

## Mentoring Minds' Research for Motivation Math

Mathematics is a universal subject, so much a part of life that anyone who is a participating member of society must know basic mathematics. Students' mathematical achievement, however, is ultimately determined and limited by the opportunities they have had to learn. Mathematics is not restricted to a select group of students. "All students must learn to think mathematically, and they must think mathematically to learn" (Kilpatrick, Swafford, Findell, 2001). The RAND Mathematics Study Panel (2003) also emphasized the importance of mathematics. Furthermore, the panel declared that it is essential that students develop math proficiency. No Child Left Behind Act (NCLB, 2001) directed that research about effective practices be a guide in changing the way mathematics is taught so that high standards are met leading to an improvement in achievement.

*Motivation Math* incorporates research-based strategies and pedagogically sound principles for teaching and learning. This product is designed to support and enhance the best practices for teaching the TEKS. *Motivation Math* is founded on the modeling of "Active Teaching," which is teacher-directed instruction that proceeds in small steps. Research indicates that this approach is associated with higher levels of student achievement. Students are guided through the learning process and are afforded opportunities for success which include:

- Introduction to skills
- Guided practice
- Independent practice
- Assessment
- Critical thinking activities
- Homework with parent activities

Hiebert and Wearne (1992; 1993; 1996) reported that a critical attribute in regards to student learning in mathematics, is the nature of the learning task in which to engage students. Students need mental engagement in challenging and worthwhile mathematical tasks that emphasize the conceptual aspects of the topic and promote the formation of mathematical connections. This type engagement is a prerequisite to learning skills with meaning and being able to apply those skills to solve problems. Students must receive direct encouragement to think and persist with the mathematical task at hand.

Grouws and Cebulla (2000) state that teaching mathematics with a focus on number sense encourages students to become problem solvers in a wide variety of situations and to view mathematics as a discipline which thinking is important. "Number sense" is an intuitive feel for number size and combinations, as well as the ability to work flexibly with numbers in problem situations in order to make

reasonable judgments. The processes of mentally computing, estimating, sensing number magnitudes, moving between representation systems for numbers, and judging the reasonableness of numerical results must be flexibly used. This type of instruction requires teachers to have a deep understanding of mathematics and how students learn mathematics. More specifically, teachers will encounter difficulty in teaching number sense without a working knowledge of number sense themselves.

The experiences, discussions, and review of the literature convinced the Mentoring Minds Product Development Team that resources for mathematics needed a change. Thus, the format for a Student Edition was designed to help move mathematics forward so that teachers could incorporate the teaching of TEKS in mathematics on a higher level and develop within students the confidence they need to succeed.

Each **Student Edition** is based completely on the TEKS. Each unit includes an Introduction, Guided Practice, Independent Practice, Assessment, Critical Thinking, and Homework/Parent Activity page. According to Grouws and Cebulla (2000), students need to be given both an opportunity to discover and invent new knowledge and an opportunity to practice what they have learned to improve student achievement.

Numerous studies indicate that increasing the amount of time spent in mathematics instruction is positively correlated with student achievement in mathematics. The 2001 National Research Council publication, "Adding It Up: Helping Children Learn Mathematics" states that significant time should be devoted to daily mathematics instruction in every grade of elementary and middle school. In addition, the 1999 Handbook of Research on Improving Student Achievement (Cawelti, 1999) states that a positive relationship between total time allocated to mathematics and general student performance exists.

A finding in The Nations' Report Card: Mathematics 2000, NAEP showed that the average scores of fourth and eighth graders generally increased as the amount of instructional time for mathematics increased. Grouws and Cebulla (2000) state that there is a positive relationship between total time allocated to mathematics and general mathematics achievement.

Furthermore, the way in which time is utilized in mathematics class can be paramount to the degree of student achievement. Additional time is recommended to be spent in direct instruction as opposed to seatwork or written drill. The 1999 TIMMS video study indicated that nations scoring higher than the United States on tests of mathematics achievement at grade 8 devoted more time on the average to studying new content (a range of 56 to 76% of lesson time) than reviewing previous content. In the United States, there was no detectable difference between the average percent of lesson time devoted to

reviewing previous content and studying new content (53 and 48% of lesson time respectively).

“**Assessment** plays a critical role in all aspects of teaching and learning mathematics” (NCTM, 2000). In the publication compiled from numerous writers, “What We Know About Mathematics, Teaching, and Learning”, Nancy Kober (1996) from North Central Regional Educational Laboratory (NCREL) reported that evaluation tools which closely align with the objectives are usually more beneficial for diagnosing and revising instructional needs. No Child Left Behind Act (NCLB, 2001) stated, “Beginning no later than the 2005-2006 school year, each State must administer annual assessments in ... and math in each of grades 3 through 8 and at least once in grades 10 through 12”. Therefore, an Assessment page is included at the end of each student tested expectation from whence the teacher can gather timely student information to readily and continuously maintain accountability for academic achievement standards.

A Chart Your Success page is included in the back of each Student Edition for each student to visually record and see progress on an ongoing basis. The teacher has a TEKS Checklist to chart classroom concept attainment. The Assessment page used in conjunction with other measures can provide crucial information for the teacher in improving performance. Studies support the use of a variety of measures to gauge student achievement. Due to the accountability issue, Mentoring Minds encourages teachers to maintain accurate and useful data as well as use a variety of assessment measures to form a more valid insight on where a campus, classroom, or student stands in the area of mathematical performance.

A **Critical Thinking** page appears within each section for each student tested expectation. An open-ended problem is presented for students to solve using words, numbers, or pictures and to follow up with a written explanation. A basic characteristic needed to become a proficient problem solver is flexibility. Flexibility develops through the expansion of knowledge required for solving nonroutine problems rather than just routine problems.

Nonroutine problems (those not familiar to the problem solver) and transfer of problem solving require high level transfer, which is effortful and conscious (Salomon & Perkins, 1989), whereas routine problems involves less conscious attention and rely more on low level transfer. Routine problems are those in which the learner knows a correct solution method based on past experience and is able to reproduce it and apply it. Caution, given by experts, is that students can lose the ability to articulate and reflect on the reasoning they use in solving problems if they are exposed to mostly routine problems. Nonroutine problems require the learner to use productive thinking to create a way to understand and solve the problem since an immediate solution method is not known.

A balance is needed between the time students spend practicing routine procedures and the time they devote to discovering new method solutions for nonroutine problems. There is no need for teachers to make a choice between which of these two type problems to use if students are to develop mathematical thinking power.

Assessing the work of students in a problem-solving situation differs from a traditional method of determining the accuracy of computational skills. Open-ended problems can be solved using a variety of methods or the problems can have multiple responses. *Motivation Math* utilizes a variety of assessment opportunities.

### **Homework/Parent Activity Page**

Parents can be significant contributors to the learning process. Opportunities for parents to be involved in their students' learning allow parents to show an interest in the students' work. Parent involvement helps parents become familiar with the content and the way students are learning. When parents take time to provide home encouragement, students have another opportunity to apply and practice the mathematical concepts previously learned.

Research indicates that the more parents are involved and excited in the learning of their children, the more successful a child can be academically. West (1985) and Weller (1999) indicate there are parent behaviors that can lead to effective schools. When parents show support, interest, and become involved the success rate of students can rise. Students in at-risk situations show an increase in grades, test scores, and academics when their parents become involved in instructional programs (Dolan, 1996).

Bagin and Gallagher (2001) note that communicating on a regular basis with parents can promote student learning and reduce attendance problems. Weller (1999) advocates that when schools and teachers treat parents with genuine concern and make them feel important, welcome, and needed, parents are more apt to take an active role in supporting their children in academic achievement. Thus, a letter is offered at the back of each *Motivation Math* Teacher Edition inviting parents to join in the education of their children. In addition, a one-page Homework page is included for each tested student expectation. At the bottom of each homework exercise, Parent Activities are provided to help parents support their children with meaningful and relevant applications to the previously taught concepts. The information given helps the parent and child build oral language through informal conversation. Simply written, the text invites parents to support the mathematical learning by asking questions, making relevant comments, or setting up other home learning activities to reinforce the concept.

Assignments, intended to be completed in class or at home, enhance students' understanding, skills, and proficiency in mathematics. *Motivation Math* reflects

the careful planning taken by the Mentoring Minds' Product Development Team so that the Homework/Parent Activity Page is a meaningful extension of the concepts taught in class.

Each **Teacher Edition** lists all TAKS objectives and TEKS for each page of the Student Edition. Suggested activities are noted in the Teacher's Edition that are based on each of the TEKS for each of the units. Answer keys and vocabulary for each lesson are also provided.

Research findings indicate that certain teaching strategies and methods are worth careful consideration as teachers strive to improve their mathematics teaching practices. Stigler and Hiebert (2004) advocate when the improvement of teaching methods become the focus, student performance will show more positive results. Teacher and student interaction is key to improvement. Many students learn mathematical concepts best through the manipulation of concrete materials because it helps them to build a mental representation of the concept. Manipulatives provide concrete introductions to abstract ideas.

Every student should have an opportunity to have adequate "hands on" experiences with appropriate manipulatives before engaging in pencil-and-paper activities. Textbooks and other printed resources, show the pictorial and symbolic representations of mathematical concepts. *Motivation Math* suggests the use of and identifies manipulatives to accompany each student addressed expectation. It is highly recommended that every classroom have an assortment of manipulatives for student accessibility at all times.

Upon the initial introduction of a manipulative, students need ample time for free exploration. However, the manipulative is a tool to assist students in understanding new concepts from concrete to pictorial to abstract rather than an object for play. A major benefit for students would be to use multiple types of manipulatives when learning mathematical concepts to ensure broader comprehension.

Long-term use of concrete materials is positively related to increases in student mathematics achievement and improved attitudes towards mathematics. Research by Grouws and Cebulla (2000) suggests that teachers use manipulative materials regularly in order to give students hands-on experience that helps them construct useful meanings for the mathematical ideas they are learning.

If the same materials to teach multiple ideas can be used during each school year then the amount of time to introduce the manipulatives can be shortened and students are helped to visualize and establish connections between ideas. This does not preclude a teacher from introducing other manipulatives during

certain years but provides some consistency with essential manipulatives that can be utilized at more than one grade level. The use of concrete materials should not be limited to demonstrations. It is essential that students use materials in meaningful ways rather than in a fixed and restricted way that focuses on recall rather than on thought.

Suggested literature that can be used for integrating lessons across the curriculum is noted in the Teacher's Edition. Children's literature offers excellent resources for connecting literature to mathematics instruction for students. "Through the use of books, students see mathematics as a form of communication. It has been proven that children learn best when they can apply their learned knowledge from one subject to another" (National Council of Teachers of Mathematics, 1989). Problems that emerge from books make the mathematics relevant, are exceedingly motivational, and present meaningful contexts for establishing mathematical thinking.

Literature can stimulate a variety of creative and critical thinking responses from the students, such as performing a skit from the story followed by mathematics-related problems. Problem-solving strategies, including acting it out, drawing a picture, and constructing a model using manipulatives, materialize quite readily from this type of activity. Evidence shows books encourage thinking and reasoning in mathematics when questions are presented on higher thinking levels. Discussions are encouraged to build conceptual understanding. Thaiss (1986) advocates a mathematics and literature connection to strengthen student motivation and increase higher levels of engagement. *Becoming a Nation of Readers: The Report of the Commission on Reading* (1985) stresses the importance of the integration of reading. Mathematics lends itself easily as a communication tool and thus, works directly with reading to help students become successful learners.

Active instruction includes a wide range of instructional approaches: small groups, class discussion, concrete objects, hands-on experiences, reading, and writing. In *Motivation Math*, teachers can ask students to think aloud, consider different options for solving problems, show evidence for the solution reached, and put their thoughts in writing. All of these ways help students to organize their thinking and assist teachers in determining the level of understanding of mathematical concepts. Studies indicate that instruction which emphasizes active student engagement in hands-on opportunities improves attitudes toward math and indicates a positive effect on mathematics achievement.

**Math Skill Builder CD** is packed with PDF pages for providing additional opportunities for practice and skill mastery. Enrichment or practice activities to fit the needs of a particular student or the entire class can be selected and printed on an as needed basis. Teacher Tools are included in the CD which contains mathematical templates that correspond to skills within *Motivation Math*. These

available templates can be used by teachers to foster active learning as well as provide the means to assess students beyond traditional classroom means.

Evidence from research demonstrates that a successful mathematics program must include time for students to practice what they are learning and experiences to perform the tasks for which they are to demonstrate competence.

**Vocabulary Strips (50 words)** accompany each grade level set with enrichment activities to make vocabulary learning meaningful and fun. Students have to understand vocabulary to understand the academic content they encounter in school. Stahl and Fairbanks (1986) revealed when specific vocabulary from academic subject areas is selected as the focus of instruction, the result was a 33 percent increase. Therefore, it appears when students are taught specific content vocabulary in each subject area at each grade level, students have an excellent opportunity to acquire the academic background knowledge they need to understand the subject area content. Teaching content vocabulary using a systematic approach appears to be a powerful tool for student success (Marzano & Pickering, 2005). Furthermore, research firmly documents that academic background knowledge has an effect on academic achievement. Any intervention for the achievement of students should identify increasing students' content vocabulary knowledge through direct instruction as a leading priority (Marzano, 2004).

Mentoring Minds seeks to understand the issues involved in teaching and learning mathematics. The National Research Council (2001) asserted that the performance of students in both reading and math at the conclusion of elementary school is an important predictor of their educational success. Students who have not mastered certain basic skills can expect to encounter problems in mathematics throughout their schooling and later. Summary statements such as these, other research findings, a review of mathematical literature, combined with recommendations from studies and observations from classroom experiences have yielded much knowledge about what works. With this wealth of information, *Motivation Math* was developed to serve as a complement to an existing mathematics program for any grade or campus. The Mentoring Minds' Product Development Team embraces the goal that all students receive a quality mathematics education.

The contents of *Motivation Math* focus on the TAKS objectives, the TEKS, and the Student Expectations, ensuring that the materials are appropriate, effective, and current. Bloom's Taxonomy is incorporated to stimulate and develop students' higher order thinking skills. Examples of research-based techniques found in *Motivation Math* include: standards-based instruction, active teaching, hands-on instruction, and critical thinking activities. The literature on improving student performance in mathematics concludes that effective mathematics programs provide specific information on individual student performance for teachers, parents, and students; peer feedback and support; direct or explicit

instruction; and real-world problems. *Motivation Math* meets these criteria for improving student performance.

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