# Instructional Implications of the Curriculum and Evaluation Standards, Grades K-4

Catherine P. Vistro, University of Georgia

In this new era of curriculum reform in school mathematics as marked by the publication of curriculum and evaluation standards by the Commission on Standards for School Mathematics of the NCTM, educators and researchers are rethinking how students' mathematical learning can be improved. Results of various studies on students' performance in mathematics have convinced many educators that there is an urgent need to make changes, whether they are curricular and/or instructional, in the mathematics classrooms.

*The Curriculum and Evaluation Standards for School Mathematics* (Commission on Standards for School Mathematics, 1989) document, which will be referred to here as the *Standards*, contains many proposed changes for curriculum and evaluation. After the presentation of the document at the NCTM 1989 annual meeting in Orlando, Florida, it appeared that in addition to a continued examination of the recommendations, the implementation of the proposed changes is a concern. The impact of the recommendations of the *Standards* depends largely on the cooperation of the school administrators, teachers and other educators, parents, researchers, the students, and the public.

The *Standards* addresses both elementary and high school mathematics curriculum and evaluation. Referring to the *Standards*, Lindquist (1989) asserts that, "The elementary school has the greatest responsibility for [the] success [of the *Standards*], since it will be difficult or nearly impossible to make significant changes in the secondary curriculum without first making changes in the elementary curriculum" (p. 5). Indeed, it is in the elementary school that we lay all the foundations for continued education. Although there is also a need to consider the implications for secondary mathematics teaching, in this paper I will only address some important implications of the *Standards* for the teaching of elementary school mathematics.

### *Implications of the K-4 Standards for mathematics teaching*

A significant revision of mathematics curriculum is recommended in the *Standards*. Accordingly, this document has several significant implications for mathematics instruction. By instruction, I mean all aspects of it including the curriculum, the learning environment, the teacher and students, and the teaching process itself.

To satisfy the intentions of the *Standards*, it will be necessary for the primary teacher to change his or her perceptions about the overall nature of mathematics and the kind of mathematics that elementary students should learn, keeping in mind what mathematics these students will need in the future. The grades K-4 mathematics teacher should also learn to accept the role of a facilitator of learning and not a transmitter of knowledge. The teacher must seek to study and learn more mathematics, to acquire additional pedagogical and content skills, and to become more effective in guiding students in their understanding of the subject matter. There is an implicit call for all mathematics teachers to become more professional in their teaching of the subject, their understanding of it, and their response and participation in the research community. Teachers should be alert to new discoveries in the field of both mathematics and education.

Mathematics students also need to take on a new perspective about the nature of mathematics. We should help them realize that mathematics is not simply doing computations and that being in the mathematics classroom does not only mean listening to the teacher lecture nor waiting for drills and homework to be given. These students need to understand that there is more activity required of them for effective learning to occur. We should also help them realize that they now have more responsibilities to themselves for their education since they are expected to become more active in their learning. They need to accept that calculators, computers, and other similar technological equipment are available to assist them in their understanding of mathematical concepts and are not just there for fun.

There are also a few implications that stand out relating to the teaching process. First, teachers need to provide exploratory and investigative activities for students. Second, teachers should involve students in problem solving as often as possible. Third, cooperative learning within small groups or the whole class is highly encouraged to foster more communication and expression of ideas. Fourth, teachers need to provide opportunities for students to construct linkages between mathematics concepts. Last but not least, teachers need to constantly pose questions to encourage students to think critically for themselves.

***A proposed theoretical model***

Based on the aforementioned implications of the *Standards* to elementary mathematics instruction that I have drawn, I propose a theoretical model for classroom instruction. This model will hopefully provide a groundwork for a theory from which elementary mathematics teachers can design their instruction and improve their teaching. Cooney, Davis, & Henderson (1983/1975) propose that although it may be easy to observe teachers' actions in the classroom and use these observations as guiding principles for improving instruction, a theory of teaching is still necessary. They state, "Theory enables us not only to become aware of certain phenomena and relations but also to understand them--to know why they occur and how to control them insofar as this is possible" (p. 9). Thus, a discussion of instructional implications of the *Standards* is not enough. There is a need to provide a foundational structure from which the instructional implications may be used, transformed, and applied.

Lester (1985) created a cognitive-metacognitive model of mathematical problem solving as an attempt to incorporate the metacognitive component in problem solving. His model provides a clearer picture of how metacognition is actually used in mathematical problem solving. Since problem solving is a major part of the proposed curriculum, I have adopted a few of his ideas for my model.

Psychological theories have long provided insight for mathematics instruction and its improvement. Kroll (1989) and Resnick & Ford (1981) traced a part of the history of mathematics education that was significantly influenced by psychology. They implied that a closer look at how these theories influenced mathematics instruction in the past may help today's researchers and educators in reformulating theoretical constructions for mathematics teaching. For example, Gestalt principles had several implications on the learning of problem solving strategies (Resnick & Ford, 1981). Moreover, there is a need to understand the psychology of the young learner in order to make adaptations for his or her education.

***Components and variables of the model***

*The Teacher*

As suggested by the *Standards*, the teacher is the supporting person in this drama of mathematics instruction. The mathematics teacher in the grades K-4 classroom is also the language, reading, social studies, science, and arts teacher. Apart from their classmates, she is a person that students in grades K-4 encounter throughout the day. Thus, she has considerable influence on learning.

The *teacher's beliefs* about learning and teaching play a major role in her teaching plan and instruction. The teaching of mathematics to students is largely dependent on whether the teacher views real learning as mere transmission of information or active construction of knowledge by the student. The *teacher's beliefs* about the nature of mathematics also plays an important role. The teacher who views mathematics as a great body of knowledge that is "out there" to be reached by students would teach differently from the one who views mathematics as constantly changing depending on an individual's construction of it.

The *teacher's understanding* of children's thinking and actions is an important variable. Gruber and Voneche (1986) assert that "the actual psychological significance of any method changes in subtle ways depending on the teacher's understanding of children's thinking" (p. 691). Her understanding of mathematics is also a major consideration since her instructional plan and its implementation largely depend on how well she understands the mathematical topics that are to be covered. The teacher's ability to ask good questions that will probe a child's understanding of mathematics is influenced by her knowledge of mathematics. The teacher's understanding of her own actions as a result of some considerable reflection is also important. By reflection, one can see the effective and less effective decisions and actions that have been made before, during, and after instruction.

Finally, the *teacher's actions*, both pedagogical and managerial, are important. The teacher's actions, which include verbal communications, are what the child directly and concretely experiences in the classroom.

*Mathematics*

Mathematics, the subject matter of concern, is a second major component. The *developments* in mathematics, such as the technological advances made possible because of mathematics, play a major role in classroom mathematics instruction. The *language systems* of mathematics are also significant. Although a child's language is entirely different from the conventional language and symbols of mathematics, instruction still needs to link them together. The *activities* of mathematics, which may be commonly known as branches of mathematics (e.g. applied and pure mathematics), also play an important role even in grades K-4 classrooms. Lastly, the mathematics *curriculum* established by the grades K-4 standards, plays a crucial role and is, in fact, the most influential among the variables in this model.

*Non-mathematics*

The *Standards* heavily discusses the idea of integration and mathematical connections. The non-mathematics component of this model, which reflects this recommendation, refers to the other fields of study such as science, language arts, and social studies. Analogous to the variables comprising mathematics, the non-mathematics component also includes the *developments* in the different fields, the *activities* (e.g. research) and their *language systems*. The curriculum of non-mathematics areas is not included in the model since the focus is mathematics instruction.

*The Student*

The last, yet, the most important component in this model is the student. The student's *cognitive growth* is our most important concern when teaching mathematics. The affective dimension of a child's growth, in particular, his *perceptions of mathematics*, is another concern. The child's *language and communication* with his own classmates and his teacher also play significant roles in instruction. The *Standards* strongly emphasizes the need to use a child's natural language. Last, but not least, the child's *mathematical actions* cannot be neglected since it is through his mathematical actions that we can be assured of his or her participation in the learning process.

***Interactions***

The four components, teacher, mathematics, non-mathematics, and student all affect one another in some way. As discussed in the preceding section, there are other variables under each component. The variables within one component also affect one another. For example, a teacher's beliefs may guide her actions. At the same time her actions reinforce her beliefs. A teacher's understanding may also guide her actions and again, the actions reinforce the understanding. Finally, a teacher's understanding depends largely on her beliefs that relate to the phenomenon being understood.

Figure 1 shows the relationships among the components. The arrows indicate that one component affects the other. The two-directional arrow between the teacher and the student is unique because they are the only two human components in this model. This indicates a real interaction between them. The one-

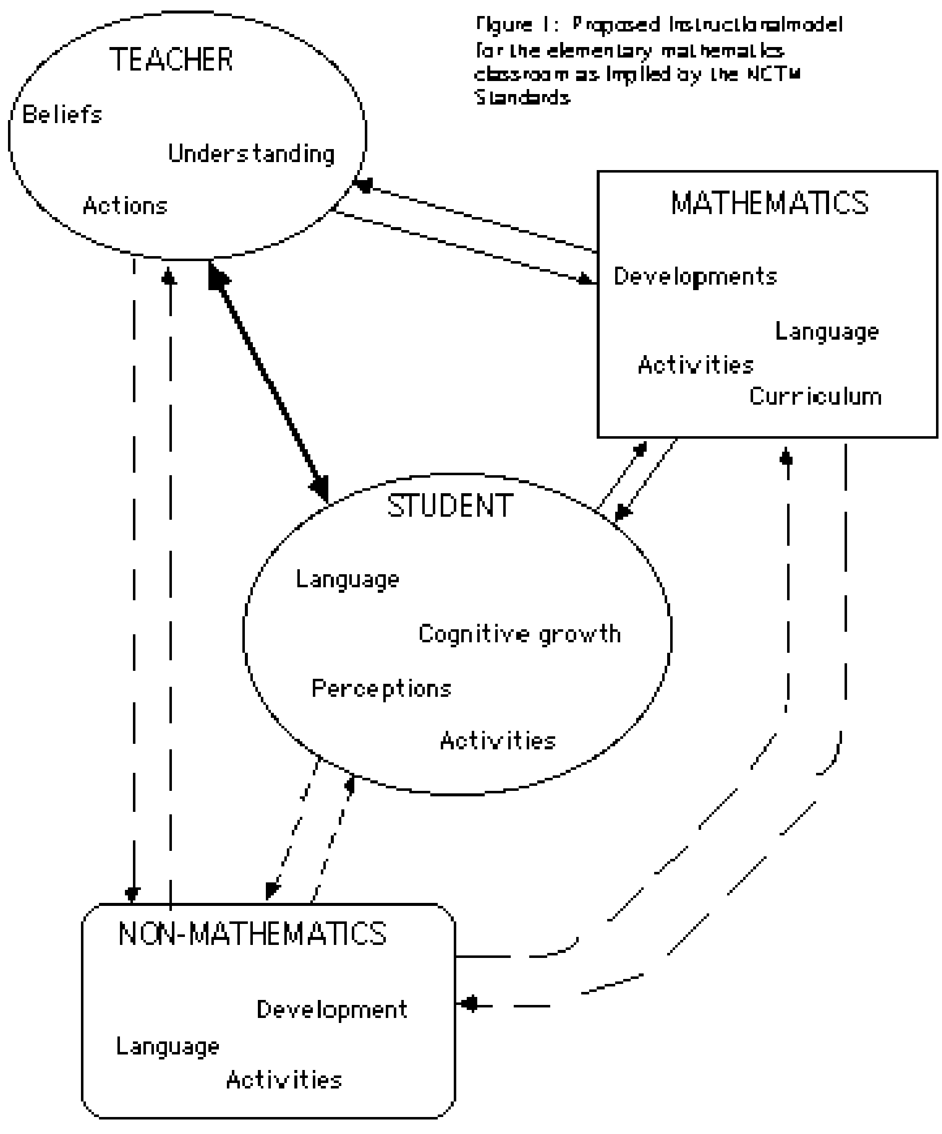


Figure 1: Proposed Instructional model for the elementary mathematics classroom as implied by the NCTM Standards

directional arrows indicate that one component affects the other in a way different from how that component affects it in turn. For example, the mathematics curriculum offers to the teacher guidelines for the topics that need to be covered. In turn, however, the teacher affects mathematics by her pedagogical actions and contributes to the curriculum, activities, and developments. The dashed arrows mean that I am de-emphasizing the links between some components. For example, the link between the non-mathematics component and the student is de-emphasized because this is an instructional model for a mathematics classroom.

The teacher's understandings, beliefs, and actions guide the instructional plan for the student of mathematics. The teacher certainly affects the student and interacts with him or her through constant communication, activities, and other materials given in class. The student responds by communicating back, by participating in activities, and by constructing knowledge for oneself. The teacher, through the instructional plan adds shape to the mathematics curriculum and contributes to the activities, developments, and language. Certainly, the mathematics component affects the teacher in planning for instruction.

The student through instruction constructs his or her mathematics as influenced by the developments, activities, language, and the curriculum. In turn, the student contributes to mathematical activities and developments through his or her own knowledge. The non-mathematics component, as implied by the *Standards*, affects the teacher, the student, and the mathematics.

### *The model*

What does this model tell us? I claim that this is an instructional model for the elementary mathematics classroom. This model illustrates how mathematics instruction can be planned and implemented in the spirit of the recommendations of the *Standards*. It shows the differing variables that affect instruction and their interrelationships. It presents to us important instructional considerations. For example, as I look at the model, I quickly observe that the activities of the student are important indications of their active learning process. This does not give direct hints to teachers for planning lessons but offers a theoretical basis on which the teaching may be designed.

### *Summary*

The *Curriculum and Evaluation Standards* (NCTM, 1989) has important implications for elementary mathematics instruction. In addition to these implications, a theoretical basis for instruction in the form of a model is appropriate. This model presents the different variables and their relationships that should be considered when planning for instruction. The model follows from the recommendations of the *Standards* and needs further refinement for the practicing teacher.

### References


Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for school mathematics.* Reston, VA: National Council of Teachers of Mathematics.

Cooney, T. J., Davis, E. J., & Henderson, K. B. (1983). *Dynamics of teaching secondary school mathematics*. Illinois: Waveland Press (Originally printed by Houghton Mifflin in 1975).

Gruber, H. E. & Voneche, J. J. (Eds.). (1986). *The essential Piaget.* NY: Basic Books.

Kroll, D. L. (1989). Connections between psychological learning theories and the elementary mathematics curriculum. In P. R. Trafton & A. P. Schulte (Eds.), *New directions for elementary school mathematics* (1989 Yearbook of the National Council of Teachers of Mathematics) (pp. 199-211). Reston, VA: NCTM.

Lester, F. K., Jr. (1985). Methodological considerations in research on mathematical problem-solving instruction. In E. A. Silver (Ed.), *Teaching and learning mathematical problem solving: Multiple research perspectives.* Hillsdale, NJ: Lawrence Erlbaum.

Lindquist, M. L. (1989). It's time to change. In P. R. Trafton & A. P. Schulte (Eds.), *New directions for elementary school mathematics* (1989 Yearbook of the National Council of Teachers of Mathematics) (pp. 1-13). Reston, VA: NCTM.

Resnick, L. B. & Ford, W. W. (1981). *The psychology of mathematics for instruction.* Hillsdale, NJ: Lawrence Erlbaum.


## Quotation

Perhaps it is true that nothing worth knowing can be taught - all the teacher can do is to show that there are paths. *Richard Aldington*