Improving Math Achievement of At-Risk Learners

Sandra L. Bryan and Adriane E. L. Dorrington

PHI DELTA KAPPA EDUCATIONAL FOUNDATION
Sandra L. Bryan is a visiting professor in the Department of Elementary and Early Childhood Education at Kennesaw State University in Georgia. Her professional interests include student cultural diversity and comparative and international education. She also works as a consultant and accreditor for international schools.

Bryan is the author of numerous articles and a book on aesthetic education, including a focus on teaching mathematics through the arts. She also is the author of fastback 443 Teaching Aesthetics.

Adriane E.L. Dorrington is the director of the Pre-Service Teacher Program sponsored by the National Aeronautics and Space Administration and administered by Norfolk State University. The program targets prospective elementary and middle school educators from underrepresented groups and provides them with opportunities to enhance their skills and confidence in teaching an integrated mathematics, science, and technology curriculum.

Dorrington has been a university cooperating teacher, adjunct professor, and department chair of education. Her bachelor of science in biology and bachelor of education in secondary education are from St. Francis Xavier University in Nova Scotia, her master’s in secondary education is from the University of Alberta, and her doctorate in curriculum and instruction is from the University of Toronto.

Series Editor, Donovan R. Walling
Improving Math Achievement of At-Risk Learners

by
Sandra L. Bryan
and
Adriane E.L. Dorrington

ISBN 0-87367-900-8
Copyright © 2004 by the Phi Delta Kappa Educational Foundation
Bloomington, Indiana
Table of Contents

Introduction .................................................. 7
Effective Instructional and Assessment Strategies ...................... 11
A Culture of Understanding ..................................... 17
An At-Risk Classroom Case Study ................................ 23
  Classroom Observation ..................................... 26
  Post-Observation Interview ................................. 29
Teachers as Leaders ........................................... 32
Conclusion ..................................................... 35
References ..................................................... 37
Introduction

Since the establishment of public education in the United States, there have been many calls for reform. The current reform movement stresses standards and accountability in the form of high-stakes tests. This current emphasis is pushing educators to close the achievement gap between at-risk students and traditionally successful students. Designing schools so that all children can learn and restructuring programs so that no child is left behind are critical issues.

University programs in mathematics education and public schools are joining in projects to address the problems of content, discourse, and community that arise when trying to teach K-8 mathematics to at-risk children. These partnerships will bring about a deeper understanding of the interplay of language, culture, and mathematics education, and thereby enhance the mathematics achievement of all students, including ethnic minority children and at-risk students. These partnerships will provide insight into students’ mathematical reasoning, how they talk and think about data and how they express those ideas.

NCTM developed five goals for students that reflect the importance of mathematical literacy:

1. Learning to value mathematics: help students develop an awareness of the interaction between mathematics and its historical development and the effect that interaction has on our culture and our lives.

2. Becoming confident in one’s own ability: enable students to see mathematics as a human activity and to see that they can use their growing mathematical power to think through problems.

3. Becoming a mathematical problem solver: problem solving should be the focus of school mathematics.

4. Learning to communicate mathematically: provide opportunities for students to learn to read, write, and discuss ideas where the language of mathematics becomes natural.

5. Learning to reason mathematically: making conjectures, gathering evidence, and building arguments
are fundamental to doing and solving mathematics (1989, pp. 5-6).

The NCTM standards are grounded in three areas: cognitive psychology, philosophy of mathematics, and how mathematicians do mathematics (NCTM 1989). The standards state that teachers should:

- Select mathematical tasks to engage students’ interest and intellect.
- Provide opportunities to deepen students’ understanding of mathematics and its applications.
- Orchestrates classroom discourse in ways that promote the investigation and growth of mathematical ideas.
- Help students use technology and other tools to pursue mathematical investigations.
- Help students seek connections to previous and developing knowledge.

Many teacher educators contend that teachers may be deficient in their knowledge of the content, knowledge regarding the nature of mathematics, and attitude toward mathematics (Featherstone et al. 1995). According to Featherstone and his colleagues, many mathematics teachers demonstrate their understanding of mathematics by using procedural or algorithmic explanations. Their understanding often is fragmented and lacks coherency, and many teachers cannot explain the mathematical reasoning behind the algorithms.
Teachers need to understand the nature of mathematics, which includes knowing 1) the distinctions between conventional and logical construction, 2) relationships among mathematical ideas, and 3) the fundamental activities of mathematics, that is, looking for patterns, making conjectures, and justifying claims (Featherstone et al. 1995, p. 2).

Mathematics teachers also must assess their own attitudes toward mathematics. Cross-cultural studies suggest that Americans, more than Japanese and Chinese adults, attribute success or failure in learning mathematics to "ability," rather than to effort or opportunity to learn (Featherstone et al. 1995). Some teachers believe that the ability to think mathematically is predetermined, and consequently they believe that some people just can't do mathematics. The myth that only those who have ability to think mathematically will succeed hurts children. Teachers must expect each student to meet or exceed standards.
Effective Instructional and Assessment Strategies

Teachers need to identify what the student will be expected to do and under what conditions it will be done. Although instruction is generally a group activity, learning is an individual activity. The teacher must be able to engage the individual learner.

The classroom activities should grow out of real-world problems relevant to the learner. However, conventional mathematics lessons seldom begin with real-world problems. Instead, conventional lessons begin by having the students do algorithms and mathematical expressions. This approach is based on the idea that skills in computation must be mastered prior to working with word problems. However, experience with problems helps students develop the ability to compute (NCTM 1989). Knowledge is constructed as the learner engages with the problem because he or she may recognize a need for a particular procedure or the application of a specific concept. After solving the problem, this knowledge can be readily reconstructed by the learner at a later date.

Students need multiple opportunities to work with real-world problems. Some teachers present problems that
can be solved easily by following recipe-type procedures. But real-world problems need to be open-ended; they should have several possible solutions, be complex, and be challenging enough to engage the learner but not impossible to solve.

Although students determine the degree to which they will become engaged in the learning process, skilled teachers know that they can greatly influence the level of engagement through their own attitudes and behaviors. Skilled teachers optimize the learning opportunities for individual students and expect them to use intuitive skills, to gather empirical evidence, to analyze and generalize the findings, and to justify their findings.

In some classrooms, teachers expect students to passively absorb information that is taught and to store it so that it can be retrieved on demand. Often, in an attempt to facilitate this process, teachers will provide drill lessons to reinforce the new learning.

Romberg and Carpenter (1986) contend that by the time young children are taught addition and subtraction, they already have devised ways to solve these situations by using such routines as “counting on” or “counting back.” Even when students are formally taught the mechanics of algorithms, many still use informal procedures because these methods continue to work. Only when their methods become inefficient and fail to provide the solutions will they find a need to adopt and use the formal procedures. Effective teachers understand the learning process and draw on the experiences that children bring to the classroom. These teachers present a variety
of experiences that allow students to use their simple, concrete, problem-solving procedures; and, in time, these teachers help the students to develop more complex and abstract problem-solving procedures. Tobins and Tippins state:

Teachers should provide opportunities for students to represent their knowledge in a variety of ways . . . by writing, drawing, using symbols, and assigning language to what is known. Student thinking needs to be stimulated by providing time to think . . . time to evaluate the adequacy of specific knowledge, making connections, clarify, elaborate, build alternatives, and speculate. (1993, p. 11)

Mathematics can be viewed as a language and as another way of experiencing the world. Thus NCTM concluded that communication is important enough to be included as a standard for grades K-12. Communication helps students to make links between their informal, intuitive, and concrete ideas to abstract, representational symbolism. Teachers must provide engaging and stimulating learning opportunities for students to “talk mathematics.” Teachers facilitate this learning experience by posing higher-order questions and by inviting students to explain, clarify, and reflect on their thinking both orally and in writing. “Representing, talking, listening, writing, and reading are key communication skills and should be viewed as integral parts of the mathematical curriculum” (NCTM 1989, p. 27).

Writing is a communication skill that allows students, especially those who may be reluctant to express their
ideas in a public forum, to express their mathematical understanding. After solving the mathematical problem, they can write how they solved the problem or write the solution in a statement format. Students may write letters to their friends or family relating their mathematical findings or write in their journal about the applicability of the mathematical finding to their world. Students can incorporate their mathematical problem into a storybook format using pictures, graphics, or symbols and text. Activities of this nature demonstrate to students that mathematics can serve a variety of purposes.

Implied in the communication standard is the opportunity for students to interact with each other, that is, collaborative learning. Listening and responding to the ideas of others enables students to appreciate that different interpretations do exist and to expand or re-evaluate their initial understanding of the problem. It also provides the teacher with a quick survey of the various levels of understanding among his or her students. However, teachers need to facilitate these discussions, to listen closely to what is being said, to be nonjudgmental, and to promote student autonomy. Teachers need to feel comfortable with the fact that there is no guarantee that a correct solution or even a correct method may be used. The value of group discussions is that students assume more autonomy for the learning process and contribute their own ideas and meanings to the lesson.

Assessment of student learning is an integral part of the instructional method. Assessment strategies used
by the teachers should reflect the standard-based mathematics curriculum that they use. The NCTM Assessment Standards propose that:

- Student assessment should be aligned with, and integral to, instruction.
- Multiple sources of assessment information should be used.
- Assessment methods should be appropriate for their purpose.
- All aspects of mathematical knowledge and its connections should be assessed.
- Instruction and curriculum should be considered equally in judging the quality of a program (NCTM 1995, p. 2).

Assessment is essential to advancing student learning because it provides opportunities for students to demonstrate what they know and what they are capable of doing. Traditional assessments often were formal and took place at the end of a unit. Current assessment emphasizes both formal and informal modes and is embedded in the learning process. It focuses less on skill and drill and more on performance-based activities that integrate students' cultural experiences, interests, and abilities and that require them to apply their knowledge to new contexts and situations. Effective teachers realize that oral comments, written papers, journal entries, drawings, computer-generated products, and other forms of mathematical representations can reveal students' levels of understanding. Current assessment em-
phasizes that students also need to learn how to become effective self-assessors and to learn how to monitor and advance their learning.
A Culture of Understanding

The students in our classrooms represent many cultures, and their families differ widely in geographic origin, cultural styles, and social and economic class. A culture of understanding in the classroom builds on the differences that students bring to the classroom. According to the National Council of Teachers of Mathematics (1989), two aspects of teaching, discourse and environment, are central to what goes on in culturally diverse math classes.

Discourse embeds fundamental values about knowledge and authority. Thus teachers convey messages about what knowledge and what ways of thinking are valued. Where there is language and ethnic diversity, who is considered able to contribute and who has status in the group is crucial. In order to promote cultural understanding in the mathematics class, teachers must ensure that students are comfortable expressing their ideas. The teacher must communicate to students that all of them, regardless of their cultural, linguistic, or socioeconomic background, can learn to think mathematically and can communicate mathematical ideas.
The environment is the setting in which learning takes place. In the mathematics classroom, the environment should emphasize that the class is a community of learners. This community culture should be acknowledged by engaging parents in promoting mathematics. For example, a Newport News, Virginia, teacher in a mathematics program for at-risk students includes parents by inviting them on mathematics field trips. The teacher uses these opportunities to help parents understand their roles in encouraging their children’s interest in mathematics. A Hampton, Virginia, teacher held a “Math for Moms” workshop and created activities to communicate with parents about the mathematics skills their children need for success.

Being mathematically literate includes having an appreciation of the value and beauty of mathematics, as well as being able to appraise and use quantitative information in one’s everyday world. Developing this aesthetic awareness provides another way of promoting a culture of understanding.

Mathematics lends itself to awe and wonder. In mathematics, students have the chance to meet something so large they cannot easily comprehend it, to be struck by something of such beauty or elegance they can be humbled by it.

Morris (1995) states that such times may occur in classrooms when students come across the idea of infinity. This will happen for many quite early on in school when they recognize that numbers go on forever. The similar realization that numbers can become infinitesimally small can cause the same wonderment. This is a
chance for some personal reflection for students that causes them to think deeply and that gives them a sense of how small we are.

In the search for the spiritual, the essential, in mathematics, teachers must draw students’ attention to its power to explain the world around us. Teachers owe it to their students to stop and savor occurrences as they arise in lessons.

Developing this aesthetic awareness also provides an opportunity for students to be creative and to recognize the mathematical creativity in works of art. For example, an elementary teacher can discuss perspective in painting as a mathematical concept. Using a reproduction of Van Gogh’s painting, Bedroom, the teacher cuts out the furniture pieces and attaches magnets to the pieces so that they can be moved within the painting. After the students move the pieces, the teacher leads a class discussion on the logic of perspective and how painters use proportion to create perspectives. This not only is visually stimulating, but it also introduces a major artist and makes connections between art and mathematics.

Many crafts are based on mathematical principles. Quilting is a fruitful area of study and presents a natural focus for studying geometric shapes, thus integrating mathematics and art. Students can use transformational geometry to create new quilt designs.

Another aesthetic project combines an introduction to geometry and Japanese culture through the art of origami. This lesson begins by giving the children background information about Japan’s history, geography,
and government, and then introduces origami to the children. The teacher goes over basic geometric terms and then leads the children step by step to make one particular object. Next the children choose the object they would like to make. This is both a multicultural lesson and a mathematical lesson. Some of the mathematical concepts the students will learn include scalene, isosceles, and right triangles, as well as quadrilateral and multiple lines of symmetry within one figure. Folding origami is also an excellent exercise for improving spatial skills.

Another art that helps mathematics to cross cultural and socioeconomic boundaries is music. Music is structured around mathematical elements. A unit on musical rhythm can reinforce concepts of fractions. Standard musical notation uses such symbols as half-notes, quarter-notes, and eighth-notes to represent duration of sound. Having students chant and clap notated musical rhythms is an engaging way to explore the adding and subtracting of fractions, as well as other relationships (Woody 1998).

Activities that help students develop spatial awareness furnish a natural connection between mathematics and dance. One exercise that relates movement and spatial awareness includes having students learn a few simple dance moves. The teacher then explains how these moves show various types of symmetry (line symmetry, point symmetry) or geometric transformations (slide, turn). Students can work in small groups to create a dance routine using physical moves that involve symmetry and transformation concepts (following each other, mirroring each other, twisting, turning).
Folk dances require spatial sense both in their formation (squares, isosceles, double circles) and in the laterality and directionality required for performance. Students must learn to move to their own right while seeing those across the circle from them moving in the opposite direction. Often, individuals will turn clockwise while the entire circle is moving counter-clockwise. Being able to picture groupings and pathways is crucial to successful movement in these activities (House and Coxford 1995).

Drama is another useful tool for interesting at-risk students in mathematics. Mathematics history presents a perfect context for this. School and classroom libraries should contain a range of relevant materials, including biographies of mathematicians. Students can act out the story of Galileo for classmates, or they could conduct an imaginary interview with a mathematician. Students can create a screenplay, a poem, or a song lyric about an individual or a discovery from mathematics history.

Students in the beginning of a school year can present their personal mathematics histories. In mathematics portfolios, students can include a section for accomplishing learning goals for the year. They can write and recite a mathematics-based poem, story, or play for the portfolio. Constructing word problems for the portfolio around mathematics objectives and acting these out contribute to verbal education as a fundamental aspect of aesthetics.

Using visuals, crafts, music, dance, story, and drama in the mathematics classroom has one goal, to capture the learner's attention as he or she engages in the under-
standing and expression of mathematics. Storytelling, writing and reading poetry, drama, and art activities are useful ways to learn mathematics and provide at-risk students with the opportunity to apply mathematics in their lives.
An At-Risk Classroom Case Study

Ms. Swords is a second-grade teacher with five years of experience. She holds an M.A. in teaching and currently is pursuing certification for the National Board for Professional Teaching Standards. She has spent her short teaching career at the Newsome Park Elementary School, which is a technology magnet school and a Title I school in Newport News, Virginia.

Newsome Park Elementary School currently has 52% of their students on free or reduced lunch. The school’s principal reports that Newsome has started to become a “school of choice” because the school has shown a significant improvement on Virginia’s high-stakes test. Parents are requesting to have their children enrolled in the school, and consequently the percentage of students on free and reduced lunch has decreased from a high of 60% to the current level.

There were 20 students in the class, 12 African Americans, one Asian, two Indo-Asian, and five white students. Three of the students were diagnosed as special needs due to speech impairments. Swords used the Phonological Awareness Literacy Screening (PAL) to determine the stu-
dents’ at-risk status. According to Swords, at least 25% were not reading at grade level. She reported that parent involvement was very low not only for her class, but for the school as a whole.

Swords stated that she believes that every child comes to her classroom possessing some type of skill. As a “community of learners,” every child has something important to offer; and her job is to find and cultivate those skills. She describes her classroom as a team, with her as team leader, and the whole team needs to achieve its goal. This means that students are encouraged to help one another whenever possible.

Swords uses a constructivist approach in her mathematics class. She assumes that students often have some misunderstanding of what is being taught; and, as a facilitator, she guides the discussion so that all students have opportunities to construct their own knowledge. They are encouraged to seek out their own meanings using their own experiential base. Swords first seeks out students’ explanations and is careful not to provide any modeling or solution to a given problem. The teacher does not begin with algorithms; first she wants to ensure that students are able to make the transitions from models and symbols to algorithms and that they have developed a conceptual understanding. Although a few students may use algorithms, she does not assume that these students fully understand the abstract nature associated with algorithms. “It’s possible that parents are helping their kids,” she said. When students are asked to provide explanations to their mathematics problems, she is very careful not to say, “correct” or “right.” However, Swords
indicates that some students are frustrated when she does not immediately provide solutions.

Her mathematics lesson focuses on what she labels “Math Talk,” which are word problems she prepares. She explains that she builds relevancy in her questions, using actual students’ and teachers’ names and actual school events. The students love to see their names in the questions.

The Math Talk sheet contains at least three problems. Given that they are word problems, she constantly emphasizes the importance of reading, writing, and proper grammar. Often she will insert grammatical errors into the questions to determine if students can identify and correct the errors. This provides her with an opportunity to assess how well students understand and can identify proper grammar. Also, it teaches the children that proper grammar is important to use in all of their subjects.

On the Math Talk sheet, the students are expected to work through the first problem individually. Afterward, students are invited to use a class flip chart to show their work and explain how they arrived at their answers. Again, Swords is careful not to indicate to the students whether their answers are right or wrong; but she asks guiding questions to help the students focus or reassess their thinking. She also asks the other students whether they agree with the solution presented by a student and whether they have another way to solve the problem. Students are encouraged to question each other’s work.

The “On Your Own” word problem is designed to be done individually; and after a specified amount of time,
students are instructed to locate three other people who had the same answer and to compare their work. The last question is labeled the “Challenge,” and this is a question that has been constructed by one of the students. Students consider it to be a great accomplishment to have their question included on the Math Talk sheet.

**Classroom Observation**

The lesson began with the teacher acknowledging that one of the students wrote a great Math Challenge question, and she wanted him to post it on the Wall of Fame. This challenge question, she said, would be included on a future Math Talk sheet. The class applauded the student. Swords then called on a student to read the question: “Mrs. Swords sent book orders home. Bianca bought $16 worth of books. Karishma bought $24 worth of books, and Tywuan bought $12 worth of book. [sic] How much money did the students spend on books?"

She told them that there is an English error in the question. After several minutes, two students pointed out the error — the word “book” in the third sentence should be plural. “Great job finding that! Now I want you to do the [current Math Challenge] question quietly in your brain.”

Most of the students began to write quietly, but four or five chatted among themselves. Swords kept the students focused on the mathematics problem. After six minutes, it appeared that some students were finished; and she told them to work on the Math Challenge that was written by a fellow classmate.
Ten minutes later, the majority of the students had completed the question. Swords asked for someone to come to the flip chart and show how they solved the problem. At least four or five hands went up, and one student was chosen. He began to solve the problem using algorithms. The students had not been formally taught how to use algorithms, but they had been taught how to use symbols to represent tens and ones. As he struggled with the answer, several students raised their hands in an attempt to comment on something that he was doing. Swords asked the students to put down their hands and allow the first student to finish. After the student explained how he reached his solution, Swords asked the class: “Anybody have a better way, faster way, or disagree with the answer? First of all, does anybody agree or disagree with the answer?”

When a student indicated that he disagreed with the answer, he was invited to show his work to the class. He used symbols to represent tens and ones. He drew a large rectangle to represent 10 and six smaller rectangles to represent six ones. He continued using this method and arrived at the same answer as the first student.

Again Swords asked if there was anyone who disagreed with his work. A third student was called on to show his work. After discussing that solution, a fourth student was called. When no other students disagreed, Swords asked if anyone could do the question faster. Two students were invited to show the class their solutions.

After the class had a good understanding of the question and how to solve it, the teacher asked them to do the “On Your Own” question. The teacher actively en-
couraged and sustained student talk during the first portion of the lesson. During this final stage, students were expected to solve the question themselves and then find three other students who had the same answer. The teacher circulated around the class, asking students to explain how they arrived at their answers. Many students were interested in showing and explaining their work to the teacher.

The mathematics class closed with students turning in their Math Talk sheets. Several of the papers that were turned in revealed that the students chose to use algorithms to solve the problem. Swords commented in the post-observation interview, "The problem with these papers is that I am never sure if they truly understand what they are doing or if their parents showed them how to use this method." She also explained that this is the reason why she does not circulate when she first assigns the problem. "By not circulating, I don't know what they have written on their paper."

Swords restated that her first goal was to help students understand the concept of re-grouping, and then she would proceed to using algorithms. Also, she said that is why she does not circulate when they do the first question, because she does want to be swayed or biased, which could result in her unconsciously selecting them to show their work.

It was obvious from the work turned in that several students changed their initial work and copied down one of the methods shown on the flip chart. Although not requested, one student chose to construct a challenge question and included it on the back of his Math Talk
sheet. Every other day at the end of her mathematics lesson, she invites students to construct their own challenge question.

**Post-Observation Interview**

In the post observation interview, the teacher said the objective for the lesson was addition with regrouping, and the objective was achieved. She explained it was evident when the students who came to the flip chart were able to explain their work. They were able to re-group the numbers using a variety of methods. Although some methods did not lead to the correct answer, the process they used reflected that they had a basic understanding of re-grouping.

Also, when she later circulated throughout the class, many of the students were able to explain how they solved their problems. She was able to hear students telling each other how they solved their problems. She did not hear anything that required her to intervene and redirect the students' explanations.

Although she had not invited them to develop a challenge question in this lesson, at least one student passed in questions that he developed during the math lesson. She commented that the students are excited to have their questions placed on the Wall of Fame and placed on the next Math Talk sheet.

Swords said that the lesson allowed for making changes. She explained that the need for a flexible lesson was evident in the many ways that the students chose to solve their problems and to respond to their classmates' solutions.
Swords claims that she does not do anything different for at-risk students. Even though she has 11 students on “free and reduced lunch,” which is a district criterion used to identify at-risk, she chooses to identify at-risk as those students who are not reading at grade level. Because at least 25% of her students were not reading at grade level at the beginning of the school year, she places a great deal of emphasis on reading in the lessons. She believes that they are doing much better. She does not report any difference in achievement between her at-risk students and the rest of the class.

She indicates that she encourages and invites her students to develop problems they can share with their classmates. Most of her students, including her at-risk students, readily accept this invitation. She believes that these types of teaching strategies benefit all students.

The case study of Swords’ classroom shows that at-risk students can develop their mathematical reasoning and can use their mathematical ideas and experiences as building blocks to solve real-world problems. Students engage in dialogue while exploring, conjecturing, and sharing their reasoning with their classmates. The classroom operates as a learning community and parents, caregivers, and other members of the community often are invited to her classroom and on field trips. She continually encourages parental participation because their involvement always positively affects the students’ achievement.

Swords understands the importance of facilitating and encouraging students to share their ideas while the
teacher remains nonjudgmental. The exchange of ideas was respectful, and the teacher encouraged the participation of all students.

In this case study, Swords demonstrated mathematical literacy and incorporated the NCTM standards and principles in her teaching. Her students’ ability to raise their mathematics scores also can be attributed to the fact that the school administration encourages and supports teachers as leaders. She has a commitment to lifelong learning that she models and explains to her students.

Her principal uses a model that encourages his teachers to develop innovative instructional and assessment strategies. The school has undergone a systemic change that is supported and sustained by school policies and improvement plans that enhance the learning of all students.

Every year Newsome Park Elementary School identifies an authentic schoolwide project, and the teachers are expected to develop classroom or subject projects that support the school project and that connect to their community. This problem-based learning, with its strong connection to the real world, has been very successful. Swords has been able to use her innovative strategies and assessment techniques to raise the mathematics scores of her class while closing the achievement gap between her African-American students and her white students.
Teachers as Leaders

It is essential for teachers to be leaders in the change process. Although the role of principals as instructional leaders is unquestioned, they cannot cause lasting change by themselves. Recognizing and supporting the informed leadership of teachers is the best way to implement new programs and curricula.

Teachers now have real opportunities to lead education change without leaving the classroom. Teachers serve as research colleagues, work as mentors to new teachers, and facilitate professional development activities as master teachers. Teachers also are members of school-based leadership and instructional support teams. In addition, teachers are developing and implementing programs that they believe will result in positive change.

When teachers assume leadership roles, they teach differently. They demonstrate a greater respect for each other and for students, and they coordinate their efforts across the curriculum.

There is no single key to reform. Newsome Park Elementary School has an approach to system change that uses schoolwide projects. The principal and his staff
meet every week for a common planning period to review student projects and to check that each fulfills the state standards.

Another approach to increasing the mathematics achievement of at-risk learners was a cooperative staff development project involving three school districts and Texas Christian University. This project focused on changing the traditional roles of teachers, administrators, and university personnel. In particular, teachers were encouraged to be less dependent on the mathematics textbook and to increase their own knowledge of mathematics. Students were encouraged to become active learners and to engage in cooperative learning. And administrators emphasized their roles as instructional leaders and became actively involved in the change initiative (McGrevin 1990).

In the Chicago area, the Teachers Academy for Mathematics and Science (TAMS) is working to improve the professional development of K-8 math and science teachers. Chartered in 1990 by a consortium of 14 universities and colleges in the Chicago area, TAMS is a powerful model of professional development in mathematics and science for large, urban, public school districts. The academy’s successes result from keeping focused on the products of professional development, that is, classroom practices and student achievement.

The role of students in the classroom and the nature of the work they do there are fundamental to reform. These factors need direct and concerted attention. However, reform efforts also should focus on the teachers, on their values, beliefs, and competencies. Teachers
need to be supported as they work for change, and the nature of those supports should be determined largely by the teachers themselves.
Conclusion

At-risk students are capable of enhancing their mathematical thinking skills and building confidence in their ability to solve complex mathematical problems. However, the teacher also needs to have those skills and confidence before he or she can teach them to students. In addition, effective teachers have an extensive understanding of the learning process and use the knowledge of their students to individualize learning.

To be effective, assessments need to be aligned with the curriculum goals. Teachers should ensure that their assessment plan is flexible enough so that students can participate in the development of assessment goals and instruments.

Students and teachers, especially in economically and socially diverse classrooms, must be members of learning communities. This diversity will shape the communication among the members. Teachers must be able to capitalize on the diverse strengths and interests that are present among their students. They need to find successful and more meaningful ways to involve parents and guardians.
Teachers need to help students realize that mathematics provides another way of viewing the world. Students also must develop an aesthetic awareness so that they see the beauty that resides in a mathematical world.

Teachers who are mathematically literate and who understand and value mathematics in their everyday world can build on the abilities of all students. The economic success of the nation and quality of our lives depend on these teachers and, in turn, their students.
References


National Council of Teachers of Mathematics (NCTM). 

National Council of Teachers of Mathematics (NCTM). 

Romberg, Thomas A., and Carpenter, Thomas P. “Research 
on Teaching and Learning Mathematics Two: Discipline of 
Scientific Inquiry.” In *Handbook of Research on Teaching,* 3rd 

Tobins, T., and Tippins, D. “Constructivism as a Referent for 
Teaching and Learning.” In *The Practice of Constructivism in Science Education,* edited by Kenneth Tobin. Washington, 
D.C.: American Association for the Advancement of 

Woody, R. “Music in the Education of Young Children.” 

**Websites**

National Council of Teachers of Mathematics Standards 
www.nctm.org/standards

Mega Mathematics 
www.c3.lanl.gov/mega-math

Cynthia Lanius Fun Mathematics Lessons 
www.math.rice.edu/~lanius/Lessons

Cynthia Lanius Fractals 
www.math.rice.edu/~lanius/frac

King’s List of Online Math Activities 
www.k111.k12.il.us/king/math.htm
Arithmetic Activities
www.learning.caliberinc.com/math1.html

Awesome Library
www.awesomelibrary.org

Elementary Math Resources
www.kcmetro.cc.mo.us/pennvalley/math/eisen/96/elemmath.htm

Math for Elementary Teachers
www.mtlakes.org/ww/tech/webtools/math.htm

Elementary Math Students in the CyberZone
www.globalclassroom.org/authors/florida/math

Kathy Schrock’s Guide for Educators
www.school.discovery.com/schrockguide/math.html
Recent Books Published by the Phi Delta Kappa Educational Foundation

**Virtual Schooling: Issues in the Development of E-Learning Policy**
Donovan R. Walling, ed.
Trade paperback. $19.95 (PDK members, 14.95)

**Educating Language-Minority Students**
Michael S. Mills
Trade paperback. $17.95 (PDK members, $13.95)

**Improving Classroom Questions, 2nd Edition**
Kenneth R. Chuska
Trade paperback. $14.95 (PDK members, $11.95)

**Gifted Education: Promising Practices**
Joan Franklin Smutny
Trade paperback. $17.95 (PDK members, $13.95)

**Psychology of Success**
Emery Stoops
Trade paperback. $14.95 (PDK members, $11.95)

**Vouchers, Class Size Reduction, and Student Achievement**
Alex Molnar
Trade paperback. $10.95 (PDK members, $8.95)

Use Order Form on Next Page or Phone 1-800-766-1156

*A processing charge is added to all orders.*
*Prices are subject to change without notice.*

Complete online catalog at [http://www.pdkintl.org](http://www.pdkintl.org)
Order Form

SHIP TO:

STREET

CITY/STATE OR PROVINCE/ZIP OR POSTAL CODE

DAYTIME PHONE NUMBER

PDK MEMBER ID NUMBER

<table>
<thead>
<tr>
<th>QUANTITY</th>
<th>TITLE</th>
<th>PRICE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

ORDERS MUST INCLUDE PROCESSING CHARGE

<table>
<thead>
<tr>
<th>Total Merchandise</th>
<th>Processing Charge</th>
</tr>
</thead>
<tbody>
<tr>
<td>Up to $50</td>
<td>$5</td>
</tr>
<tr>
<td>$50.01 to $100</td>
<td>$10</td>
</tr>
<tr>
<td>More than $100</td>
<td>$10 plus 5% of total</td>
</tr>
</tbody>
</table>

Special shipping available upon request. Prices subject to change without notice.

SUBTOTAL

Indiana residents add 6% Sales Tax

PROCESSING CHARGE

TOTAL

☐ Payment Enclosed (check payable to Phi Delta Kappa International)

Bill my ☐ VISA ☐ MasterCard ☐ American Express ☐ Discover

ACCT # ____________________________ DATE

EXP DATE ____________________________ SIGNATURE

Mail or fax your order to: Phi Delta Kappa International, P.O. Box 789, Bloomington, IN 47402-0789. USA

Fax: (812) 339-5556. Phone: (812) 339-1156

For fastest service, phone 1-800-766-1156 and use your credit card.
Phi Delta Kappa Fastbacks

This series, published each fall and spring, offers short treatments of a variety of topics in education. Each fastback is intended to be a focused, authoritative work on a subject of current interest to educators and other readers. Since the inception of the series in 1972, the fastbacks have proven valuable for individual and group professional development in schools and districts and as readings in undergraduate and graduate teacher preparation classes. More than 500 titles in the series have been published, and more than eight million copies have been disseminated worldwide.

For a current list of available fastbacks and other publications, please contact:

Phi Delta Kappa International
P.O. Box 789
Bloomington, IN 47402-0789 U.S.A.
1-800-766-1156
(812) 339-1156
http://www.pdkintl.org
The Phi Delta Kappa Educational Foundation is focused on the future. Contributions to the Educational Foundation support scholarships, educational publications, and professional development programs — resources needed to promote excellence in education at all levels.

The Educational Foundation is pleased to accept contributions of cash, marketable securities, and real estate, as well as deferred gifts. The Educational Foundation is tax exempt under Section 501(c)(3) of the Internal Revenue Code, and contributions are tax deductible. PDK is more than willing to work with your estate planner, attorney, or accountant to find a plan that best meets your needs.

For more information about the Educational Foundation and how to make a contribution, please contact:

Phi Delta Kappa Educational Foundation
P.O. Box 789
Bloomington, IN 47402-0789
USA

Toll-free: 1-800-766-1156
Voice: (812) 339-1156
Fax: (812) 339-0018
E-mail: headquarters@pdkintl.org
http://www.pdkintl.org

ISBN 0-87367-900-8