Cautionary Issues To Consider

In response to the ongoing crisis in the learning and teaching of mathematics, the National Council of Teachers of Mathematics (NCTM) published the *Curriculum and Evaluation Standards for School Mathematics.* Released in 1989, this document, referred to as *The Standards*, represents the NCTM's framework and vision for achieving their overall objective: " . . . to develop in each and every student an understanding of mathematics that lasts a lifetime and grows to meet changing demands."

In accordance with this position *The Standards* maintains that the substance of mathematical knowledge is conceptual understanding. This document consistently stresses that teachers foster deliberate connections among physical models, pictures and symbols to associate conceptual and procedural knowledge. Communication of mathematics concepts and relationships, routine, and nonroutine problem solving, and spatial reasoning are critical components of **how** mathematics should be taught.
We praise the *NCTM Standards* as a necessary and well-formulated set of guidelines to assist teachers and administrators in transforming mathematics instruction from rote to meaningful. However, educators who want to put these **guidelines into action** need to seriously consider the following issues that could interfere with or abort their well-intentioned efforts.

ISSUE ONE: Textbooks/Other Resources That Make Use Of Manipulatives

To comply with *The Standards*, most textbook series as well as other mathematics resources give credence to the use of manipulatives. Yet research (see pages 15 - 16) as well as our personal experience based on many years of staff development work with schools and school districts confirm that the use of manipulatives alone does not in any way guarantee effective instruction.

Textbook series that make use of manipulatives have several inherent problems. First, very little staff development is provided to help teachers use concrete and pictorial models. A general orientation is usually given after the text has been adopted. Once the promotion and sales have been completed, the teachers are on their own. While the teacher's guide may briefly describe how to conduct a lesson using a concrete or pictorial model, most teachers skip it, since they do not know how to skillfully incorporate it. Therefore, teachers' implementation typically results in a conventional lesson, i.e. directly moving into symbolic mode instruction with minimal to no concrete or pictorial connections. Second, the pictorial mode is rarely related in any direct or consistent manner with concrete or symbolic representations.

Another example of missuse that is common in many text series relates to the integration of the pictorial mode with concrete and symbolic representations. In many instances, students are introduced to a symbolic procedure by means of a picture atthe top of the text page. Only one example is pictured and little or no instruction is given as to how the picture directly relates to the symbols. Students are then expected to complete the symbolic exercises on that page and subsequent pages with understanding. Rarely, if ever, do students draw pictures. If the text does mention optional use of manipulatives prior to the lesson, the pictures frequently do not relate to the corresponding concrete model. Although reference is made that there is some

connection between the two modes, it is cursory and unsystematic.

Third, textbook series, as well as most other math programs, do not organize instruction from least to greater abstraction and make systematic and developmental connections among concrete, pictorial, and symbolic representations. Thus, the two worlds of models and symbols are not meaningfully linked and students are "on their own" to figure it out. While some students might, on occasion, figure it out, this hardly meets *The Standards'* goal that **ALL** students develop an understanding of mathematics that lasts a lifetime. Such presentations do not implement many of the aspects related to concrete, pictorial, and symbolic representation and transfer between representations that are inherent in MEBA.

A fourth inherent problem is that texts do not consistently deal with the different forms of the basic operations to assist students in solving word problems, eg. comparing and contrasting the three forms of multiplication: array (area), repeated addition, and combinatorics. Commencing in the concrete mode and advancing through the symbolic mode MEBA™ stresses that students differentiate between the various forms of each operation. This facilitates students success in nonroutine problem-solving situations and transferring their understandings to various applications.

ISSUE TWO: Common Belief That A School's Math Program Is The Text

For many decades school districts have dedicated significant energy into textbook adoption which usually occurs every six years. Typically, a math textbook adoption committee is formed and several text series are considered. Once a decision has been reached and major financial resources have been expended, most educators/parents believe that the only task is for teachers to follow the teacher's guide at each grade level. Since most texts make reference to the use of manipulatives, the general educational community assumes that such materials are being used and meaningful learning will occur. Similar assumptions were made in the 1960's and 1970's. Unsystematic, random use of concrete and pictorial models has been prevelant in the past and continues into recent times when they are not systematically incorporated into instruction. If this trend continues, teachers, administrators, parents, and students will become frustrated and disillusioned and will return to conventional rote methods. Yet this outcome would not be consistent with research findings, the guidelines provided by *The Standards*, nor our recommendations based on over 20 years of staff development work.

ISSUE THREE: One-Time "Hands-On" Workshops

The effective use of concrete and pictorial models may also be hampered by one-time, "hands-on" manipulative workshops. In many instances such workshops expose teachers to a variety of manipulatives in a short period of time. Small packets of each type of manipulative are frequently given to participants. Information about how to use each model is brief and little or no connection between the world of manipulatives and the world of symbols is made.

Another danger of one-time, "hands-on" workshops is that they tacitly suggest to teachers that there is little to learn about the effective use of manipulatives. Thus, the implicit message is that manipulatives are effortless teaching aids and, based on

one workshop, teachers will understand all they need to learn about their use.

Although such sessions may create initial excitement about the potential benefits of manipulatives, our experience with this type of workshop suggests a short-lived effect. Once teachers return to their classrooms and do not know how to connect manipulatives to symbols and the content that they are expected to teach, they shelve the materials or only make occasional use of them.

ISSUE FOUR: Attitudes Regarding Concrete And Pictorial Models

In our long-term staff development work which integrates concrete and pictorial models we have frequently heard remarks from teachers and parents such as, "Oh, we get to play today." or "What fun - toys and math!" While we value the importance of play and the educational significance of some toys, we do not equate the effective use of concrete and pictorial models with toys. Furthermore, there is a great danger when teachers communicate to students that concrete and pictorial models are toys. Such messages are many times conveyed by children to their parents about what they did in school. When children express to their parents that they spent their math class playing with toys, parents are typically concerned or upset.

Our experience has repeatedly shown that if teachers perceive and refer to concrete and pictorial models as toys rather than serious instructional tools, then children will also regard them as such. Also, since many models are used in science instruction in a serious manner, why can't the same be true for mathematics instruction?

We encourage teachers to describe concrete and pictorial models in an accurate manner in concert with appropriate mathematics terminology. When this occurs, students are much more likely to refer to concrete and pictorial models as tools rather than toys when they describe classroom experiences to their parents.

The mind set that concrete and pictorial models were developed for students having learning problems is another negative attitude which may surface in the form of questions such as: "Why does my child have to spend time with this? He's good in math. He knows all his facts and does well on his tests." This attitude may be expressed by teachers as "How much time do we need to spend on this? When will my students be ready to use the text and workbook pages?" Administrators may echo this attitude with comments such as "Well this is all fine and good but we only have so much time for math and we can't be wasting it." And, teachers/parents of "gifted and talented" students might be particularly frustrated and make remarks such as "My students are fifth graders but are using the sixth grade text. Why should we hold them back?" All of these questions come from adults who have little basis in their own personal experiences to support anything other than rote and highly routinized paper-pencil exercises. In response to such questions we guide educators to stress the following **two points** which are inherent to the MEBA framework and philosophy.

POINT ONE: Nonroutine problem solving stresses the importance of heuristics. Since building a model or drawing a picture of a problem situation are two critical heuristics, we are responsible and accountable as educators to develop these skills in our

students. SIMs™ incorporates these as a natural part of the instructional process to develop an understanding and memory of mathematics that lasts a lifetime. Are we "wasting precious academic time" by including the use of models to develop these skills in our students? We don't think so. We believe that parents and educators should understand that just as a good nutrition is essential for developing healthy bodies, a connected and systematic use of concrete and pictorial models and the engagement of learners in nonroutine as well as routine problem solving experiences provides the essential nutrition for mathematics thinking. We can no longer afford to evade the development of these skills and **must** consider them as essential components of our mathematics curriculum.

POINT TWO: Visual imagery has played a major role in the development of mathematics as well as science as documented by many great mathematicians/scientists. Why should we blind our students to mathematics and deprive them of life-long problem-solving skills?