Classroom Compass

HIGHLIGHTS

Promoting Diversity, Valuing Difference

The census data for 2000 confirm what most teachers already know: our student populations are becoming more and more diverse. The United States is on its way to becoming a plurality of minorities, and the changing demographics are profoundly affecting the makeup of student populations. Now more than ever, schools and teachers must find ways to engage a wider range of students with more diverse backgrounds, interests, and experiences.

Previous efforts to foster greater inclusion warn us that addressing the current needs will not be easy. Ironically, a system of universal schooling designed to provide opportunities for all has matured into a system that more frequently than not sustains social and cultural divisions. From the great struggles for racial integration and second language instruction to the mainstreaming and detracking movements, American schools have strongly resisted political and pedagogical pressures to serve broader audiences more equitably. Though the resistance has eventually been overcome, the pattern of quality in schools continues to mirror closely our uneven social, cultural, and linguistic demographics. If schools are to provide a meaningful experience for all, then we must begin to think very differently about the goals and purposes of schooling.

Continued on page 2

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Promoting Diversity, Valuing Difference *continued*

Schools are truly remarkable institutions. Parents, even grandparents, can walk into a typical high school physics or algebra classroom and feel at home; some things just have not changed that much. Yet the social role of schools has changed dramatically. Traditionally, schooling serves two functions for a society: first, the transmission of particular skills from experts to novices; second, the transmission of social traditions and standards. As institutions for the preservation of social systems, schools are highly resistant to novelty and invention. Schools are therefore essentially conservative institutions; that is to say, they are designed to pass along understanding and knowledge that are already defined and codified.

At the same time, however, schools have become the prime marketplace for the youth-to-youth exchange of popular culture. Fads in music, clothing, and media create instantly fashionable icons and superstars resistant to the rules. The struggle for identity for many youth frequently hangs on the actions of their crowd as they track quick reversals of what is "in" or "out." The struggle to fit in creates a youthful solidarity where difference can create a painful isolation.

In classrooms, another type of sorting takes place as teachers differentiate students based on perceived ability to learn. Deciding whether or not students should be promoted into programs for further study is a commonly and widely practiced part of teachers' evaluations of students, anchored rather thinly on the teachers' capacity to accurately assess student understandings. Teachers sometimes think of themselves as miners for rare gems in the great matrix of ordinary students.

At each step in the educational process, those students who best fit teachers' expectations of "most able" are filtered from the general student body and are offered more advanced learning experiences. Eventually only "the brightest" students survive to be selected by colleges and universities. When schools provide preferential treatment toward certain students, they can no longer claim to function neutrally to provide equal opportunities for every student.

At the dawn of the twenty-first century, however, the vision for schooling has been redefined to include "all." The mantra for the new administration has become "no child left behind." With an official education policy focused on serving all students equally, the metaphor for schools has changed from "filters" to "pumps." Especially in science and mathematics, the stated purpose of schooling has shifted from finding and polishing a few diamonds in the rough to creating opportunities for all students to reach their greatest potential. Yet, in reality, schools have been slow to adopt strategies to narrow the gaps in achievement that closely track income and ethnicity.

With this push for inclusiveness, many educators have come to see equity as part of ethnic equality, and diversity is commonly linked to racial or ethnic identities. Author Neil Postman has noted this change:

> some schools [have attempted] to ensure that students cultivate a deep sense of ethnic pride, a task once undertaken mostly by the family…I think this to be a bad idea—to the extent that it subordinates or ignores the essential task of public schools, which is to find and promote large, inclusive narratives for all students to believe in. The principle of diversity is such a narrative… diversity wants one to turn outward, toward the talents and accomplishments of all groups. Diversity is the story that tells of how our interactions with many kinds of people make us into what we are (1996).

Ultimately, public schools will become institutional spaces where the great variety of Americans can come to know and understand each other. As more diversity among students is recognized and honored, the life stories and insights of all students become part of the narratives of the schoolyard. Schools will have to make the diversity narrative positive for all, and this will require reconsid eration of some basic

educational ideas. The goal for educators has moved from making all students the same to creating learning environments that nourish the differing strengths of each student.

The Classroom Ecosystem

Using a healthy ecosystem as an analogy to a healthy learning environment lends another perspective to the issues surrounding diversity. In biology, the well-being of an ecosystem is measured by the diversity of its species — greater diversity is an ecological *advantage*. Increased diversity means more interconnected relationships that lead to greater stability. When a relationship weakens, the community picks up the slack.

If we think of classrooms and students from an ecological perspective, we see the analogy extends to educational systems as well. When both teacher and student understand the strengths and limits of the student's skills, these can be utilized in a healthy, productive manner with teamwork. When a task lies outside a student's individual boundaries, creating opportunities to work together to benefit from the strengths of others can be productive. This method promotes strong relationships, encouraging codependency within groups and a greater chance for success. Multiple relationships distribute the load, taking the pressure for the maintenance of the system off of any particular species or interspecies relationship.

Our insistence that all students meet the same criteria for success — criteria based on national norms dominated by one cultural, ethnic, and language group — creates a permanent underclass in schools (Furr 2001). Driven by high stakes tests promoting basement learning expectations, the culture of schools enables the academically acculturated student to collect the rewards of success with little effort. At the same time, devaluing diversity forces students from unique backgrounds and experiences into a shadow world of pretense and catch-up, a world that rarely rewards their strengths and cultural background knowledge. There is only one path to success in the classic classroom ecology, and most students are never able to follow it.

Often, racism, sexism and social class are key determinants in the "ability" labeling process prevalent in the majority of the American education system. Predominant methods of science teaching and assessment basically select students most able to perform the rituals of note-taking, memorization, and timed tests that define divisions according to the ability label (Gill and Levidow 1989). In an interview with teacher-researcher Josiane Hudicort-Barnes, Rogers Hall notes that she identifies the tendency of some teachers who might begin class with a set of expectations and a task to accomplish. The "model student" is usually the one to take up the teacher's agenda and participate in the way that the teacher expects. When teachers create a more flexible learning environment that allows the exploration and expression of ideas while leveraging students' language and cultures, diverse students show a greater capacity for comprehending difficult mathematics and science content (Hall 2001). In fact, research shows that when students can relate personal experiences to a science task, for example, they show a more complete understanding compared to their performances with unfamiliar tasks (Fradd, Lee, and Sutman 1995).

Teachers who discover, value, and promote the differences of each of their students create a rich learning environment, one with many paths to success. The teacher can alter the factors in the classroom to assure that each student is nurtured with multiple opportunities to thrive. Rather than filtering and sorting by focusing only on some of the students, teachers can develop strategies to help all students succeed.

It is important for teachers to value diversity. The real benefit, however, comes when teachers can use diverse student perspectives as an asset in instruction. Then, teachers create learning environments where all students can truly flourish. To successfully promote students with widely different skills and backgrounds, however, teachers must do much more than simply change their outlook. They must also look closely at classroom goals and practices for ways to support their students as they create diverse narratives.

Integrating Differences

New Mexico high school mathematics teacher Marilyn Gutman has developed a variety of techniques for classroom inclusion. When asked about her encounters with diversity in the classroom, she responds: "If you're a good teacher, you realize each person is so different from the other that you hardly notice it." At her school, 50% of the students are Hispanic, and many of those are non-native English speakers. In addition to bilingual students in her class, she has a student with cerebral palsy who is in a wheelchair.

Promoting Diversity, Valuing Difference *continued*

She challenges teachers to be flexible, make accommodations, and use many different types of assessment. Ms. Gutman has students do most of their work in groups, using extended projects, labs and discovery-type activities in place of tests as the sole assessment tool: "Let big group projects count as tests. In those, they are doing a lot of math and don't even realize it."

She has partnered with New Mexico State University on a long term, hands-on mathematics and science group project involving deeper thinking. This project has been extremely beneficial to her because there are so many different levels of learning to which she is teaching.

She finds that when students work together, they are in effect teaching each other because their group grade depends on it. The result is that they learn twice as much, and all students benefit. The key to group work, according to Ms. Gutman, is having many jobs for each student as this results in a variety of shared responsibilities. She says, "Having diversity in the assignments so that one student or group of students does not get singled out as the special one who only has to do half of the work is important."

Ms. Gutman also pairs bilingual students with native English speaking students to facilitate lessons. For book work, she allows them to split the assignments when they are working together so that both benefit. One may do the even numbered problems, and the other might do the odds: "If they both can show they know it, that's all I care about."

Valuing difference rather than sameness in schools includes all students as part of a larger system, a classroom ecology. Each child contributes important ideas and energies that promote diversity by honoring difference through interrelationships, interdependence, and the unique qualities in each classroom.

Supporting Diverse and Personal Connections

Even teachers who value diversity can still miss opportunities and misunderstand students' intentions. Consider this dialogue adapted from an incident reported in **Closing the Achievement Gap** (Urban Education National Network 1995, 30):

Teacher: Today, class, we are going to think about eggs. [She holds up a chicken egg.] Think about the times you have cooked and eaten eggs. What do you remember about those eggs? [A few seconds of silence follow as the children think, and the teacher waits for them to collect their thoughts. Soon, a little girl on the front row hesitantly raises her hand, and the teacher acknowledges her.]

Teacher: Yes, Rosa, what do you remember about the eggs that you have eaten?

Rosa: Well, my grandmother always prepares this special egg dish for me when we visit her house. She cuts up bread and…

Teacher: I know that your grandmother must make some really wonderful dishes, Rosa, but what about the eggs themselves? What did you notice about them?

Rosa: The eggs themselves? Well, my grandmother and I gathered them

from the hens. She told me about how you have to be really careful because the roosters can be mean and attack you when…

Teacher: Rosa, let's focus on the eggs. What did you see when you looked at the eggs?

Bill: Well, you know when I eat eggs there is a yellow part and a white part.

Teacher: Yes, Bill, what about those parts? What can you tell us about them?

Bill: Well, the white part is all around the yellow part and sometimes there's this slime…

Obviously, this teacher is trying to draw on the daily life of students by asking them to recall their own experiences with eggs, but Rosa's attempts to talk about eggs from within her cultural context are being misinterpreted. Rosa values objects as part of social relations. She approaches the egg as part of a particular social experience. Bill and the teacher, on the other hand, are more comfortable talking about the egg as a physical object and discussing its constituent parts.

This teacher, and all teachers, can consider some steps that will help them value the differences science and mathematics learners bring to school.

- Honor the understandings that students bring with them to school about how and why things work.
- Listen carefully to understand student ideas because these will not always be clearly articulated and because listeners will not immediately see the value they offer.
- Provide opportunities for students to engage with the learning in a variety of ways and demonstrate their understandings in a variety of assessments.
- Look for multiple solutions or perspectives to a problem or issue. Ask for alternative solutions and consider them all.
- Create personal links to knowledge, events, and ideas and encourage conversation about those links.
- Move to create a sustaining community around the ideas.

Diversifying Teaching Strategies

The teacher in the vignette did not clearly hear the relevance of Rosa's story to her lesson. She did not recognize it as one of many possible perspectives on the natural world. More importantly, she did not attempt to see if there was a connection. Rosa's contribution could have been paired with Bill's as two parts of the discussion about the nature of eggs. This process begins when teachers demonstrate that student understandings and experiences are valued in the classroom.

By valuing Rosa's stories about eggs and her grandmother, the teacher could have provided all the students with a richer learning experience. Experience, observation, and work, however, are needed to acknowledge each student's understanding and to make it available to the whole class. The teacher will have to consider and support what each student can contribute to the diverse understandings of rest of the class.

For a mathematical lesson that encourages a range of approaches to problem solving to help diverse student populations understand the abstract idea of number concepts, see the lesson in this Classroom Compass: "Making Connections among Mathematical Concepts." The activity is also available online at **http://www.sedl.org/scimast.**

In **Other People's Children**, Lisa Delpit lists five ways good teachers can show that they value all student experiences (1995):

1. Good teachers care whether students learn. They challenge all students, even those who are less capable and then help them to meet the challenge.
2. Good teachers are not time-bound to a curriculum and do not move on to new subject matter until all students grasp the current concept.
3. Good teachers are not bound to books and instructional materials but connect all learning to "real life."
4. Good teachers push students to think, to make their own decisions.
5. Good teachers communicate with, observe, and get to know their students and the students' cultural background.

Following Delpit's guidelines, the teacher in the vignette could have responded to Rosa's stories by allowing the class time to depart from the curriculum and explore, for example, how Rosa's grandmother's experiences resemble those of their own grandmothers. She could have used these real life connections to return to her consideration of eggs as physical objects and could have asked the class to compare their own and their relatives' egg stories with the descriptions in the textbook. Are there any differences between these stories? Any contradictions between stories? By carefully interweaving all the stories in the class, she would have acknowledged the diverse backgrounds in the class and helped each student to connect the classroom learning to the world outside. Students whose ideas are valued in this way will create their own community of ideas.

Learning is contextual — we interpret the world based on our diverse beliefs and backgrounds. In mathematics, there are multiple ways to arrive at a solution; in science, there are many techniques of knowing how something works. Teachers must learn to build on belief systems held by each student, helping them make their own connections to science and mathematics. In turn, students gain confidence in their abilities to do science and mathematics and develop a greater understanding of the many narratives they will hear throughout life.

Special thanks to Marilyn Gutman, a Presidential Awardee and SCIMAST teacher mentor, for her contributions and insights within this article.

Southwest Teacher Diversity Chart

"I am keeping in mind that the purpose of public education is to help the young transcend individual identity by finding inspiration in a story of humanity."

Neil Postman, *The End of Education,* p. 170

While the student population is becoming more diverse in the five states served by SCIMAST, teachers remain overwhelmingly white. The Council of Chief State School Officers (CCSSO) has the most recent (1998) figures on teacher diversity. The CCSSO broke down teacher population in percentages by subjects taught and race or ethnicity. *No data were available for Louisiana.*

Arkansas Teachers

	Hispanic	white	black	Asian	Native American
Mathematics	0%	91	8	.2	.2
Biology	0%	90	9	.2	.2
Chemistry	0%	95	5	0	0
Physics	0%	97	3	0	0

New Mexico Teachers

	Hispanic	white	black	Asian	Native American
Mathematics	19%	78	1	1	1
Biology	14%	83	.5	.5	2
Chemistry	10%	89	0	1	0
Physics	8%	92	0	0	0

Oklahoma Teachers

	Hispanic	white	black	Asian	Native American
Mathematics	0.1%	95	2	.2	3
Biology	0.4%	94	2	.2	3
Chemistry	0.4%	96	1	0	3
Physics	1%	97	1	0	2

Texas Teachers

	Hispanic	white	black	Asian	Native American
Mathematics	12%	80	7	1	.2
Biology	12%	79	8	1	.5
Chemistry	9%	84	5	1	1
Physics	7%	89	2	1	1

SCIMAST is developing responses to this problem through its teacher diversity meetings. This network is made up of educators interested in developing teacher preparation and retention programs focused on potential and practicing educators from underrepresented groups. For more information contact scimast@sedl.org.

AN ACTIVITY FOR UPPER LEVEL STUDENTS

Making Connections among Mathematical Concepts

Too often, students are taught to solve mathematical problems in only one way — the algorithmic approach. This strategy requires students to follow a standardized procedure to reach an answer. Often, algorithms are learned by repeated "drill and practice" approaches. Drill and practice can be extremely effective for teaching short-lived procedural skills, but for real understanding to occur, students must be engaged in a deeper exploration of what the problem means and how to resolve it. Liping Ma, in her book **Knowing and Teaching Elementary Mathematics**, talks to the importance of helping students find multiple solutions to a problem: "Being able to and tending to solve a problem in more than one way, therefore, reveals the ability and the predilection to make connections between and among mathematical areas and topics" (112).

Encouraging the exploration of a wide range of approaches and examples with the same problem can help students value and use powerful problem solving strategies based on a deeper understanding of fundamental mathematical concepts. Naturally, when you try to express something, you understand it better ("Wired for Mathematics: A Conversation with Brian Butterworth," *Educational Leadership*, 59 (3), p. 18-19).

One problem with teaching mathematics strictly at a procedural level is that students have no framework of what the multiplication of mixed numbers really means or why it works the way it does. Taught in isolation, none of these approaches alone enables students to attain a clear picture of what it means to multiply two mixed numbers. They are forced to carry around a large set of disconnected procedures for each mathematical problem. However, when students look at many different ways to approach a mathematical problem, it is easier to make critical connections that enable them to construct and remember the "big picture."

Making Connections among Mathematical Concepts challenges students to create different ways or manipulatives to solve one problem. Then, they are encouraged to make connections between each of these manipulatives so that they develop an understanding of what it means to create and solve an algorithm. At the end of the exercise, they will have the confidence and base knowledge they need to tackle similar mathematical problems from many perspectives.

How many different ways can you find to solve a multiplication problem?

Multiple Multiplication Perspectives

For this activity, challenge teams of students to find as many solutions to a word problem as they can. One way to encourage their creativity is to look at it from different mathematical systems. Though the methods to solve the problem each depend on a different knowledge base, they all lead to the same "correct" solution.

Divide students into pairs, taking fullest advantage of the diverse abilities of the classroom. Present the word problem in a way that is situated in the local knowledge of your classroom and community that reflects $3\frac{1}{2}$ times $2\frac{1}{2}$. Perhaps offering problems in a variety of contexts to strike chords with your diverse student population might be ideal. Have fun and be creative and flexible. Here is an example:

> While your parents were away, your little sister decided to go bowling on your parents' kitchen floor, destroying the tiles in the corner section of the room. The tiles that must be replaced cover a $3\frac{1}{2}$ by $2\frac{1}{2}$ foot area. If each of the tiles is one foot by one foot, how many will you need to repair the destroyed area?

Challenge each pair to find two unique ways to solve the problem. This may take some prompting from you. Suggest that they consider the problem visually or algebraically to stimulate additional solutions. Allow the students to make arguments about which method works or does not work and why. What is equivalent? What is different?

Making Connections among Mathematical Concepts *continued*

Here are some perspectives that may come out of the group work.

Number sense

What is multiplication? In its simplest form, multiplication is the repeated addition of equal sized groups. For example, $3 \times 2 = 2 + 2 + 2$.

If 3×2 by definition is three groups of two in each group, then $3\frac{1}{2} \times 2\frac{1}{2}$ means three and a half groups of two and a half in each group.

This number sense method (three and a half groups of two and a half units each) can be expanded like this:

$$3\tfrac{1}{2} \times 2\tfrac{1}{2} =$$

$$2\tfrac{1}{2} + 2\tfrac{1}{2} + 2\tfrac{1}{2} + \frac{2\frac{1}{2}}{2} =$$

$$7\tfrac{1}{2} + 1\tfrac{1}{4} =$$

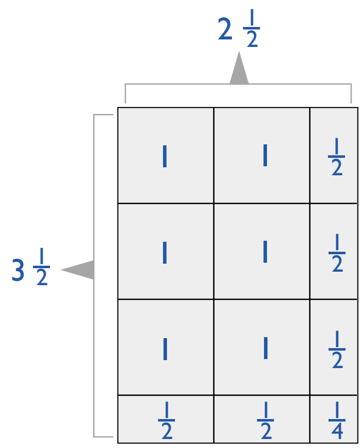
Students may have difficulty with the final term $\frac{2\frac{1}{2}}{2}$.

They might figure it out if it was rewritten $\frac{2}{2} + \frac{\frac{1}{2}}{2}$, but even in this expanded form, they need to understand how to divide fractions. It could help if they think of $\frac{2}{2}$ as $\frac{1}{2}$ of 2, which everyone knows equals 1. They still may struggle with $\frac{1}{2}$ of $\frac{1}{2}$, but they should be able to comprehend that using money.

Another way to solve this is by laying out the problem geometrically, using a different approach so that division does not have to take place. (See the graphic to the right.)

The geometric or measurement perspective using area

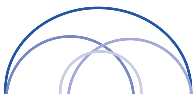
This perspective encourages the student to create a picture to help visualize the problem. In this case, the tool used to solve the problem is a rectangular grid using the idea of area and square units. Drawn to scale, the area of each rectangle reflects the size of the fraction it represents. Students can solve this without actually doing any "multiplication." Instead, they can add like terms (ones, halves, quarters), then combine them.



$1 + 1 + 1 + 1 + 1 + 1$	$= 6$	(six individual whole units)
$+ \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$	$= 2\frac{1}{2}$	(five one-half units — three vertical and two horizontal)
$\frac{1}{4}$	$= \frac{1}{4}$	(one half of a half unit)
	$8\frac{3}{4}$	sum of the rectangular units, "unit" being a 1 x 1 square

Algebraic perspective using the distributive property

Students may be unaware that they have been using the distributive property since they started multiplying multi-digit numbers. They may need to see whole numbers such as 23 x 54, for example, decomposed and then multiplied horizontally as opposed to the vertical method more commonly used.



$$23 \times 54 = (20 + 3) \times (50 + 4)$$
$$= (20 \times 50) + (20 \times 4) + (3 \times 50) + (3 \times 4)$$
$$= 1000 + 80 + 150 + 12$$
$$= 1242$$

Using the above example and substituting the problem's values of $3\frac{1}{2}$ and $2\frac{1}{2}$, students' work might look like this.

$$(3 + \tfrac{1}{2})\ (2 + \tfrac{1}{2})$$
$$(3 \times 2) + (3 \times \tfrac{1}{2}) + (\tfrac{1}{2} \times 2) + (\tfrac{1}{2} \times \tfrac{1}{2})$$
$$= 6 + 1\tfrac{1}{2} + 1 + \tfrac{1}{4}$$
$$= 8\tfrac{3}{4}$$

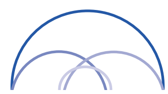
Ask students to compare their algebraic solution with the number sense and geometrical approaches discussed earlier. There are similarities. All three perspectives partition out the problem so that addition can be used to solve the multiplication problem.

Using decimals

Decimals are not often considered fractions, but they are. In fact, parts of wholes are more commonly represented by decimals in the real world than by fractions. Restated in decimals, the problem looks like this.

$$3.5 \times 2.5 =$$

Once restated in decimal notation, the problem can be solved using any of the approaches already described. Take the distributive property, for example:



$$(3 + .5)\ (2 + .5)$$
$$(3 \times 2) + (3 \times .5) + (.5 \times 2) + (.5 \times .5)$$
$$6 + 1.5 + 1 + .25$$
$$= 8.75$$

Seeing the similarities between the four approaches can be powerful for helping students understand visually, conceptually, and, finally, procedurally how the multiplication of mixed numbers works.

> *What is taught in grade school as arithmetic is, for the most part, not ideas about numbers but automatic procedures for performing operations on numerals — procedures that give consistent and stable results. Being able to carry out such operations does not mean that you have learned meaningful content about the nature of numbers, even if you always get the right answers!*
>
> — George Lakoff and Rafael E. Nuñez, *Where Mathematics Come From: How the Embodied Mind Brings Mathematics into Being*, p. 86

Making Connections among Mathematical Concepts *continued*

The standard algorithm perspective

The algorithm is the most efficient way to do the mathematics but is not the best way to understand it. The algorithm provides a process for solving the problem that relies on breaking down the problem down into easily calculated steps. Algorithms are so simple that calculators and computers rely on them heavily to solve complex problems, but they depend heavily on rote meaning of procedural rules and contribute little to students' conceptual understanding. They should be used only after the student understands the underlying mathematics that go into solving the problem.

$$3\frac{1}{2} \times 2\frac{1}{2} =$$

$$\frac{7}{2} \times \frac{5}{2} = \frac{35}{4} = 8\frac{3}{4}$$

Students change the mixed numbers to improper fractions, do the necessary multiplication, then simplify the fraction and/or convert the answer to a mixed number. The standard algorithm statement looks very close to the algebraic problem without the addition: $(3\frac{1}{2})\ (2\frac{1}{2})$. When creating the problem from the top row $(2\frac{1}{2})$ and the left column $(3\frac{1}{2})$ of the geometric perspective, the standard algorithm is reflected. Of course, when the fractions in the algorithm are turned to decimals $(\frac{1}{2} = .5)$, the decimal problem is created.

How many children leave school with good grades in mathematics but no understanding of what they were doing? Surely a lot, judging from the large numbers of perfectly intelligent adults who cannot add fractions. If only they understood what was going on, they would never forget how to do it. Without such understanding, however, few can remember such a complicated procedure for long once the final exam has ended.

— Keith Devlin,
The Math Gene: How Mathematical Thinking Evolved and Why Numbers Are Like Gossip, p. 67

Making connections

Solely teaching the algorithm shortchanges the development of students' understanding of how a problem works. According to Ma, "Being able to calculate in multiple ways means that one has transcended the formality of an algorithm and reached the essence of the numerical operations — the underlying mathematical ideas and principles" (112). Based on students' understanding of multiple strategies, they can make connections between the parts of the problem. During this exercise, students have used geometry, algebra, decimals, and a visual diagram to solve one multiplication problem. Challenging students to solve mathematical problems a number of ways allows them to relate underlying mathematical relationships that they will remember when using the more efficient algorithm method.

This lesson is an adaptation of a SCIMAST teacher professional development training module. Special thanks to Concepcion "Como" Molina, SCIMAST program specialist, for his assistance with this lesson.

National Standards

National Science Education Standards

Teaching Standard B:

Teachers of science guide and facilitate learning. In doing this, teachers:

• Recognize and respond to student diversity and encourage all students to participate fully in science learning.

In all aspects of science learning as envisioned by the Standards, skilled teachers recognize the diversity in their classes and organize the classroom so that all students have the opportunity to participate fully. Teachers monitor the participation of all students, carefully determining, for instance, if all members of a collaborative group are working with materials or if one student is making all the decisions. This monitoring can be particularly important in classes of diverse students, where social issues of status and authority can be a factor.

Teachers of science orchestrate their classes so that all students have equal opportunities to participate in learning activities. Students with physical disabilities might require modified equipment; students with limited English ability might be encouraged to use their own language as well as English and to use forms of presenting data such as pictures and graphs that require less language proficiency; students with learning disabilities might need more time to complete science activities (page 32, 36-37).

Teaching Standard E:

Teachers of science develop communities of science learners that reflect the intellectual rigor of scientific inquiry and the attitudes and social values conducive to science learning. In doing this, teachers:

• Display and demand respect for the diverse ideas, skills, and experiences of all students.

Respect for the ideas, activities, and thinking of all students is demonstrated by what teachers say and do, as well as by the flexibility with which they respond to student interests, ideas, strengths, and needs. Whether adjusting an activity to reflect the cultural background of particular students, providing resources for a small group to pursue an interest, or suggesting that an idea is valuable but cannot be pursued at the moment, teachers model what it means to respect and value the views of others. Teachers teach respect explicitly by focusing on their own and students' positive interactions, as well as confronting disrespect, stereotyping, and prejudice whenever it occurs in the school environment.

Science is a discipline in which creative and sometimes risky thought is important. New ideas and theories often are the result of creative leaps. For students to understand this aspect of science and be willing to express creative ideas, all of the members of the learning community must support and respect a diversity of experience, ideas, thought, and expression. Teachers work with students to develop an environment in which students feel safe in expressing ideas (page 45-46).

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Principles and Standards for School Mathematics

The latest edition of the **Principles and Standards for School Mathematics** was released during the NCTM 78th Annual Meeting in April 2000 and incorporates a clear set of principles that accompany the standards. The first of the six principles for school mathematics addresses this overarching theme:

• Equity. Excellence in mathematics education requires equity—high expectations and strong support for all students.

All students must have the opportunity to study and the support to learn mathematics, regardless of backgrounds, personal characteristics, and physical challenges. This does not mean that each student should receive identical instruction; rather, appropriate accommodations should be made so that access and attainment is a reality for all students (page 12).

Equity requires high expectations and worthwhile opportunities for all. Equity in mathematics education challenges the belief held by many in North America that only certain students are capable of learning mathematics. Traditionally, non-native speakers of English, females, students with disabilities, and many nonwhite students have been more likely than their counterparts in other demographic groups to be the victims of low expectations.

Teachers can communicate high expectations in their interactions with students during classroom instruction, through comments on student papers, when assigning students to instructional groups, through presence or absence of consistent support for students who are striving for high levels of attainment, and in their

National Standards *continued*

contact with significant adults in a student's life.

Equity requires accommodating differences to help everyone learn mathematics.
In addition to high expectations, students need access to an excellent, equitable mathematics program that provides strong support for their learning and responsiveness to their prior knowledge, intellectual strengths, and personal interests.

For example, non-native speakers of English may need assistance to allow them to participate fully in classroom discussions or assessment accommodations so that their understanding is not only assessed in English. More time to finish assignments might be necessary for students with disabilities while students with exceptional talent may require additional enrichment activities to engage them (page 13).

Equity requires resources and support for all classrooms and all students.
It has been well documented that all students can learn mathematics when they have access to high quality instructional programs supporting their learning. To achieve equity in schools, instructional tools, curriculum materials, special supplemental programs, and community resources play important roles. Professional development for teachers is also a key component. Finally, teachers must understand and confront their own beliefs and biases in order to accommodate differences among students effectively and sensitively (page 13).

National Council of Teachers of Mathematics (2000). ***Curriculum and Evaluation Standards for School Mathematics.*** *Reston, VA: NCTM.*

Access Centers

SCIMAST Access Centers: Useful Teaching Materials You Can Borrow for Free!

To help teachers identify and attain hands-on experience with high quality classroom materials, the Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST) has partnered with school district offices, universities, museums, and professional development centers to provide teachers with 40 access centers throughout the Southwest. Access centers act as libraries for printed materials, hands-on activities, high quality curriculum, and online resources as well as offering training about materials that support mathematics and science instruction and network sessions for teachers to share what they learn. Lending policies and hours vary depending on the center. For more information or to search for a resource, visit the access centers online at **http://www.sedl.org/scimast/accesscenters/**.

Sample resources relating to diversity contained in one or more access centers include:

Matematica para La Familia/Family Math

Stenmark, J.K., Thompson, V., & Cossey, R.

The book is part of the EQUALS program that has helped educators and families acquire methods and materials to make mathematics more accessible for all students with a special focus on those from groups that are not well represented in mathematics. There are hands-on activities for teachers or parents and children ages four to eight years old to do together to make mathematics fun.

Math Around the World

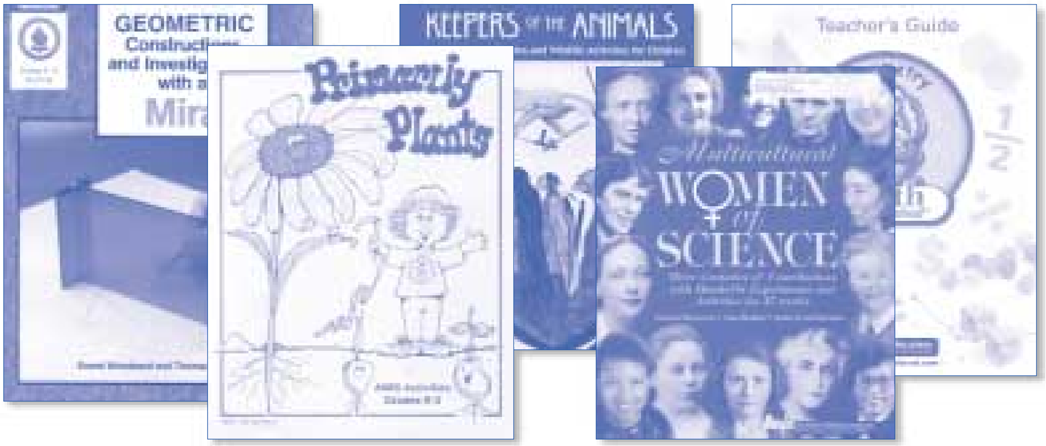
Great Explorations in Math & Science (GEMS), Braxton, B., Gonsalves, P., Lipner, L., Barber, J.

Geared toward grades five through eight and created by the GEMS program, this book is a collection of eight games from four continents that allows students to use mathematics relevant to them as they play the games. The role of diverse people/ancestors in the creation of mathematics is stressed with an emphasis on guided discovery and experiential learning.

Anno's Mysterious Multiplying Jar

Creative Publications

This book is for grades pre-K to 3rd grade and demonstrates the concept of factorials by using colorful pictures, such as rolling landscapes and castles, and a mysterious jar with some water that becomes a sea. By using pictures to depict subdivisions of the sea into an island, the island possessing two countries, the two countries containing three mountains, and so on until the reader has counted to 3,638,800. A dot diagram is used to illustrate the



process. The book moves logically from the concrete to the abstract, telling the story and then illustrating how to arrive at the answer.

Geometric Constructions and Investigations with a Mira™

Woodward, E. & Hamel, T.

Useful in grades six through 12, the Mira™, a piece of red acrylic plastic used for tracing line reflections, is used with the 21 lessons in this book to help students visualize geometric relationships. The hands-on activities are particularly useful when working with learning disabled students.

Primariamente Plantas/ Primarily Plants

AIMS Education Foundation;
Hoover, E., Mercier, S.

This is a plant study for grades K-3 that is available in English and Spanish. Materials were developed by the Activities Integrating Mathematics and Science Foundation (AIMS) and include interdisciplinary and hands-on methods.

Keepers of the Animals: Native American Stories and Wildlife Activities for Children

Caduto, M.J., & Bruchac, J.

This book contains environmental lessons interwoven with the cultural heritage of Native Americans and is suitable for ages five through 12. Extensively field-tested and interdisciplinary, the activities aim to engage the child's whole self while emphasizing creative thinking and synthesis of knowledge and experience.

Multicultural Women of Science

Bernstein, L. et al.

Each chapter contains a biographical sketch of a notable woman of science, a hands-on activity, a Think Work Act page with critical thinking questions, and at least four activities featuring a variety of skills and learning styles. A teacher's addition is included, as well. In addition to this book, there is a set of books with specific cultures represented (i.e., Latino Women of Science and African and African-American Women of Science).

Math in a Nutshell

Delta Education

Developed and tested by teachers, Math in a Nutshell is a kit of game-based activities with durable manipulatives to teach students math concepts and skills. Engaging, hands-on activities are aligned to NCTM standards, and the product includes a student activity and teacher's guide. The kit comes in these different titles and more: geometry, problem solving, money, time, and addition and subtraction.

Online Mentoring Program

The Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST) has a valuable resource for science and mathematics teachers: an online mentoring program and archive.

The mentoring project Web site is a place that mathematics and science teachers can access for help in addressing teaching difficulties. Teachers send in questions via the SCIMAST mentoring Web page; then, regional mathematics and science teachers recognized as Presidential Awardees respond to the questions via email. The question and answer is both posted on the Web site in an archive that teachers can browse or search and is emailed to teachers who request to receive notification of new mentoring dialogue. Some examples of questions appropriate for this service are:

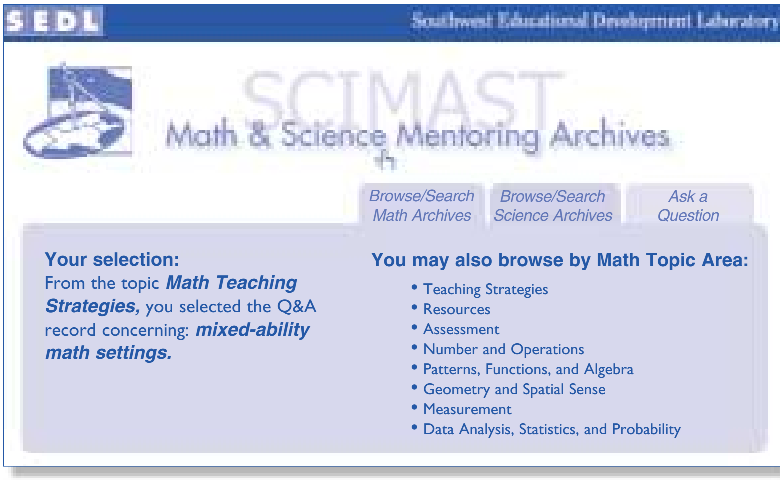
- How do I make 9th grade astronomy relevant to culturally diverse students?
- What is the best software to use with my science textbook?
- How can I make good use of block scheduling in my high school mathematics classroom?
- Where should I look on the Internet to find the best mathematics education resources?

To ask a mentor a question, use this link: **http://www.sedl.org/scimast/mentoring.html**.

To join the list to be notified when there is a new submission and response or to browse or search the archive, use this link: **http://www.sedl.org/scimast/archives/**.

Online Mentoring Program
continued

Here is a sample of the latest post relating to teaching mixed-ability students mathematics.



TOPIC: Mixed-ability Math Settings

QUESTION: I teach students in a mixed ability, middle school math setting. What are some instructional and assessment strategies to help me meet "all" of their needs?

ANSWER: I have taught many classes of mixed-ability students, and I find that group hands-on or writing projects and peer teaching work best for me. With hands-on projects, some students who are not mathematically inclined do very well, begin to feel that they can really do math, and actually improve their math skills because of their positive attitude. I have them build something to present to the class or discover how to do the next math concept by working in a group with manipulatives and then present it orally, on the overhead or with a poster. You should grade student projects partly on effort and partly on the way the group worked together, as well as grade the product.

This year I have a group of ten small projects that my students do and hand in, and I give ten points per project and count it as a test grade or let it replace a test grade. I find such projects in new textbook samples, in supplemental booklets from various textbook companies, from university professors in the nearby university who are interested in math education, and in the *Mathematics Teacher* magazine from NCTM. There is a middle school publication from NCTM called *Mathematics Teaching in the Middle School* that is also a good source. I've also made up a lot of projects.

Regarding peer teaching, the "student-teacher" does only a few problems from a section to show me that he knows what to do, and then I let him help a student who has trouble. I assign them as a pair and the student-teacher teaches the other how to do the section and helps him with the work. The student-teacher has a stake in helping the other really understand, because he is rewarded (grades, extra credit, candy, free time, free homework, etc.) when his "student" gets a test or quiz grade higher than his usual test average. An additional advantage of this method is that maybe some of the student-teachers will decide to be a teacher in the future.

I have even given group tests or had students work on concepts together and then randomly picked one of the groups to put a problem on the board and given a partial group grade for that. As you can see, there are many ways that the students can be helpful in meeting "all" of the needs in a mixed-ability setting.

GRADE LEVEL: 6-8

Resources and Opportunities

1. *Hands On!*

Published by TERC, an education research and development organization with a mission to improve mathematics, science, and technology teaching and learning, the latest edition (Fall 2001, volume 24, number 2) of the newsletter *Hands On!* contains articles based on research efforts to determine why some students get left behind and how classrooms can change to engage all students in rigorous science and mathematics learning. Topics include factors influencing the way we hear and understand students talk in science class, a curriculum that uses examples from everyday life to demystify math for non-traditional adult learners, and the role of physical enactment in developing an understanding of distance, time and speed. To sign up for a free print or online subscription or to view the newsletter online, go to: **http://www.terc.edu/TEMPLATE/handson/index.cfm**.

2. *Making Schools Work for Every Child*

The Department of Education's Eisenhower National Clearinghouse offers a CD-ROM titled *Making Schools Work for Every Child* as a resource for educators who are concerned about creating equitable conditions in which every child can succeed. It provides a collection of math and science equity materials to help teachers and administrators acknowledge children's diverse strengths, identify inequities, and improve the ways in which we currently serve students with varied needs. This resource is available free to educators through the Eisenhower Regional Consortium. Those in the Southwest region interested in ordering the CD-ROM can contact the Southwest Consortium for the Improvement of Mathematics and Science Teaching (SCIMAST) at 1-800-476-6861.

3. *ENC Focus: Multicultural Approaches in Math and Science*

This issue of *ENC Focus*, a resource catalog of mathematics and science instructional materials, brings together a selection of multicultural materials and perspectives to help teachers use this approach in their classrooms. Included are interviews with educators from different parts of the country, in both rural and urban settings, who share their insights and strategies. There are also resources that connect mathematics and science to historical roots in various cultures. Sample titles include *Reaching All Students with Mathematics, Science for All Cultures,* and *Creating Culturally Responsive Classrooms*. To access this issue, use this link: **http://www.enc.org/focus/multi/**.

4. *Anti Racist Science Teaching*

Dawn Gill and Les Levidow edited this collection of articles analyzing how racism permeates science and science teaching in order to involve science teachers in the process of exposing racist ideology and challenging racist practice. The papers extend from general issues about science, nature and race to practical teaching guides and suggested projects to offering proposals for an anti-racist curriculum. The book is $25 and can be ordered from the publisher, Free Association Books, 1-800-944-6190 or from the Web site at: **http://www.fa-b.com/**.

5. NASA's Observatorium: Planes, Flying and K-12 Education

NASA is funding eight educational projects at universities, school districts, and private corporations to develop curriculum material based on planes and flying with projects, paying special attention to the needs of students who have learning disabilities or are physically challenged, as well as students in inner city and rural districts who often have limited resources. The idea is this: planes and flying are fun for kids and allow the teaching of a lot of technology, physics, chemistry, and math. NASA hopes that this approach will help teachers hook students on these subjects. To access the eight participating projects and their web addresses, use this link: **http://observe.ivv.nasa.gov/nasa/exhibits/planes/planes_2a.html**.

6. The Algebra Project

The Algebra Project is a program founded by Robert P. Moses, an African-American mathematician and parent who wanted to ensure that his and other children develop a concrete understanding of algebra. The project develops and implements curricular interventions that address a conceptual shift from arithmetic to algebraic thinking, using experiences students intuitively understand and find interesting to open up the basic concepts of algebraic thinking. The Web site contains information on teacher training and support programs as well as curriculum using activities drawn from African and African Diasporic drum-making and drumming traditions that serve as tools to explore various mathematical concepts such as ratio and proportion, multiples, number, pattern, and area. For more information, go to **http://www.algebra.org**.

7. *The Inclusive Classroom: Mathematics and Science Instruction for Students with Learning Disabilities*

A publication from the Northwest Regional Educational Laboratory (NREL) called *The Inclusive Classroom: Mathematics and Science Instruction for Students with Learning Disabilities* contains key principles of inclusion, special education, multicultural education, and standards-based reform to help teachers create optimal learning environments where diverse learners can thrive. A section on science instructional strategies suggests that "organizing curriculum and instruction around big ideas and interdisciplinary themes" can facilitate science achievement. This allows students to organize, connect, and apply component facts and ideas, enabling them to see

Resources and Opportunities *continued*

meaningful relationships between science and other disciplines and everyday applications. In math, for example, simplifying and reducing, recognizing patterns, making tables and graphs, and acting out or simulating are a few of the many ways students with learning disabilities can develop reasoning and problem-solving skills. The publication is available online at **http://www.nwrel.org/msec/book7.pdf** or can be ordered at 1-800-547-6339, ext. 457 ($7.65 for teachers outside of the Northwest region).

8. Native American Geometry

Native American Geometry is a Web site that explores designs from various Native American nations to illustrate the physical geometry of the simple circle while emphasizing multiple intelligences. The site provides a real, concrete scientific application. The Web site claims: "If you can make a circle, draw lines and connect dots, you can learn and teach a great deal about square roots, proportional constants, and irrational numbers. Instead of introducing these fearsome concepts as numerical abstractions, square roots are built into the shapes that you are constructing on paper during art class." Instructions with activities and templates for creating two-dimensional geometric designs are provided along with informative histories of geometric symbols used. Teachers can easily reproduce lessons, using tools available in most classrooms, such as a compass, a ruler, paper, and crayons. The Web site is accessed at: **http://earthmeasure.com**.

9. Women's Educational Equity Act Equity Resource Center

A national project established 20 years ago, the Women's Educational Equity Act Equity Resource Center (WEEA) has a Web site rich with information promoting gender equitable education for all students. The WEEA offers products, services and referrals to education professionals, including curricula, books, a discussion board, working papers, digests, and online courses. These resources are available at: **http://www.edc.org/WomensEquity/**.

10. Council for Exceptional Children

The Council for Exceptional Children (CEC) is the largest international professional organization dedicated to improving educational outcomes for individuals with exceptionalities, students with disabilities, and/or the gifted. There are CEC newsletter articles online, an ERIC Clearinghouse on Disabilities and Gifted Education (ERIC EC), and discussion groups. To access this and other information, go to **http://www.cec.sped.org/**.

11. BioScience Productions

The BioScience Productions Web site promotes an understanding of biodiversity while engaging students, teachers, and the community at large to reflect on how their actions may affect the natural course of evolution. On the biodiversity page, samples of online articles include threats to biodiversity, biotechnology risks, endangered species, and extinction. There are teacher resources, a bioscience events calendar, and an area to take action on these issues. The Web site can be found at **http://www.actionbioscience.org**.

12. National Information Center for Children and Youth with Disabilities (NICHCY)

The NICHCY is a national information and referral center that provides information on disabilities and disability-related issues for families, educators, and other professionals. It is also part of a clearinghouse consortium that provides information on disability-related issues. Online news digests have helpful resources with titles like "Interventions for Students with Learning Disabilities" and "Planning for Inclusion." To access the information, go to **http://www.nichcy.org/**.

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Building Knowledge to Support Learning

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Requests for additional copies should be addressed to SCIMAST. Call (512) 476-6861 or write SCIMAST/SEDL, 211 East Seventh St. Austin, Texas 78701. The *Classroom Compass* is also available online at http://www.sedl.org/scimast.

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