid Can Say!

Steven C. Reinhart

AFTER EXTENSIVE PLANNING, I presented what should have been a masterpiece lesson. I worked several examples on the overhead projector, answered every student's question in great detail, and explained the concept so clearly that surely my students understood. The next day, however, it became obvious that the students were totally confused. In my early years of teaching, this situation happened all too often. Even though observations by my principal clearly pointed out that I was very good at explaining mathematics to my students, knew my subject matter well, and really seemed to be a dedicated and caring teacher, something was wrong. My students were capable of learning much more than they displayed.

Implementing Change over Time

THE LOW LEVELS OF ACHIEVEMENT of many students caused me to question how I was teaching, and my search for a better approach began. Making a commitment to change 10 percent of my teaching every year, I began to collect and use materials and ideas gathered from supplements, workshops, professional journals, and university classes. Each year, my goal was simply to teach a single topic in a better way than I had the year before.

Before long, I noticed that the familiar teacher-centered, direct-instruction model often did not fit well with the more in-depth problems and tasks that I was using. The information that I had gathered also suggested teaching in nontraditional ways. It was not enough to teach better mathematics; I also had to learn to teach in ways that I had never observed or experienced, challenging many of the old teaching paradigms. As I moved from traditional methods of instruction to a more student-centered, problem-based approach, many of my students enjoyed my classes more. They really seemed to like working together, discussing and sharing their ideas and solutions to the interesting, often contextual, problems that I posed. The small changes that I implemented each year began to show results. In five years, I had almost completely changed both what and how I was teaching.

The Fundamental Flaw

AT SOME POINT DURING THIS METAMORPHOSIS, I concluded that a fundamental flaw existed in my teaching methods. When I was in front of the class demonstrating and explaining, I was learning a great deal, but many of my students were not! Eventually, I concluded that if my students were to ever really learn mathematics, *they* would have to do the explaining, and *I*, the listening. My definition of a good teacher has since changed from "one who explains things so well that students understand" to "One who gets students to explain things so well that they can be understood."

Steven C. Reinhart, steve_reinhart@wet.pbs.org, teaches mathematics at Chippewa Falls, WI 54729. He is interested in the teaching of algebraic thinking at the middle school level and in the professional development of teachers.

Reprinted with permission from *Mathematics Teaching in the Middle Schools* (NCTM), April 2000.

"Being able to reason is essential to understanding mathematics."
– NCTM, 2000

Contents:

Getting middle school students to explain their thinking and become actively involved in classroom discussions can be a challenge. By nature, these students are self-conscious and insecure. This insecurity and the effects of negative peer pressure tend to discourage involvement. To get beyond these and other roadblocks, I have learned to ask the best possible questions and to apply strategies that require all students to participate. Adopting the goals and implementing the strategies and questioning techniques that follow have helped me develop and improve my questioning skills. At the same time, these goals and strategies help me create a classroom atmosphere in which students are actively engaged in learning mathematics and feel comfortable in sharing and discussing ideas, asking questions, and taking risks.

Questioning Strategies that Work for Me

Sculpture on campus at Mills College, Oakland, California.

ALTHOUGH GOOD TEACHERS PLAN DETAILED LESSONS that focus on the mathematical content, few take the time to plan to use specific questioning techniques on a regular basis. Improving questioning skills is difficult and takes time, practice, and planning. Strategies that work once will work again and again. Making a list of good ideas and strategies that work, revisiting the list regularly, and planning to practice selected techniques in daily lessons will make a difference.

Create a plan. The following is a list of reminders that I have accumulated from the many outstanding teachers with whom I have worked over several years. I revisit this list often. None of these ideas is new, and I can claim none, except for the first one, as my own. Although implementing any single suggestion from this list may not result in major change, used together, these suggestions can help transform a classroom. Attempting to change too much too fast may result in frustration and failure. Changing a little at a time by selecting, practicing, and refining one or two strategies or skills before moving on to others can result in continual, incremental growth. Implementing one or two techniques at a time also makes it easier for students to accept and adjust to the new expectations and standards being established.

"Every time I am tempted to tell students something, I try to ask a question instead."

1. Never say anything a kid can say! This one goal keeps me focused. Although I do not think that I have ever met this goal completely in any one day or even in a given class period, it has forced me to develop and improve my questioning skills. It also sends a message to students that their participation is essential. Every time I am tempted to tell students something, I try to ask a question instead.
2. Ask good questions. Good questions require more than recalling a fact or reproducing a skill. By asking good questions, I encourage students to think about, and reflect on, the mathematics they are learning. A student should be able to learn from answering my question, and I should be able to learn something about what the student knows or does not know from her or his response. Quite simply, I ask good questions to get students to think and inform me about what they know. The best questions are open-ended, those for which more than one way to solve the problem or more than one acceptable response may be possible.
3. Use more process questions than product questions. Product questions—those that require short answers or a yes or no response or those that rely almost completely on memory—provide little information about what a student knows. To find out what a student understands, I ask process questions that require the student to reflect, analyze, and explain his or her thinking and reasoning. Process questions require students to think at much higher levels.

4. Replace lectures with sets of questions. When tempted to present information in the form of a lecture, I remind myself of this definition of a lecture: "The transfer of information from the notes of the lecturer to the notes of the student without passing through the minds of either." If I am still tempted, I ask myself the humbling question "What percent of my students will actually be listening to me?"

5. Be patient. Wait time is very important. Although some students always seem to have their hands raised immediately, most need more time to process their thoughts. If I always call on one of the first students who volunteers, I am cheating those who need more time to think about, and process a response to, my question. Even very capable students can begin to doubt their abilities, and many eventually stop thinking about my questions altogether. Increasing wait time to five seconds or longer can result in more and better responses.

Good discussions take time; at first, I was uncomfortable in taking so much time to discuss a single question or problem. The urge to simply tell my students and move on for the sake of expedience was considerable. Eventually, I began to see the value in what I now refer to as a "less is more" philosophy. I now believe that all students learn more when I pose a high-quality problem and give them the necessary time to investigate, process their thoughts, and reflect on and defend their findings.

"What percent of my students will actually be listening to me?"

Share with students reasons for asking questions. Students should understand that all their statements are valuable to me, even if they are incorrect or show misconceptions. I explain that I ask them questions because I am continuously evaluating what the class knows or does not know. Their comments help me make decisions and plan the next activities.

Teach for success. If students are to value my questions and be involved in discussions, I cannot use questions to embarrass or punish. Such questions accomplish little and can make it more difficult to create an atmosphere in which students feel comfortable sharing ideas and taking risks. If a student is struggling to respond, I move on to another student quickly. As I listen to student conversations and observe their work, I also identify those who have good ideas or comments to share. Asking a shy, quiet student a question when I know that he or she has a good response is a great strategy for building confidence and self-esteem. Frequently, I alert students ahead of time: "That's a great idea. I'd really like you to share that with the class in a few minutes."

Mathematics as Art
Sculpture by David Schrandt

Be nonjudgmental about a response or comment. This goal is indispensable in encouraging discourse. Imagine being in a classroom where the teacher makes this comment: "Wow! Brittni, that was a terrific, insightful response! Who's next?" Not many middle school students have the confidence to follow a response that has been praised so highly by a teacher. If a student's response reveals a misconception and the teacher replies in a negative way, the student may be discouraged from volunteering again. Instead, encourage more discussion with one another, discover their own errors, and correct their thinking. Allowing students to listen to their fellow classmates is a far more positive way to deal with misconceptions than announcing to the class that an answer is incorrect. If several students remain confused, I might say, "I'm hearing that we do not agree on this issue. Your comments and ideas have given me an idea for an activity that will help you clarify your thinking." I then plan to revisit the concept with another activity as soon as possible.

Try not to repeat students' answers. If students are to listen to one another and value one another's input, I cannot repeat or try to improve on what they say. If students realize that I will repeat or clarify what another student says, they no longer have a reason to listen. I must be patient and let students clarify their own thinking and encourage them to speak to their classmates, not just to me. All students can speak louder—I have heard them in the halls! Yet I must be careful not to embarrass someone with a quiet voice. Because students know that I never accept just one response, they think nothing of my asking another student to paraphrase the soft-spoken comments of a classmate.

"Students generally feel much more confident in stating ideas when the responsibility for the response is being shared with a partner or group."

"Is this the right answer?" Students frequently ask this question. My usual response to this question might be that "I'm not sure. Can you explain your thinking to me?" As soon as I tell a student that the answer is correct, thinking stops. If students explain their thinking clearly, I ask a "What if?" question to encourage them to extend their thinking.

Participation is not optional! I remind my students of this expectation regularly. Whether working in small groups or discussing a problem with the whole class, each student is expected to contribute his or her fair share. Because reminding students of this expectation is not enough, I also regularly apply several of the following techniques:

1. Use the thinking-pair-share strategy. Whole-group discussions are usually improved by using this technique. When I pose a new problem; present a new project, task, or activity; or simply ask a question, all students must think and work independently first. In the past, letting students begin working together on a task always allowed a few students to sit back while others took over. Requiring students to work alone first reduces this problem by placing the responsibility for learning on each student. This independent work time may vary from a few minutes to the entire class period, depending on the task.

   After students have had adequate time to work independently, they are paired with partners or join small groups. In these groups, each student is required to report his or her findings or summarize his or her solution process. When teams have had the chance to share their thoughts in small groups, we come together as a class to share our findings. I do not call for volunteers but simply ask one student to report on a significant point discussed in the group. I might say, "Tanya, will you share with the class one important discovery your group made?" or "James, please summarize for us what Adam shared with you." Students generally feel much more confident in stating ideas when the responsibility for the response is being shared with a partner or group. Using the think-pair-share strategy helps me send the message that participation is not optional.

   A modified version of this strategy also works in whole-group discussions. If I do not get the responses that I expect, either in quantity or quality, I give students a chance to discuss the questions in small groups. On the basis of the difficulty of the question, they may have as little as fifteen seconds or as long as several minutes to discuss the question with their partners. This strategy has helped improve discussions more than any other that I have adopted.

2. If students or groups cannot answer a question or contribute to the discussion in a positive way, they must ask a question of the class. I explain that it is all right to be confused, but students are responsible for asking questions that might help them understand.

The abacus is a calculator that dates back thousands of years.

4. Always require students to ask a question when they need help. When a student says, “I don’t get it,” he or she may really be saying, “Show me an easy way to do this so I don’t have to think.” Initially, getting students to ask a question is a big improvement over “I don’t get it.” Students soon realize that my standards require them to think about the problem in enough depth to ask a question.

5. Require several responses to the same question. Never accept only one response to a question. Always ask for other comments, additions, clarifications, solutions, or methods. This request is difficult for students at first because they have been conditioned to believe that only one answer is correct and that only one correct way is possible to solve a problem. I explain that for them to become better thinkers, they need to investigate the many possible ways of thinking about a problem. Even if two students use the same method to solve a problem, they rarely explain their thinking in exactly the same way. Multiple explanations help other students understand and clarify their thinking. One goal is to create a student-centered classroom in which students are responsible for the conversation. To accomplish this goal, I try not to comment after each response. I simply pause and wait for the next student to offer comments. If the pause alone does not generate further discussion, I may ask, “Next?” or “What do you think about _____’s idea?”

6. No one in a group is finished until everyone in the group can explain and defend the solution. This rule forces student to work together, communicate, and be responsible for the learning of everyone in the group. The learning of any one person is of little value unless it can be communicated to others, and those who would rather work on their own often need encouragement to develop valuable communication skills.

7. Use hand signals often. Using hand signals—thumbs up of thumbs down (a horizontal thumb means “I’m not sure”)—accomplishes two things. First, by requiring all students to respond with hand signals, I ensure that all students are on task. Second, by observing the responses, I can find out how many students are having difficulty or do not understand. Watching students’ faces as they think about how to respond is very revealing.

8. Never carry a pencil. If I carry a pencil with me or pick up a student’s pencil, I am tempted to do the work for the student. Instead, I must take time to ask thought-provoking questions that will lead to understanding.

9. Avoid answering my own questions. Answering my own questions only confuses students because it requires them to guess which questions I really want them to think about, and I want them to think about all my questions. I also avoid rhetorical questions.

10. Ask questions of the whole group. As soon as I direct a question to an individual, I suggest to the rest of the students that they are no longer required to think.

11. Limit the use of group responses. Group responses lower the lever of concern and allow some students to hide and not think about my questions.

12. Do not allow students to blurt out answers. A student’s blurted out answer is a signal to the rest of the class to stop thinking. Students who develop this habit must realize that they are cheating other students of the right to think about a question.

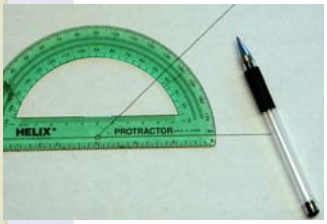
Geometry is everywhere!

When a student says, “I don’t get it,” he or she may really be saying, “Show me an easy way to do this so I don’t have to think.”

Summary

LIKE MOST TEACHERS, I entered the teaching profession because I care about children. It is only natural for me to want to be successful, but by merely telling them answers, doings things for them, or showing them shortcuts, I relieve students of their responsibilities and cheat them of the opportunity to make sense of the mathematics that they are learning. To help students engage in real learning, I must ask good questions, allow students to struggle, and place the responsibility for learning directly on their shoulders. I am convinced that children learn in more ways than I know how to teach. By listening to them, I not only give them the opportunity to develop deep understanding but also am able to develop true insights into what they know and how they think.

Making extensive changes in curriculum and instruction is a challenging process. Much can be learned about how children think and learn from recent publications about learning styles, multiple intelligences, and brain research. Also, several reform curriculum projects funded by the National Science Foundation are now available from publishers. The *Connect Mathematics Project*, *Mathematics in Context*, and *Math Scape*, to name a few, artfully address issues of content and pedagogy.



Bibliography

Burns, Marilyn. *Mathematics: For Middle School*. New Rochelle, N.Y.: Cuisenaire Co. of America, 1989.

Johnson, David R. *Every Minute Counts*. Palo Alto, Calif.: Dale Seymour Publications, 1982.

National Council of Teachers of Mathematics (NCTM). *Professional Standards for Teaching Mathematics*. Reston, Va.: NCTM, 1991.

Focus on Teachers & Teaching

"Real mathematics does not come neatly divided into mathematics strands."

This is a newsletter for mathematics teachers, but it is also *about* mathematics teachers and mathematics teaching. Teachers are making a difference in their classrooms every day. Each issue of *APS Mathematics Teacher* will recognize teachers for their special accomplishments and unique projects.

Mathematics Web Sites

Each month *APS Mathematics Teacher* will highlight certain mathematics web sites that can enhance the teaching profession.

http://forum.swathmore.edu The Math Forum is an excellent link to many math resources.

www.nctm.org National Council of Teachers of Mathematics provides excellent resources, including the National Mathematics Standards.

www.ithaca.edu/compass COMPASS is a math information site regarding high school mathematics curricula.

http://showmecenter.missouri.edu Show-Me-Center is a math information site regarding middle school mathematics curricula.

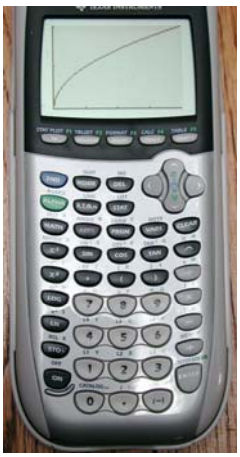
www.maa.org Mathematical Association of America

What's Happening?

AP New Mexico and *Teaching & Learning Systems* are co-sponsoring a **graphing calculator workshop** for APS mathematics teachers on Wednesday, March 16, 8:30 a.m. to 3:30 p.m., at the Montgomery Complex. Ronda Davis will be the chief facilitator. Registration information will be sent out to schools in mid-February via Math Leaders. Contact Martha Fenstermacher (880-8249 ext. 117) or Bill Schrandt (880-8249 ext. 235) for additional information.

Sat., Feb. 5	*IMP* Gathering	8:30-3:30	South Valley Academy
Mon., Feb. 7	AACTM – data-gathering technology	7:00-8:30	Montgomery Complex
Tue., Feb. 8	Elementary Math Leaders	8:30-11:30	Montgomery Complex
Tue., Feb. 8	Vertical Articulation–All Math Leaders	12:30-3:30	Montgomery Complex
Thu., Feb. 17	AP Differentiating Instruction–Math	8:00-3:00	TVI Workforce
Feb. 28-Mar.17	NMSBA Testing Window		
Sat., Feb. 19	Algebra Readiness/Math Lab Workshop	8:30-3:00	Montgomery Complex
Feb. 25-26	AP New Mexico State Conference		Santa Fe Community College
Sat., Feb 26	Differential Equations Workshop, Rm 18	8:30-11:30	Montgomery Complex
Sat., Mar. 5	Secondary Math Leaders	8:30-3:30	Montgomery Complex
Tue. Mar. 8	Elementary Math Leaders	4:30-7:30	Montgomery Complex
Sat., Mar. 12	Algebra Readiness/Math Lab Workshop	8:30-3:00	Montgomery Complex
Wed., Mar. 16	AP/TLS Graphing Calculator Workshop	8:30-3:30	Montgomery Complex
Mar. 21-25	APS SPRING BREAK		
Mar. 31-Apr. 3	NSTA National Conference		Dallas, TX
April 6-9	NCTM National Conference		Anaheim, CA
Sat., Apr. 9	*IMP* Gathering	8:30-3:30	South Valley Academy
Tue., Apr. 12	Elementary Math Leaders	8:30-3:30	Montgomery Complex
Thu., Apr. 14	Middle School Math Leaders	4:00-6:00	Montgomery Complex
Sat., Apr. 16	Algebra Readiness/Math Lab Workshop	8:30-3:00	Montgomery Complex
Sat., Apr. 16	Middle School Math Contest		
Tue., Apr. 19	High School Math Leaders	3:30-5:30	Montgomery Complex

Feature Problems



Graphing Calculator

As you and/or your students work on these problems, reflect on *how* you thought about solving the problems and how you might make the problems even richer for your students.

1. In North America, a telephone number consists of a three-digit *area code*, followed by the three-digit *prefix*, followed by four more digits. For example, the telephone number for *TLS* is (505) 880-8249.

(505) 880-8249

area code prefix

   a. The first digit of an area code and the first digit of a prefix must be greater than or equal to 2.

   b. How many telephone numbers with an area code of 505 are possible?

   c. Toll-free telephone numbers have an area code of 800 or 888. How many toll-free telephone numbers are possible?

   d. How many telephone numbers with the same area code and prefix as your telephone number are possible?

   e. How many different U.S. telephone numbers are possible?

APS Mathematics Teacher

Bill Schrandt, Editor

Teaching & Learning Systems
3315 Louisiana Blvd. NE
Albuquerque, NM 87110

Phone:
505-880-8249 ext. 235

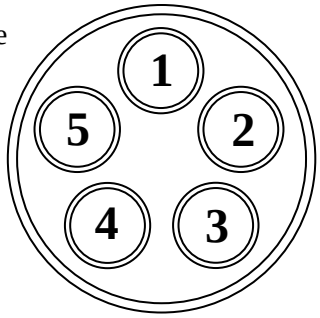
E-Mail:
schrandt@aps.edu

Fax:
505-880-8287

Building a Professional Learning Community.

Feature Problems, continued

2. A Simplex lock consists of five buttons arranged in a circle. To open the lock, one must depress the correct combination of buttons. A combination is a sequence of 0 or more pushes, each involving at least 1 button. Each button may be used at most once (once pressed, it remains in). A button may not be depressed at all. Here, for example, is a possible combination: press buttons 2 and 3 simultaneously, then button 4, and finally press buttons 1 and 5 simultaneously.



How many possible combinations are there for this type of lock?

Editorial

I have visited several math departments in recent months. As a Resource Teacher, I am concerned with teachers' needs and ways I can support what they are doing in the classroom. This newsletter is, in part, in response to some of the expressed needs. It is my hope that this publication can serve as a central clearinghouse for pertinent information. I must rely on you to help me gather this information. Please send me information regarding creative teachers and teaching, important events or opportunities, interesting web sites and rich problems. It is my hope to publish *APS Mathematics Teacher* monthly during the academic year.

As part of *Teaching & Learning Systems*, I am at your service.

About Teaching & Learning Systems…

Teaching and Learning Systems supports Standards implementation through systemic, job embedded, capacity building professional development with a focus on literacy across the content.

Our standards-based system asks teachers to make deep changes in the way they teach math. Standards-based math curricula, funded with support of the National Science Foundation (NSF), help teachers implement new teaching strategies. Teachers require effective professional development that is intensive and sustained.