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Young children's acquisition of mathematical knowledge and mathematics education in kindergarten

Kuei-Er Chung

Iowa State University

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Young children’s acquisition of mathematical knowledge and mathematics education in kindergarten

Chung, Kuei-Er, Ph.D.

Iowa State University, 1994
Young children’s acquisition of mathematical knowledge and mathematics education in kindergarten

by

Kuei-Er Chung

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GENERAL INTRODUCTION

Mathematical learning in the United States has been characterized by certain ineffective practices that are suspected causes of the poor achievement of American students compared with their peers in other countries (Song & Ginsburg, 1987; Stevenson, Stigler, Lee, Lucker, Kitamura, & Hsu, 1985; Stevenson, Lee, & Stigler, 1986; Stigler, Lee, Lucker, & Stevenson, 1982; Stigler, Lee, & Stevenson, 1987). Such ineffective practices include less time allotted to teaching and learning mathematics; less time spent using effective teaching methods such as direct teaching and use of manipulatives and of real-world problems; and more inappropriate behaviors during mathematics learning time (Stevenson et al., 1985; Stevenson et al., 1986; Stigler et al., 1982; Stigler et al., 1987). Moreover, lack of connection between children's informally learned mathematical knowledge and school-taught formal mathematics is a major concern (Song & Ginsburg, 1987).

Kindergarten is a bridge linking children's informally learned mathematical knowledge to formal school-taught mathematics. Cross-cultural studies have demonstrated that preschool children in the United States can understand and apply mathematics better than children in other countries (Song & Ginsburg, 1987). But American children lose this advantage after kindergarten (Husen, 1967; Song & Ginsburg, 1987; Stevenson et al., 1985; Stevenson et al., 1986, Stigler et al., 1982). Baroody and Ginsburg (1990) suggest that this loss of advantage is the result of a notable gap between children's informal mathematical understanding and their school mathematics education.

Educational organizations such as the National Association for the Education of Young Children (NAEYC) and the National Council of Teachers of Mathematics (NCTM), as well as other groups of educators (e.g., Bredekamp, 1986; Campbell & Carvey, 1992; Kamii, 1990; Katz & Chard, 1989) have advocated that mathematics education for young children should be integrated into other subjects. However, the majority of kindergartens are not developmentally

Further, the majority of kindergarten teachers are unaware of teaching strategies that are effective in connecting children's experience to mathematics (Parker & Kurtz, 1990). As a result, many still emphasize methods such as memorization and drills in teaching mathematics and teach it as an isolated subject instead of integrating it into other learning activities. However, little research is available documenting actual classroom mathematics teaching and learning in kindergarten.

To gain a better understanding of young children's acquisition of mathematical knowledge and actual classroom mathematics teaching and learning in kindergarten, this dissertation aims to (1) examine existing literature on young children's acquisition of mathematical knowledge, (2) examine existing literature on current classroom practices in kindergarten, and (3) investigate actual classroom practices relating to mathematics education.

Explanation of Dissertation Format

This dissertation consists of two comprehensive literature reviews and a research article, each of which addresses one of the aims stated above. The first literature review addresses the first aim by reviewing the literature on children's acquisition of mathematical knowledge and factors affecting children's understanding of mathematics. The second literature review addresses the second aim by examining literature on current classroom practices in kindergarten. The research article contains a manuscript prepared for publication, which describes an observational study on mathematical learning and teaching in kindergarten classrooms and is designed to address the third aim of the dissertation.

In the first literature review, the theoretical bases for children's acquisition of mathematical knowledge, based upon Piaget's (1963, 1983) and Vygotsky's (1978) perspectives, are discussed. In the second literature review, directions for mathematics
education in kindergarten are examined and issues such as inappropriate and ineffective classroom practices in mathematics teaching and learning in kindergarten are examined. The research article includes a statement of the rationale, objectives of the study, a description of methodology, a results section, a discussion of the results, and conclusions. Three objectives of this study were to: (1) examine the relations between the amount of time spent on cognitive distancing strategies and the developmental appropriateness of the kindergarten; (2) compare children's participating behaviors in mathematics-related learning activities with their behaviors in nonmathematics-related learning activities; and (3) examine the relations between teachers' teaching behaviors and children's participating behaviors. This study was approved by the Iowa State University Human Subjects Committee.

General conclusions of the dissertation as well as suggestions of practical and research interest follow the research article. References for the general introduction, the literature reviews, the research article, and the general conclusions are provided immediately after each chapter. Appendices include details of procedures for recruiting subjects, copies of correspondence used in the study, samples of instruments, and a manual for the classroom observations.

References Cited


LITERATURE REVIEW ON YOUNG CHILDREN'S ACQUISITION OF MATHEMATICAL KNOWLEDGE

Introduction

Mathematics becomes more important as science and technology increase their influence on all aspects of human life. In areas ranging from personal health care, family budgeting, and environmental ecology to national defense, mathematics is the foundation of the scientific and technological knowledge needed by people living in the modern era (Baroody, 1987; National Council of Teachers of Mathematics [NCTM], 1989, 1991; National Research Council, 1989; Steen, 1990).

As people become increasingly dependent upon computers, worldwide communication, and global markets, mathematics becomes a key to job opportunities. Such jobs require preparation in constructing new ideas, perceiving patterns, and solving problems. Mathematics is, therefore, not only a discipline of human knowledge but also a tool of daily life (Baroody, 1987; NCTM, 1989, 1991; National Research Council, 1989; Steen, 1990).

The mathematics-related requirements of new employees in industry are the ability to set up problems with appropriate operations, the knowledge of techniques to approach and to work with others on problems, and the understanding of underlying mathematical features of problems and the applicability of mathematical ideas to problems. Mathematics clearly is a key requirement for industrial jobs and thus for life. In short, it is a key to job opportunities (NCTM, 1989, 1991; National Research Council, 1989; Steen, 1990).

Mathematics is an essential part of education in that it helps children conduct their lives through such processes as problem solving, communication, and creativity. Therefore, quality mathematics education is essential for children to learn to think in mathematical ways and to solve their everyday problems (NCTM, 1989, 1991; National Research Council, 1989).
Before discussing the goals and the new direction of today’s mathematics education, recognition of the essence of mathematics will clarify the importance of mathematics to us and point out why mathematics education is essential to our children and in fact to all of human society.

Mathematical Knowledge


Internalized knowledge

According to Piaget (1965, 1983; Kamii, 1982, 1990), mathematical knowledge is an understanding of relations between and among objects. It is different from both physical knowledge, which involves knowing the external reality of objects, and social knowledge. The individual creates these relations and acquires the coordination of such relations in his/her own mind. The source of mathematical knowledge, therefore, is internal. Based on what she/he already knows, the individual reflects and interprets what has been perceived through observations and interactions with objects, people, and environments. This kind of interpretation is quite personal and makes sense only to the individual through his/her own understanding (Elkind, 1976; Kamii, 1982, 1990; Noddings, 1990; Piaget, 1983).
**Conceptual knowledge**

Mathematical knowledge involves understanding of concepts (Hiebert & Lefevre, 1986). It involves a process of thinking to construct a unit of abstract conceptual knowledge through linking all pieces of information in an individual’s mind. In the process of building up conceptual knowledge, the individual examines the attributes of different pieces of information and connects the pieces of information with his/her understanding to decide the existing relations between or among pieces of information. Thus, mathematical knowledge is generated by the individual through his/her own active involvement with all pieces of information that make sense to him/her (Baratta-Lorton, 1976; Castaneda, 1987; Hiebert & Lefevre, 1986; Kamii, 1982; NCTM, 1991; Piaget, 1965, 1983; Wolfinger, 1988). Mathematical knowledge acquired through conceptualization entails understanding the underlying structure of mathematics (Eisenhart, Borko, Underhill, Brown, Hones, & Agard, 1993; Hiebert & Lefevre, 1986). For example, understanding the total number of a set of objects by counting indicates a child’s understanding of the concept of cardinality (Gelman & Gallistel, 1978). If a child does not hold the conceptual knowledge of cardinality, he/she may give the total of a set of objects other than the last number word he/she has counted.

**Constructive knowledge**

Mathematics is more than a set of computational skills. Number facts cannot satisfy the search for relations. Mathematics is a process of problem solving that includes hypothesizing, testing, reasoning, and concluding (Castaneda, 1987). Piaget (1963, 1965, 1983) states that not only are intellectual processes themselves constructive, but cognitive structures themselves are products of continued construction. Thus, the individual acquires his/her mathematical understanding through continued construction. This active construction implies both a base structure from which to begin construction (i.e., structure of assimilation) and a transformative

When confronted with new information, the individual may face a situation of problem solving. By using what he/she already knows, together with an understanding of the new situation, the individual makes his/her own judgment and conclusion. The newly achieved conclusion works as the most acceptable and satisfactory answer to the hypothesis, relations of objects and explanation of relations. But when the individual finds something contradictory in the conclusion, he/she may begin searching for a better means of describing and explaining the relations (Piaget, 1983). Mathematical knowledge, therefore, is also a process of continual revision of structure (i.e., a process of accommodation) that involves changing thinking patterns (Baroody, 1987; Noddings, 1990; Piaget, 1973, 1983).

Procedural knowledge

In addition to the characteristics of internalization, conceptualization, and construction, mathematical knowledge involves mastery of computational skills. Procedures for identifying mathematical components and algorithms, as well as for knowing how to identify a problem and how to solve it correctly, are needed to obtain solutions (Eisenhart et al., 1993; Hiebert & Lefevre, 1986). The first aspect of the procedural knowledge of mathematics is knowledge of the format and syntax of the symbol representation system (e.g., counting system and written numerical system). The other aspect of the procedural knowledge of mathematics is knowledge of rules and algorithms. Some rules are symbolic and can be used to complete mathematical tasks. In short, procedural knowledge of mathematics includes the conventional expressions and representativeness of knowledge and rules and steps of problem-solving strategies (Eisenhart et al., 1993; Hiebert & Lefevre, 1986).

In summary, mathematics is rich in relations. Mathematical knowledge is a process of internalization, conceptualization, construction, and understanding of concepts and procedures.
Understanding in mathematics comes from perceiving relations either between or within mathematical ideas. Individuals actively and personally construct their own mathematical knowledge.

**Mathematics Education Reformation**

The definition and interpretation of mathematical knowledge and its functions and influences on children and their futures have led to different foci in mathematics education. For example, educators who view mathematics as a set of skills tend to provide increased opportunity for training in skills and for memorization of formulas (Bereiter & Englemann, 1966; Katona, 1940). These educators are more likely to introduce basic skills to young children, to use didactic instructional approaches and to emphasize recitation and memorization. Educators who regard mathematics as conceptual knowledge may provide more opportunities for meaningful learning, such as using materials that children know how to manipulate to solve problems relating to their own experiences (Baratta-Lorton, 1976; Baroody, 1987; Castaneda, 1987; Campbell & Carvey, 1992).

A rapidly changing society and its new demands require that educators reconsider the direction of mathematics education. For example, the National Council of Teachers of Mathematics, the National Research Council, and other groups of mathematics educators have been searching for the best ways to prepare children and students to live in an age of new technology (e.g., Baroody, 1987; Campbell & Carvey, 1992; Castaneda, 1987; Ginsburg, 1982; Kamii, 1982, 1990; NCTM, 1989, 1991; National Research Council, 1989).

**Goals of Mathematics Education**

Acquiring mathematical knowledge is not merely a matter of learning how to obtain correct answers; thus, acquisition of the procedure to obtain facts must not be the only objective of mathematics education (Castaneda, 1987; Hiebert & Lefevre, 1986), because focusing on obtaining correct answers is not the same as using mathematical knowledge to deal
with everyday life. The goal of mathematics education is to help children develop mathematical abilities that will enable them to explore their world, conjecture, hypothesize, and give reasons (NCTM, 1989, 1991; National Research Council, 1989). With sound mathematical knowledge, children will be able to solve conventional and unconventional problems and to communicate what they know about mathematics and what they know through mathematics. Mathematics education should help children become confident in connecting ideas within mathematics as well as between mathematics and other intellectual activities. It should promote children's interests in mathematical activities so that they will be comfortable using quantitative information in problem solving and decision making (NCTM, 1989, 1991; National Research Council, 1989).

To achieve the goal of enhancing children and students' mathematical knowledge and ability, the NCTM (1989) proposed that the objectives of mathematics education for all students be:

1. learning to value mathematics,
2. becoming confident in one's own ability,
3. becoming a mathematical problem solver,
4. learning to communicate mathematically, and
5. learning to reason mathematically (pp. 5-6).

Young Children's Acquisition of Mathematical Knowledge

Most children do mathematics naturally (Gelman & Meck, 1983), discovering patterns and making conjectures based upon interactions and observations (Baratta-Lorton, 1976; Kamii, 1982, 1990). Natural curiosity is a powerful teacher, especially for mathematics (National Research Council, 1989). But preoperational children (ages 2 to 7), as Piaget (1965, 1973, 1983) proposed, are able to center on no more than one dimension of an event or an object at a time. During Piaget's number conservation task, for example, children may be able to focus on the length of rows of two sets of objects, without considering the density of the distribution of the objects of the two rows, and conclude that the set in the longer row contains more objects.
The ways in which young children acquire mathematical knowledge need to be linked to the goals of mathematics education for young children and to developmentally appropriate methods of promoting young children's mathematical understanding. The next section discusses how young children learn mathematics, according to Piaget's cognitive developmental theory and Vygotsky's sociocultural theory.

**Knowledge Acquisition**


Piaget regarded knowledge as a process. Knowledge involves an internal self-regulation of understanding. That is, the individual actively constructs relations between and among objects and elements. To know something means to act on that thing. The action can be either physical or mental or both; action can be on objects, images, and symbols that are somewhat familiar to children (Kamii, 1982; Piaget, 1963, 1983; Thomas, 1992). Knowledge is acquired continually during development and during passage from one developmental stage to another. The essential part of knowledge is structure, which is a unit of relations meaningfully connected and organized (Baroody, 1987; Hiebert & Lefevre, 1986; Piaget, 1963, 1965, 1973, 1983).

Piaget (1965, 1983) contended that mathematical knowledge is the individual's mental construction of relations between and among objects. With their mathematical framework, children construct both physical and social knowledge (Kamii, 1982, 1990; Piaget, 1963, 1965,
Based on Piaget's cognitive developmental theory, the development of mathematical knowledge involves qualitative changes in thinking as well as quantitative changes in amount of information stored. Essential to the development of understanding are changes in thinking patterns (Baroody, 1987; Hiebert & Lefevre, 1986; McKeough, 1991; Piaget, 1965, 1983; Thomas, 1992).

In contrast to Piaget's cognitive developmental perspective, the sociocultural theorist Vygotsky (1978, 1987) stated that knowledge reflects an interaction of sociocultural convention. Knowledge is transmitted in the social and the cultural communities; it is transmitted from more mature and experienced people who know what is especially valuable in the culture. The source of knowledge is culture and society, and knowledge can be acquired only by examining the social and the cultural process from which it derives (Bruner, 1986; McKeough, 1991; Vygotsky, 1978, 1987; Wertsch, 1985; Wertsch & Tulviste, 1992). According to Vygotsky (1978), knowledge is the functioning of the individual. Human activities are interactions between external world and individual minds. The child's development in a culture is both sociocultural and internal. Higher mental functions occur first on the other-regulatory plane and later on the self-regulatory plane (Vygotsky, 1978; Wertsch, 1985; Wertsch & Tulviste, 1992).

Vygotsky did not distinguish mathematical knowledge from other mental functioning. He agreed with Piaget that knowledge is internal functioning of the individual and that knowledge is a process of conceptualization rather than memorization (Vygotsky, 1978). However, Vygotsky argued (1978, 1987) that the acquisition of mathematical knowledge should not be discussed without considering the influences of culture and society (Cobb, Wood, & Yackel, 1990; Popkewitz, 1988; Vygotsky, 1978, 1987). Mathematical knowledge is acquired through transmission in the social and the cultural communities (Rogoff, 1990; Vygotsky, 1978). For example, Asian students, practicing the abacus, operate numbers in a
manner different from the conventional computation process taught to American students. Asians perceive numbers as they are indicated on the abacus (Hatano, 1988; Hatano, Amaiwa, & Shimizu, 1987; Stigler, Chalip, & Miller, 1986). Similarly, people in different cultures use different counting systems and different body parts or gestures to indicate quantity (Baroody, 1987).

In summary, Piaget and Vygotsky agreed that knowledge is a process of internal regulation of mental functioning. However, Piaget contended that mathematical knowledge begins with the understanding of the individual acting on something; in contrast, Vygotsky argued that knowledge is acquired by the individual seeking messages in social and cultural communities.

**Learning and the Learner**

To discuss how children acquire mathematical knowledge, the essential elements of both Piaget's and Vygotsky's theories regarding learning and the learner will be discussed. Piaget and Vygotsky held different views on how learning takes place. Piaget (1963, 1965, 1973, 1977, 1983) suggested that learning occurs when the individual seeks balance among maturation of central nervous system, physical experiences, and social interactions. Vygotsky (1978, 1987), on the other hand, focused on the expansion of the individual's zone of proximal development through communicative speech in social transmission of knowledge. The zone of proximal development is defined as the distance between a child's actual developmental level and the higher level of potential development.

Piaget and his colleagues (1965) conducted studies on children's learning of mathematical knowledge and summarized three stages in the development of mathematical concepts. At the first stage, children did not grasp these mathematical concepts. They considered only one dimension of the perceptual relations. At the second stage, children began to coordinate the perceptual relations with logical reasoning to achieve true understanding,
which was completed at the third stage. When children acquired true understanding, they became able to use the logical coordination to solve the mathematical problems. Vygotsky (1978) drew the same conclusion as Piaget as a result of his research on a block problem-solving task. Vygotsky classified three stages of conceptual development as follows: (1) thinking in an unorganized way based on physical perception; (2) thinking in complexities combined of subjective impression and bonds that actually exist among objects; and (3) thinking in concepts requiring spontaneously abstract operations. From their empirical studies, Piaget and Vygotsky both concluded that learning is connecting new observation to existing understanding; it progresses from concrete to abstract.

Both Piaget and Vygotsky stated that learning is a problem-solving process. True learning involves changing thought patterns; it is not merely adding up facts or memorizing information. The child is an active learner. With their natural curiosity, children make efforts to understand the world. Piaget and Vygotsky hold different perspectives, however, on the roles of the adult and the child in learning. In Piaget's view, children are involved actively in things around them and engaging their minds to construct relations between/among objects or elements. In contrast, Vygotsky's view is that children are active in connecting the relations between communicative speech and completion of the task. Consequently, children acquire knowledge from the process of completing the task.

Piaget (1963, 1983) identified four periods of intellectual development: sensorimotor, preoperational, concrete operations, and formal operations. During the sensorimotor period, from birth to age 2, infants organize their understanding of the world by motor and perceptual adjustments. They cannot differentiate between themselves and the world. Sensory and motor modalities dominate learning.

From age 2 to 7, preoperational children organize objects in their environment as being separate from themselves, but they are unable to distinguish between how something appears
to them and how something actually is. Their thinking is tied to their perception. Preoperational children are not able to construct their understanding by logical operation because their structures are limited. Preoperational children are unable to solve tasks relating to classifications with the limited structures they have before they understand the relations of part and whole. When a 3-year-old child is asked, "Do you have more flowers or more white flowers?" he/she may answer, "More white flowers." Preoperational children are capable of focusing on only one dimension of a situation at a time. For example, they may focus on the height of the container while ignoring the width and conclude that the volume of liquid in a thin, tall tube is more than the same volume in a wide container. At this stage, egocentrism of young children leads them to assume that everyone thinks as they do. Egocentric speech is interpreted as their assumption that the whole world shares their thoughts, feelings, and desires.

During the preoperational period, the child acquires the ability to internalize and to symbolize the reality of the world. A child's symbols include mental images, drawings, dreams, make-believe, and play. Symbolic manipulations and language free the child's thinking from the immediately perceptible and permit the child to create thoughts out of his/her imagination.

Children in the concrete operations period (i.e., ages 7 to 11) go beyond perception and conceptualize the world in terms of mental actions. Although their thinking is not limited by immediate perceptions, it is tied to what is concrete and active. Problem solving at this stage involves identifiable objects, either directly perceived or imagined.

Children achieve the formal operations period from preadolescence to mid-adolescence. Adolescents in the formal operational period do not focus exclusively on what comes to their senses. Their thinking is moving from reality to possibility. Adolescents are freed from concreteness and can analyze the world abstractly, hypothetically, and inferentially. Research has demonstrated, however, that not all adolescents use formal operations thinking (Ginsburg & Opper, 1969).
Disequilibrium

Piaget (1963, 1983) hypothesized that equilibrium maintains a balance within the individual among maturation, physical experience, and social transmission. New types of information or experience that disturb the individual's current state of equilibrium cause the compensatory process of equilibration, which leads to a new level of structuring. The imbalance between assimilation and accommodation among maturation, experience, and social interaction creates cognitive conflicts, or states of disequilibrium, which motivate the individual to seek better solutions and which lead to intellectual growth. The transition from one level in the formation of the intellectual structure to the next one occurs. The individual plays an important role in organizing his own experiences and in contributing to his own intellectual progress (Athey & Rubadeau, 1970; Palmer, 1970; Piaget, 1963, 1983; Thomas, 1992).

Physical Experience

According to Piaget, children are active seekers of meaning. They are born with curiosity to explore questions of values, feelings, meanings, and relations of self to others. Children's thought is action internalized. Thus, sensory and motor adaptation to environmental events is the main method by which the young child acquires intellectual understanding. Concrete objects are provided for perceptual knowledge and thus facilitate concrete operation. From direct manipulation, observation, and listening, the child generates logical thinking and knowledge of the properties of things and their functioning. Piaget stresses that it is not observation of the passive objects themselves that develops the child's logic or intelligence, but rather the set of conclusions that the child draws from his/her actions bringing about events and influencing objects (Athey & Rubadeau, 1970; Elkind, 1976; Kamii, 1982, 1990; Piaget, 1963, 1983; Thomas, 1992).

According to Vygotsky's sociocultural theory, knowledge is transmitted from adults or from more mature and experienced peers. These adults or tutoring peers are able to sense
changes and to recognize values in the culture. During the process of learning, the individual takes responsibility (i.e., self-regulation), which shifts gradually from the tutors (i.e., other-regulation).

Zone of Proximal Development

Vygotsky (1978) contends that through the use of cultural tools, the process of transition of human cognitive activities from other-regulation to self-regulation is affected by the individual’s zone of proximal development. The zone of proximal development is defined as the distance between a child’s actual developmental level and the higher level of potential development. The actual developmental level is determined by independent problem solving, whereas the level of potential development is determined through problem solving under adult guidance or in collaboration with more capable peers (Vygotsky, 1978).

From his observations of the interactions between mothers and their children during puzzle construction, Wertsch (1979) categorized four levels of this zone. At the first level in the transition from other- to self-regulation, the child’s understanding of the task is so limited that communication is difficult. Even though the adult may try to provide strategic assistance, the child may not be able to appropriately connect the adult’s utterances with the flow of the activity.

At the second level in the transition, the child seems to realize that the adult’s utterances are connected with the task in some coherent way and begins to participate successfully in understanding instruction. But the child’s understanding of the task is still far from being in complete agreement with the adult’s.

The child at the third level in the transition becomes able to function adequately in the other-regulation speech. He makes all the inferences needed to interpret an adult’s directives, which sometimes may be quite nonexplicit. The child has taken on a significant share of the strategic responsibility for the task.
At the fourth level, the child has taken over complete responsibility for the problem-solving effort. The process shifts from the interpsychological to the intrapsychological plane, and the transition from other- to self-regulation is complete. The further the transition from interpsychological to intrapsychological functioning in connection with problem solving, the less direct will be the connection between the external social interaction involved in other-regulation and the psychological processes involved in self-regulation.

According to Vygotsky and other sociocultural theorists, the learner is a social being who gradually becomes adept at using the tool provided by the culture to express his/her ideas (Vygotsky, 1978). The child’s effort in establishing and maintaining coherence between his/her own action and the adult’s instruction (speech) moves him/her from one transitional level to the next in the zone of proximal development. The child in the zone of proximal development must himself/herself create the coherence between instruction and action. The child comes to share the adult’s definition of situation because he/she carries out the task through other-regulation (Bruner, 1985; Vygotsky, 1978; Wertsch, 1979).

Communicative Speech

Because of the emphasis on instruction and on functional transmission, language is a tool with both a communicative function and a cognitive function. Through language, tutor and tutee make their thoughts known to one another and build a common understanding of their cognitive states. By using language, the child can internalize the concept (Bruner, 1985; Cole, 1985; McKeough, 1991; Vygotsky, 1978, 1987; Thomas, 1992; Wertsch, 1991). Vygotsky views teaching and learning as a social activity characterized by the transmission of speech. The speech of adults and of more competent peers plays a great role in guiding the learner in the task and in gradually leaving the responsibility of completing the task to the learner (Vygotsky, 1978, 1987; Wertsch, 1979, 1985).
The communicative speech shapes what can be transmitted and, consequently, what can be understood (Vygotsky, 1978, 1987). Thus, what is passed on to the child in the context of mediated learning is a product of the construction of specific meaning to a particular speech. In this way, the zone of proximal development is shaped by the nature of the social language and so is defined mutually by teacher and learner (Vygotsky, 1978, 1987; Wertsch, 1985, 1991).

In Vygotsky's (1978, 1987) view, the highly contextualized potential is tied to the developmental processes involved in the transition from social speech to egocentric and inner speech. Contextualized potential refers to the child's ability to complete the task with the assistance of the adult during the task, which the child may not be able to complete without help. At the beginning of the transition of mental functioning, social speech provides the individual assistance and guidance with which the individual is developing his/her own understanding of concepts. Egocentric speech, in contrast to Piaget's perspective, has a self-guiding function. After the transition of functioning is complete, the internalized concept takes the place of egocentric speech and becomes inner speech. From this transition, the individual develops his/her concepts from complexities. The move towards using cultural tools in a context to another similar or different context is what Vygotsky uses to explain conceptual development in the individual as tied to the social environment (Vygotsky, 1978; Wertsch, 1991).

The child, in Vygotsky's view, is gradually learning to use the cultural tools when he/she interacts with objects and people in the environment. Therefore, physical experience is essential during knowledge acquisition. From directly interacting, manipulating, observing, and listening, the child generates the relations between adult instructional speech and the task. The child may ignore the adult's attempts to assist at the beginning but gradually will understand the meaning of the speech related to the task. When the child understands the relations between adult
communicative speech and the task, he/she moves to a new function or conceptual system. As a result, he/she is able to use the internalized relation as a tool with which to solve problems or to complete tasks without assistance (Wertsch, 1979, 1985).

In summary, Piaget and Vygotsky agree that learning is a problem-solving process and that the child is an active problem solver. Their theories differ in terms of perspective on the learning process. Piaget focuses on the individual as the starting point; learning is a self-regulating process. Vygotsky, in contrast, focuses on the social basis of mind; learning is a process of transition of human functioning from other-regulation to self-regulation. Piaget believes that development occurs when the individual seeks equilibrium to balance the conflict between assimilation and accommodation. Vygotsky, however, argues that changes in thinking pattern occur as a result of understanding the relation between communicative speech and task. Both Piaget and Vygotsky emphasize that physical experience is essential for children to conceptualize understanding of the world.

Social Interactions

Although Piaget and Vygotsky differ in their perspectives on learning, they both believe that social interaction influences conceptual development. Both theories emphasize the importance of a common frame of reference in social interactions. Communication is based upon shared understanding with a common focus of attention and upon certain shared presuppositions. However, Piaget and Vygotsky have different views of the function of social interaction in learning.

Piaget and other cognitive developmental theorists believe that social interaction is important in that it reveals to and assists the child in what has not been perceived or learned. Social interaction plays a role in stimulating and maintaining the child's interest in seeking meanings. It constitutes a crucial source of opportunities to learn mathematics in that the process of constructing mathematical knowledge involves disequilibrium, reflection, and active

According to Piaget, mathematical knowledge cannot be taught directly. The research of Piaget and his colleagues has shown that number is something that each human being constructs by creating and coordinating relations (Piaget, 1965). Mathematical knowledge is learned when the child actively constructs relations between and among objects through his/her own actions. The child must put different elements of information (objects, events, and actions) into various relations.

Social interaction fosters change through the induction of cognitive conflict, and the logical operations carried out by children attempt to balance differing ideas to achieve equilibrium in understanding. Social explanation merely should displace the problem to stimulate equilibration. That is, the social interaction assists understanding only after the child has some experience with the imbalance of the situation or with the process of arriving at an acceptable explanation by himself/herself (Kamii, 1982; Piaget, 1973, 1983; Thomas, 1992).

Scaffolding

Vygotsky and other sociocultural theorists believe that assistance and guidance from adults or from more capable peers are essential to learning. Thus, social interaction is the major activity in passing on cultural values and hastening the alteration of mental function from other-to self-regulation. In the formal instructional setting, teaching involves a kind of scaffolding process enabling a child to solve a problem and to carry out a task or to achieve a goal usually beyond the child’s actual developmental level. This scaffolding involves the adult’s controlling the elements of the task within the zone of proximal development. The adult reduces the elements that are initially beyond the learner’s capacity and thus permits her to concentrate upon and to complete only those elements within the range of the child’s competence
(Vygotsky, 1978; Wood, Bruner, & Ross, 1976). The adult continues defining and redefining the task situation according to the child's understanding to make it possible for the child to become involved and to complete the job. When the child understands the relations between adult communicative speech and the situation of the task, he/she moves to a new function or conceptual system. As a result he/she is able to use the relation as a tool to complete the task without assistance (Bruner, 1985; McKeough, 1991; Vygotsky, 1978; Wertsch, 1979, 1985, 1991; Wertsch & Tulviste, 1992). For example, child candy sellers in Brazil with little or no schooling develop sophisticated mathematical abilities as the result of buying candy from wholesalers, pricing it in collaboration with adults and experienced peers, and bargaining with customers on city streets (Saxe, 1988).

In summary, both Piaget and Vygotsky believe that social interaction is as essential to the process of problem solving as to learning. In Piaget's view, development moves from the individual to the social. Individuals work independently to construct their own understanding. Social transmission occurs only after the child has some experience with the imbalance of the situation or with the process of arriving at an acceptable explanation by himself/herself. Social interaction can be used to display the problem. In Vygotsky's perspective, development moves from the social to the individual. Joint problem solving occurs between partners. Social transmission is expected to promote development through the guidance provided by interaction with people more skillful in the use of cultural tools.

**Peers and Adults**

In their views of social transmission, Piaget and Vygotsky attribute varying degrees of importance to the roles of adults and peers. Piaget (1926) believes that peer interaction gives rise to disequilibrium between companions of equal status. This cognitive conflict between peers can lead children to reconsider their ideas. Piaget states three conditions promoting disequilibrium in children's cognitive development. The first is that the partners have a common
scale of intellectual values, which allows them to understand terms in the same sense. The second condition is that when children try to justify their own propositions to their partners, they may encounter disequilibrium that otherwise may go unnoticed in their own egocentric thoughts. The third condition for disequilibrium is that there is reciprocity between partners so that their thoughts are treated interchangeably (Piaget, 1963, 1983; Rogoff, 1990).

Piaget argues that children's discussions with adults are unlikely to lead to cognitive restructuring because of the unequal power relations between adults and children. To Piaget, such interactions are essentially asymmetrical in that the adult has the power, and this disrupts the condition of reciprocity for achieving equilibrium in thinking (Piaget, 1963, 1983). Children tend to agree with adults' ideas without examining them; they do not learn to construct concepts or verify for themselves what they are taught. However, Piaget accepts the possibility that adults may be able to interact with children in a cooperative way to allow the reciprocity required for children to advance to new levels of equilibrium (Piaget, 1983).

For Vygotsky, social interaction facilitates cognitive development as apprenticeship (Rogoff, 1990; Silver, 1990). A novice works closely with an expert in joint problem solving in the zone of proximal development. Ideal partners are unequal, because inequality in skill and understanding promote the transition of mental functioning. Thus, interaction with either adults or peers can bring about cognitive growth, but cognitive development can occur during peer interactions only if one partner is more capable. Interaction, according to Vygotsky, is the means by which children begin to use the intellectual tools of their society. Thus the partner must be someone who knows more about the tools than does the child (Vygotsky, 1978; Wertsch, 1979).

Shared thinking, according to Vygotsky, provides the opportunity to participate in a joint decision-making process. From this process, children may decide appropriately what to contribute for later use. The child is assumed to be interested in gaining from the more expert
partner, who is seen as responsible for adjusting the dialogue to fit within the child's zone of proximal development. Understanding therefore is achieved with a stretch leading to growth (Rogoff, 1990; Vygotsky, 1978; Wertsch, 1979).

In summary, Piaget and Vygotsky differ in their views of the roles of adults and peers in children's learning. Piaget focuses on changes in perspective, from one view of a problem to another, based on his interest in understanding qualitative transitions in mathematical thinking. Vygotsky, in contrast, focusing on the use of cultural tools, addresses the importance of the partner's skill and competence in using intellectual tools (Rogoff, 1990).

Social interaction is not a source of processes to be internalized. Instead, it is the process by which individuals create interpretations of situations fitting those of others for the purposes at hand. Mathematical learning thus is viewed as an interactive as well as constructive activity (Steffe & Cobb, 1988; Yackel, Cobb, Wood, Wheatly, & Merkel, 1990). The individual child and the social partners are inseparable contributors to ongoing activities in the cultural setting (Rogoff, 1990).

Educational Implications: Learning with Meanings

True learning involves search for meaning (Piaget, 1963, 1983; Vygotsky, 1978). The purpose of early childhood mathematics education is to build a solid foundation on which children can construct mathematical knowledge now and in the future (Baroody, 1987; Baroody & Ginsburg, 1990; NCTM, 1989; Sonquist, Kamii, & Derman, 1970). To plan meaningful learning of mathematical knowledge for young children, it is necessary to consider the roles of teachers, peers, environments, manipulatives, experiences, and individual needs.

Role of Teacher

Although Piaget and Vygotsky have said very little about education, many educators apply their theories to mathematics education. Some theorists and educators, adopting both Piaget's and Vygotsky's perspectives, have proclaimed themselves socioconstructivists (e.g.,

**Connecting Children's Existing Ability and Knowledge**

The early childhood mathematics curriculum is influenced by teachers' decisions based upon what is known about the development of children's thinking and the thinking evidenced by individual children in the classroom (Campbell & Carvey, 1992; Davis et al., 1990). Teachers' understanding of mathematics and of mathematical learning in individuals and in social settings helps them make decisions regarding mathematics curriculum. Teachers' knowledge of their students' experience and existing knowledge helps them to match their use of teaching strategies with students' abilities, which promote students' learning (Steffe, 1990a, 1990b). With an understanding of what mathematics means to their students, what has already been learned, and what thinking processes the students have used, the teacher connects children's past experience and existing knowledge to new situations and reveals mathematics to children as a meaningful set of relations relevant to them. Effective teachers make their conversations rich with mathematics vocabulary to link children's experiences to mathematics and to make them aware of the existence of quantity and number in their everyday lives (Haugen, 1985). These teachers create opportunities for children to explore, to organize and to deepen self-understanding; they provide support to respond to children's spontaneous questions, suggestions, ideas, and interests (Cobb et al., 1990; Steffe, 1990a, 1990b).

Cobb and his colleagues (1990) conducted a mathematics teaching experiment in a second-grade classroom; this experiment focused on what the child might be thinking. The researchers visited the classroom each day to videotape both small-group work and whole-class discussion. The instructional activities were developed in the course of the experiment on the
basis of ongoing observations of children's mathematical activity. Teachers' classroom practices and ways of interacting with students changed throughout the experiment. The better the teachers understood their students' experiences and problem-solving skills, the more they could scaffold the situation to allow children to construct mathematical understanding. These findings support the notion that the teacher's role in children's mathematics education is to connect children's existing skills and knowledge to new situations and events (Campbell & Carvey, 1992; Carpenter & Fennema, 1991; Cobb et al., 1990; Davis et al., 1990; Forman & Fosnot, 1982; Steffe, 1990a, 1990b; Steffe & Cobb, 1988; Yackel et al., 1990).

**Stimulating Thinking**

Teachers' strategies for stimulating children to think while constructing mathematical knowledge are essential to keeping children attentive and interested in learning. Effective teachers are those who can stimulate students to learn (National Research Council, 1989). They may create situations that invite children to use reasoning. They may induce conflicts and present problems to stimulate children to become involved in problem solving (Forman & Fosnot, 1982).

Effective teachers may tailor the components of the activity to allow children to participate at their own level. They facilitate mathematical discussions between students and act as participants in moving mathematical activities to the goal of learning. When the child encounters difficulty, the teacher may reveal other views for him or her to use in rethinking the problem or may suggest that he or she focus on what can be understood (Vygotsky, 1978).

**Encouraging Problem Solving**

Wood and his colleagues (Wood, Bruner, & Ross, 1976) studied the adult's role of tutoring in a problem-solving task. Thirty children, ages 3, 4, and 5, divided equally among three age groups, were accompanied by their parents. The task was to use 21 blocks, in various shapes and sizes, to form a pyramid. Each child was invited to play with the blocks
without any idea of what the blocks might look like when put together. A tutor was trying to verbally adjust the child’s behavior to support the needs of the individual child to complete the task. This study demonstrated that adults sensitively tailored support of children’s efforts according to the children’s skill. The younger children (3-year-olds) needed more help than the older children did in maintaining their interest in the task and in completing the goal and needed more direct assistance in the task. With the 4-year-olds, the tutor tended to help them recognize the nature of the discrepancy and what the task required. With the 5-year-olds, the tutor acted more as a confirmer or as a checker of constructions. The adults’ support of scaffolding as in the strategies described above helped children advance.

Supporting Children’s Active Learning

Many studies have shown that teachers’ support and care create an environment in which children feel comfortable exploring objects and sharing thoughts (Bredekamp & Rosegrant, 1992a, 1992b; Carpenter & Fennema, 1991; Cobb et al., 1990; Confrey, 1990; Davis et al., 1990; Goldin, 1990; NCTM, 1989, 1991; National Research Council, 1989; Steffe, 1990a, 1990b; Yackel et al., 1990). Children’s attention and skill with objects can be influenced by adults’ highlighting events during social interactions. Henderson (1984) has shown that adults’ active and supportive involvement in children’s exploration of new objects led to more exploration by young children than did the adults’ simple presence.

Henderson (1984) studied the exploration of 97 children, 3 to 7 years of age, in independent and adult-supportive sessions. Children were identified as high-, medium, or low-exploratory on the basis of a pretest task. Each child then participated in an independent session and in a supportive session with an adult. The supportive sessions were of two types; the adult either stressed close attention and showed active interest in the child’s exploration or modeled and gave directions to the child. The results of this study indicated higher levels of questions, manipulations, and time explorations in both types of supportive sessions than in
independent sessions. Children made more manipulations and spent more time exploring under the focused supportive condition. These results are consistent with Vygotsky's concept of the zone of proximal development; additional exploratory potential was revealed in children beyond their independent performance when a minimal, unintrusive level of coordinated social support was provided. Thus teachers' attention to and interest in children's activities or their supportive behaviors expand children's potential to actively explore the environment.

However, teachers must foster a belief that they are not the only mathematics authorities in the classroom. Children should not be taught to appeal to their teachers as sources of correct answers (Kanold, 1990; Yackel et al., 1990). A model of instruction suggested by Confrey (1990) includes four techniques to involve students effectively in mathematics learning: questioning student answers, whether right or wrong; encouraging students to give reasons for their answers; helping children start in a potentially productive direction; and encouraging children to evaluate their own success. In reviewing the studies of teacher behavior and student achievement, Brophy and Good (1986) have concluded that in either small-group situations or whole-class instruction, teachers' active and supportive involvement promotes children's active learning.

In summary, to facilitate mathematics understanding, teachers of young children must understand children's ability and knowledge as well as how children acquire mathematics knowledge. Teachers provide opportunities for children to explore freely and to experience success; they also stimulate mathematical thinking by presenting conflicts or asking questions. They encourage children to participate in activities and demand that children be cognitively active in constructing their own knowledge. In these ways, teachers facilitate children's exploratory behavior in the environment.
Teacher's Cognitive Distancing Strategies

To facilitate children's construction of mathematical knowledge, teaching strategies must stimulate children's mathematical thinking (NCTM, 1989, 1991; Piaget, 1983; Vygotsky, 1978). From Piaget's (1983) perspective, the teacher's role is to provide opportunities for children to explore and to seek equilibrium to balance the conflict between assimilation and accommodation. Teachers' teaching strategies can bring children into conflicting situations that demand the children's active mental operations to connect concrete experience with abstract representation and to construct new understandings of the world around them. From Vygotsky's view (1978), teachers' interactive and communicative strategies bring about change in children's thinking patterns and help children to achieve social expectations. Through interactions, children are encouraged to construct new understandings of the relations among objects, people, and events; their zones of proximal development are expanded. By presenting cognitive conflicts and through scaffolding, the teacher demands that children operate in a manner that is mentally active. Based on both Piaget's and Vygotsky's theories, Sigel's model of distancing teaching strategies is effective in facilitating children's construction of links between concrete experiences and abstract concepts (Coppie, Sigel, & Saunders, 1984; Sigel, 1970, 1986, 1990).

According to the distancing model, the creation of distance between the individual and the object requires the individual to represent an experience. During the process of representation, the individual distances self from the here and now. The experience is transformed into a representation through existing knowledge or through anticipation of intention (Sigel, 1970, 1986, 1990). Such an experience leads to the development of abstract knowledge. "Distancing is proposed as the concept to denote behaviors or events that separate the child cognitively from the immediate behavioral environment" (Sigel, 1970, p. 110). Cognitive distancing is a way to "characterize differentiation of the subjective from the
objective, the self from others, ideas from actions" (Sigel, 1970, p. 113). By using distancing strategies, the teacher challenges the child to think in the nonpresent. The child is given opportunities to seek the multiple attributes of an object and the alternative actions so as to interact with objects that lead to alternative means of problem solving. In addition, the child comes to know that ideas, objects, and events can be presented in various media or symbols. Most importantly, the child is engaging actively in reconstruction of anticipation experiences while transcending the immediate present (Copple et al., 1984, Sigel, 1970, 1986, 1990).

Sigel categorizes his model of distancing strategies into three levels of mental operational demand. Low-level distancing occurs when the child is required to label, to produce information, to describe/define, to demonstrate, and to observe. Medium-level distancing occurs when the child is required to sequence, to reproduce, to describe/infer similarities and differences, and to classify. High-level distancing occurs when the child is required to evaluate, generalize, conclude, plan, and solve problems (Copple et al., 1984; Sigel, 1970, 1986, 1990). A great number of these distancing strategies have been identified during parent, teacher, and peer interactions (Copple et al., 1984; Pellegrini, Brody, & Sigel, 1985; Pellegrini, McGillicuddy-Delisi, & Sigel, 1986; Pellegrini, Perlmutter, Galda, & Brody, 1990; Sigel, 1981, 1986, 1990).

Sigel and his colleagues have demonstrated that teachers’ distancing strategies relate to children’s representational competence and achievement in mathematics and in reading (Cataldo, 1977; Rosner, 1978; Sigel, Secrist, & Forman, 1973). In their experimental preschool programs, disadvantaged children aged 2 1/2 to 4 1/2 were enrolled with teachers trained to use distancing strategies. These programs emphasized using distancing strategies as the basic teaching strategies and transforming experience into various representational modes (e.g., motor action into a picture, or a picture into a story about dealing with symbols). It was said that these educational programs dealt with both internal representations and their externalization (Cataldo, 1977; Rosner, 1978; Sigel, 1981; Sigel, Secrist, & Forman, 1973).
Children enrolled in the distancing programs performed at significantly higher levels on tasks involving anticipation of consequence, reconstruction, and understanding of causal relations (Cocking, 1977; Sigel et al., 1973). For example, children in distancing programs demonstrated better comprehension and production skills in expressing future and past events, as measured by the frequency of use of future and past tenses in sentences (Sigel et al., 1973). These skills were considered indications of distancing competence because they required children to think beyond here and now. Cocking (1977) demonstrated similar results; children in distancing programs performed at a higher level on comprehension and use of past time, causal connectives, and conditionals than children in traditional preschool programs. Children in the distancing program also were found to exhibit more self-naming and planning than children in the nondistancing programs (Cocking & Copple, 1979).

Using Piaget's conservation tasks to assess children's mathematical understanding, Sigel and Cocking (1977) found that children in distancing programs demonstrated greater competence in anticipating consequences and predicting outcomes of transformation than did children in regular programs. In addition, more children in the distancing programs than in the comparison programs were able to provide appropriate predictive statements.

Two years after leaving the program at the end of first grade, children in distancing programs were performing at a higher level in reading and mathematics on the Stanford Early School Achievement Test, when compared with the children in control group. Children from distancing programs were described by their first-grade teachers as "having strong language skills, being talkative, having some generally positive academic qualities, such as being academically oriented, constructive, and enjoying science-types of activities, and they were seen as being happy" (Cataldo, 1977).

Pellegrini et al. (1986) studied parents' teaching strategies with their young children in 120 families. Each family included a target child, a mother and a father; 60 families had a
communicative handicapped (CH) child, and 60 matched families had a noncommunicative handicapped (NCH) child between the ages of 3 years, 6 months and 5 years, 8 months. Parents engaged in a book reading and a paper folding task with their target child. Parents' teaching strategies were recorded and categorized according to the levels of cognitive demand, and each child's level of task engagement was rated. Data indicated that parents' teaching strategies varied according to children's communicative status and the tasks in which they were engaged. Parents tended to be more directive and less demanding with CH children than with NCH children. Parents of CH children used more of the following strategies: nonverbal management, low demand, conversational management, turns, and time. Parents of NCH children, on the other hand, used more high- and medium-cognitive distancing strategies. This study supports Vygotsky's theory that adults teach children through the zone of proximal development. Parents adjust their teaching strategies to children's level of competence in specific tasks. The result also indicated that parents' teaching strategies varied according to task. That they used less didactic strategies with their children in the book-reading task than in the paper-folding task further supports the theory of zone of proximal development.

In another study on mothers' behaviors in book reading with young children (ages 3 years, 7 months to 5 years), Pellegrini et al. (1990) reported similar results, namely that mothers used different teaching strategies in reading different genres of books. Mothers generally used more teaching strategies in reading expository books than in reading narrative books. These researchers also found that children's participation level was greater around the expository than around the narrative texts. Mothers who showed more competency in the familiar context (familiar expository book) used more high cognitive distancing strategies with their children. Mother's use of high cognitive distancing was positively related to their children's participation in the task.
Peer Interactions

Immediate feedback facilitates the construction of mathematical knowledge (Baroody & Ginsburg, 1990; Davidson, 1990; Kamii, 1982; Kamii & DeVries, 1980). Social interactions provide support for mathematics learning and offer opportunities for success for all students in mathematics. In addition to interactions with the teacher, peer interactions should be encouraged so that exchange of ideas can take place in social settings, such as in informal small groups formed by children themselves or assigned by the teacher. Researchers have demonstrated that children learn mathematics better when working in small groups that promote cooperation on tasks and expression of thoughts (Cobb, Yackel, & Wood, 1992; Yackel et al., 1990; Yackel, Cobb, & Wood, 1991).

Mathematics problems usually are ideally suited for discussion and often can be solved by several different approaches (Davidson, 1990). Discussion has a scaffolding role in relation to specific tasks or understandings. During discussions, different perspectives are presented, and children are encouraged to reconsider ideas to balance cognitive conflict; thus opportunities are offered for creative thinking (Davidson, 1990, Piaget, 1963). Because they share cognitive status, children can share ideas and understand each others' thinking with relative ease (Piaget, 1963, 1983; Rogoff, 1990). Students working in social settings can help one another master basic facts and necessary procedural knowledge and skills. Moreover, working with peers promotes discussion, listening, explanation, and thinking with others, which in turn helps individuals construct personal understandings of mathematics. The opportunity to articulate one's thoughts helps one organize ideas (Vygotsky, 1978, 1987).

Perret-Clermont (1980) studied 100 6-year-old children in Geneva with respect to their understanding of the concept of conservation of quantities of liquid. According to the pretest on their understanding of conservation, children were divided into three groups: conservers, intermediates, and nonconservers. Two to 3 weeks after the pretest, groups of three children
were gathered together to do the conservation task. Among them, two had been nonconservers and the third either a nonconserver or an intermediate on the pretest. Each task required approximately 10 minutes and included social interactions in which children helped one another get the same amount of juice. The posttest indicated that social interactions facilitated the process of understanding of conservation by nonconservers and intermediates. Perret-Clermont suggested that the clashes of opinions and efforts to resolve disagreements can stimulate preoperational children to form new relationships and to reason at a higher level than they would have otherwise.

Social interactions that promote learning are presumed to be based on cooperation and are focused on children’s shared interest and understanding. Piaget (1963) questions the usefulness of social interactions at school that place priority on the authority of the teacher and on primarily verbal transmission. He believes that these social interactions lead to perversion of thinking in the direction of simple, collective, obligatory beliefs. It may be more important for children to see others’ perspectives and to accept alternative solutions. For example, children in a small group need to share an interest in solving problems and in paying joint attention (Piaget, 1963, 1983; Rogoff, 1990; Vygotsky, 1978; Wood et al., 1976).

Yackel et al. (1991) used small-group problem-solving strategies for all aspects of second-grade mathematics instruction for an entire school year. Thirty teachers and their second graders were involved. Based on analysis of clinical interviews and on models of early number learning, researchers developed instructional activities to present problem-solving situations for the children paired for small-group problem solving at the request of the teacher. During small-group work, the teacher was involved actively with the children from one group to the next, observing and giving necessary intervention or support by encouraging cooperation and collaborative dialogue and by discussing the children’s attempts to generate solutions. Typically, small-group problem-solving sessions lasting 20 to 25 minutes were followed by 20
to 25 minutes of whole-class discussion. The rest of the hour of class time was used for introducing activities or for other whole-class activities. Data collection was through classroom observations, field notes, and notes made during review of videotapes.

Cobb et al. (1992) found that children attempted to accommodate their own mathematical understanding to those of others when working in small groups. In short, they were trying to interpret the other children's statements or approaches to the problems. An interesting example of the discussion between a pair of boys illustrated a form of collaboration. Each of the two developed his own solution methods and did not attempt to achieve a mutually acceptable solution. Through the discussion, neither child seemed to attend to the explanations given by the other. Yet each child's final conceptualization of the task was influenced crucially by something the other said. Cobb et al. thus concluded that small-group problem solving yields opportunities for learning that do not typically occur in traditional classrooms and that include opportunities for collaborative dialogue and mutual construction of classroom norms for cooperative learning.

Activities set up in the environment can either facilitate or hinder interactions among children. For example, puzzles are not as helpful as legos or blocks in encouraging social interactions, and peer interactions occur more frequently at dramatic play centers than at art table (Griffing, 1983). Teachers can arrange small-group activities so as to encourage social interactions. When placing children in small groups, the teacher must consider that the children need to cooperate to solve the problem and that they should reach a consensus but that it is not necessary that peers in the same group be at the same level of cognitive development. Slight differences in cognitive development of peers may facilitate equilibration (Piaget, 1963, 1983; Rogoff, 1990; Vygotsky, 1978; Wood, et al., 1976).
**Problem-Solving Environments**

To promote children's active construction of mathematical knowledge, early childhood mathematics activities should be presented in an environment that promotes learning through exploration and through the accompanying interaction among peers and adults. In a review of research on children's mathematical knowledge, Kamii (1982) concluded that the environment can speed up or retard development of mathematical knowledge. Children exposed to environments demanding mathematical thinking generally develop faster than do those in less demanding environments. Children should be encouraged to put objects, events, and actions into relations (Kamii, 1982). A stimulating environment invites children to learn mathematics and encourages them to communicate ideas. Activities for young children can be designed to engage children in problem solving. As Piaget (1983), and other educators (Cobb et al., 1992; Kamii, 1982; Sigel & Saunders, 1979; Sigel, et al., 1973) have suggested, good problems force children to attempt solutions. Providing opportunities for children to make decisions promotes the construction of relations (Williams & Kamii, 1986). Communication in the classroom also fosters children's development of patterns of verbal communication as they talk about mathematics and allows teachers to learn about their students' thinking. Children need opportunities to exchange viewpoints with peers, and talking about mathematical ideas helps children clarify and modify their own concepts and those of others (Campbell & Carvey, 1992).

**Manipulatives**

Mathematical learning involves active construction of meaning. The use of concrete models to facilitate young children's mathematical thinking has been accepted as an appropriate teaching strategy (Baroody, 1987; Dougherty & Scott, 1993; Kamii, 1982, 1990; Sonquist et al., 1970). Young children first construct mathematical knowledge from their perceptions of objects and from their actions upon them (Kamii, 1982, 1990; Piaget, 1965, 1983). Children understand relations between/among objects by what they perceive, and by acting on objects.
Psychologically, it is impossible for young children to separate physical from mathematical knowledge. Physical knowledge is acquired when children handle objects and observe how they react. Manipulative materials refer to those objects, materials, and pieces of equipment with which children can interact by themselves. Blocks, legos, puzzles, sand, and water are examples of some of the numerous manipulative materials that can be used to facilitate opportunities for interacting with materials. The use of manipulative materials, along with diagrams and/or symbols to characterize desired mathematical relations or concepts, is especially meaningful to the child (Baroody, 1987; Campbell & Carvey, 1992; Charlesworth, 1984; Kamii, 1982, 1990; Piaget, 1973, 1965, 1973, 1983).

Researchers (e.g., Gelman & Meek, 1983, 1986; Sophian, 1988) have studied children's mathematical knowledge in relation to Piaget's quantity conservation tasks. They have demonstrated that preschool children showed relatively good understanding when concrete objects are used in context. Other researchers demonstrated similar findings and suggested that, because mathematics is so abstract, it is difficult for children to understand without depending on concrete objects or concepts (Hughes 1981, 1983; Larson & Slaughter, 1984).

Larson and Slaughter (1984) studied nine Title 1 teachers and their second- to fifth-grade students who scored below the 17th percentile on a mathematics test. Teachers were taught to use manipulatives for instruction, and students were shown how to use such manipulatives. For example, egg cartons and beads were used for conceptualizing numerical operations such as multiplication and division. The findings indicated that low mathematics achievers had difficulty with the vocabulary traditionally used in mathematics textbooks and that they were more successful doing manipulative activities than doing other mathematics learning-related activities.

An environment promoting mathematics learning provides concrete materials and stimulates activities for children to explore. Children are free to explore activities and
encouraged to interact with peers or adults. It is important that the teacher does not tell children how to act on the object or how one object relates to another (Williams & Kamii, 1986). Teachers should feel comfortable giving children time and opportunities to internalize concepts from their own observations as well as from cognitive conflicts with others' ideas.

**Computers and Calculators**

Although controversial, use of calculators and computers for kindergarten to fourth grade has been recommended as essential in the school mathematics curriculum (NCTM, 1989; National Research Council, 1989). The NCTM (1989) suggests that:

The K-4 curriculum should make appropriate and ongoing use of calculators and computers. Calculators must be accepted at the K-4 levels as valuable tools for learning mathematics. Calculators enable children to explore number ideas and patterns, to have valuable concept-development experiences, to focus on problem-solving processes, and to investigate realistic applications. The thoughtful use of calculators can increase the quality of the curriculum as well as the quality of children’s learning. (p. 19)

Research has indicated that the use of technology benefits children’s learning of mathematics when a teacher understands how the activity in question supports curricular goals and connects that activity to other instructional outcomes (Office of Technology Assessment, 1988).

Use of calculators by young children in elementary schools has been proved to support the constructivist view that a calculator can aid mathematics learning (Von Glasersfeld, 1990; Wheatley, Clements, & Battista, 1990). Furthermore, no harmful effects have been reported from working with computers in preschools or kindergarten. Children perceive the computer as one more interest center, with no more appeal than any other center in the classroom (Fein, Campbell, & Schwartz, 1987; Lipinski, Nida, Shade, & Waston, 1986). Other researchers found that use of computers promoted problem solving (King, 1989) and concept learning, such as understanding geometry concepts (Clements, 1989). Most of these studies were done with elementary school children. For example, King (1989), who studied verbal interaction and problem solving within computer-assisted cooperative learning groups of 36 fourth graders,
reported that using computers encourages children to ask task-related questions and helps them clarify the meaning of problem concepts and relations among concepts.

**Personally Meaningful Experience**

Development is largely a process of becoming able to internalize information and to construct relations. It may be through repeated experience in supported routines and challenging situations that children become skilled in specific cognitive process. Curricula focusing on problem solving require resources for realistic, engaging problems. The best resources are the experiences of children, either planned experiences occurring within the school setting or experiences from outside the classroom that are common to all the children. Personally meaningful experiences encourage thought (Baroody, 1987; Baroody & Ginsburg, 1990; Carpenters Fennema, 1991; Davis et al., 1990).

Young children spend a great amount of time in settings other than the school environment. The use of everyday life experiences is essential to the connection of existing knowledge with new learning activities. Teachers can use children’s commonly shared experience to lead them to a problem-solving situation or to link their informally learned mathematical knowledge to the formal mathematics taught at school (Baroody, 1987; Baroody & Ginsburg, 1990; Davis et al., 1990; Resnick, 1989).

Teachers also can enrich children’s experience in school by providing various materials, objects, and activities and by creating situations to evoke children’s interest in using what they know to construct their own understanding. Teachers must carefully design situations reflecting children’s past experience and existing knowledge to involve children’s active participation in problem solving. This is especially true for young children, because they are developing symbolic representations and decontextualizing from concrete and physical knowledge to abstract and logical thinking (Copple et al., 1984; Piaget, 1965, 1983; Sigel, 1986, 1990).
Planned Activities as Self-Directed Learning Opportunities

To develop basic number concepts that facilitate acquisition of mathematical knowledge, young children need to be encouraged to participate actively in mathematics-related activities and to construct mathematical knowledge by themselves (Baroody, 1987; Castaneda, 1987; NCTM, 1989). The National Council of Teachers of Mathematics (1989, 1991) recommends that the curricula of mathematics education for children from kindergarten to fourth grade actively involve children in a wide range of mathematics-related activities, including computation, communication, connection, estimation, and measurement. Further, mathematics education needs to help children understand geometry, time, space, statistics, and probability. Mathematics education for young children also needs to help them recognize patterns and, subsequently, to construct relations. In short, varied mathematics-related activities need to be scheduled on a daily basis to involve children actively (Baroody, 1987; Baratta-Lorton, 1976; Castaneda, 1987; Chenfeld, 1983; Kamii, 1982; NCTM, 1989).

During presentation of activities, it is essential to provide many possibilities for children to construct relations and concepts in various ways at the level of their understanding. Activities with many possibilities are open ended; they provide many degrees of freedom and encourage children to explore by different methods. Open-ended activities give children a secure base from which to seek their own answers in their own way, without fear of mistakes. Children themselves decide which activities they want to engage in and how they want to work with the materials and the objects provided (Forman & Fosnot, 1982; Katz & Chard, 1989).

It is important that teachers respond to children's initiatives and support them. Verbal expressions describing what children are doing (Gelman & Greeno, 1989) as well as revealing conflicts or problems (Davis et al., 1990; Piaget, 1983; Sigel, 1986, 1990) promote children's construction of relations. Teachers must reduce their authority as adults when participating in children's activities. The teacher's role during interacting with children is to present the
situations that call for children's attention and to maintain the children's interest by discussing and asking questions without being judgmental. Social interactions like this at free play time facilitate exchanges of perspectives and alternative solutions.

**Play and Games**

Play is spontaneous and voluntary. It is self-generated and involves active engagement on the part of the player, who enjoys doing it (Garvey, 1977). All children's activities should be presented in playful manners because children's cognitive growth occurs through active interaction with objects, people, and environments (Piaget, 1963). When engaged in play, children are motivated intrinsically. From physical interaction with objects to symbolic play, children develop the ability to represent absent object or experience through their own actions. Play gives children the opportunity to explore alternative steps in the process of constructing relations and to acquire a relaxed attitude towards tasks (Forman & Fosnot, 1982).

With some understanding of rules, children then engage in playing games with others (Kamii & DeVries, 1980; Piaget, 1967). Games can provide an interesting and meaningful way of learning for children to explore mathematical knowledge in practical situations in which they internalize mathematical concepts by observing, encountering disagreement, and following rules with other players. Children care about the score and supervise each other when involved in games, which give them immediate feedback. Games also involve social interactions, which promote secure relationships between adults and children by reducing adult power (Baroody, 1987; Baroody & Ginsburg, 1990; Hughes, 1981, 1983; Kamii, 1982, 1990; Kamii & DeVries, 1980; Larson & Slaughter, 1984).

In the study of Larson and Slaughter (1984), Title 1 teachers introduced mathematics learning-related games in addition to using manipulatives for instruction. Whether games were related to the topics of instruction or not, they benefited the low mathematics achieving students, who in turn showed great interest in playing games and actively engaged in
calculating the results of the games while watching or modifying the rules. Children's abilities and understanding of mathematical concepts were reflected during play, and teachers had opportunities to see expected and unexpected problems of their students.

Playing games encourages children to be active problem solvers when they trust adults (Davis et al., 1990). Group games also provide opportunities for children to take different points of view. During group games, children are highly motivated to be alert, curious, critical, and confident in their ability to solve problems and to communicate their ideas (Baratta-Lorton, 1976; Baroody, 1987; Baroody & Ginsburg, 1990; Chenfeld, 1983; Hughes, 1981, 1983; Kamii, 1982, 1990; Kamii & DeVries, 1980).

Hughes (1983) introduced simple arithmetical symbolism to preschoolers through the use of games. Subjects were 20 4-year-old children attending nursery school in Edinburgh. Ten were from lower class families; the other ten were from middle-class families. Symbols used were commercially available magnetic numerals (1, 2, 3, ...) and operator signs (+, -). The children played games in which they learned that numeral "2" on the lid of a box meant there were two bricks in the box. Through the game, the children later might learn that "2 + 1" on the lid meant that a further brick had been added to the box, making three bricks together. The results indicated that most 4-year-old children were able to understand and to use simple forms of arithmetical symbolism. All children in this study, whether from low-income or from middle-class families, were able to use numerals to represent quantities of objects, either symbolically or iconically, and they all grasped the idea that operator signs could be used to indicate which box had been added to or subtracted from. Hughes (1983) concluded that the children understood mathematical concepts presented through games that they found enjoyable and interesting. The introduction of symbols through the games provided children with a clear rationale as to why the symbols were being used.
Kamii and DeVries (1980) have collected and developed excellent mathematical games for children. For example, in one of the card games, all cards are dealt upside-down to two players. Each player then turns over the top card of his/her stack, and the person who has the bigger number takes both cards. For the more advanced children, the game can be changed to double contest, in which each player turns two cards and compares the total of those two cards with the total of the opponent’s two.

**Individual Appropriateness**

Each child is a unique person, with his/her own personality and individual pattern and timing of growth, and individuals therefore differ in terms of learning style as well as family background. What may be obvious to one may be abstruse to another. Therefore, understanding and meaningful learning depend upon individual readiness. Teachers who understand child development are flexible in their expectations about when and how children will understand certain concepts or relations. In the process of children's active and constructive learning, individual differences should be encouraged and developed. It is essential that a variety of methods be used to stimulate learning and to create an environment responsive to children's individual needs and interests (Baroody, 1987; Bredekamp, 1986; Katz & Chard, 1989: Piaget, 1965, 1983).

Curricula and activities should take into account individual differences in terms of learning ability, interest, existing knowledge, past experience, approach, and pacing. Teachers must use their knowledge of child development to identify the range of appropriate behaviors, activities, and materials for the individuals or for a specific age group. Teachers must, therefore, be responsive to individual children’s initiatives, questions, reactions, and attentions. For these reasons, activities and materials should be provided for a wide range of developmental interests and abilities. Such activities can be prepared to meet the needs of children exhibiting unusual interests and skills outside the norms of development while serving other children
appropriately as well (Bredekamp, 1986). For example, the National Association for the
Education of Young Children (Bredekamp, 1986) suggests that programs serving children ages 3
to 8 need to provide books of varying length and complexity; puzzles with different numbers
and sizes of pieces; games requiring a range of skills and abilities to follow rules; and other
diverse materials, teaching methods, and room arrangements.

Overall, mathematics education for young children is learning with meanings. Teachers
provide opportunities for children to explore in ways that best fit them as unique individuals and
as members of groups. Although the construction of mathematical understanding is not
teachable, various activities and interactive skills can stimulate children's active thinking and can
develop their positive attitudes towards mathematics. Through such activities, children may
perceive mathematics as valuable in their everyday lives. Based on early nonfailure experiences,
children are able and willing to tackle more advanced mathematics.

References Cited

Educational implications of Piaget’s theory (pp. xiii-xxi). Waltham, MA: Ginn-Blaisdell.


preschool, primary, and special education teachers. New York: Teachers College, Columbia
University.

Davis, C. A. Maher, & N. Noddings (Eds.), Constructivist views on the teaching and learning
of mathematics (pp. 51-64). Reston, VA: National Council of Teachers of Mathematics.


Bredekamp, S. (1986). Developmentally appropriate practices in early childhood programs
serving children from birth through age 8. Washington, DC: National Association for the
Education of young children.

Bredekamp, S., & Rosegrant, T. (1992a). Guidelines for appropriate curriculum content and
assessment in programs serving children age 3 through 8. In S. Bredekamp, & T. Rosegrant
(Eds.), Reaching potentials: Appropriate curriculum and assessment for young children (Vol.


LITERATURE REVIEW ON KINDERGARTEN MATHEMATICS EDUCATION:
A BRIDGE CONNECTING INFORMAL AND FORMAL MATHEMATICAL KNOWLEDGE

Introduction

Most people agree that going to kindergarten is a milestone in formal school education. It is important to understand what children already know before they enter kindergarten and how kindergarten facilitates children's development and their understanding of mathematics. This paper, a review of current kindergarten education, discusses kindergarten classroom practices and mathematics education.

Children's mathematical knowledge is developed in two ways: through their own construction and by systematic instruction. The self-constructed informal mathematical knowledge is developed by children themselves (Baroody, 1987; Baroody & Ginsburg, 1990; Song & Ginsburg, 1987), whereas children gain formal mathematical knowledge through instruction or formal education (Baroody, 1987). It is essential that children learn to connect their informal knowledge with the mathematics taught at school to enable them to value mathematics and use it as a tool in solving their everyday problems.

Informal Mathematical Knowledge

Before their formal education begins, children acquire a certain amount of mathematical knowledge. Quantity concepts are encountered as soon as children begin to become involved actively in mathematical knowledge; even 6-month-old infants perceive the difference between sets of one and two, two and three, and three and four (Starkey & Cooper, 1980). Within a limited range, such infants are able to recognize exact differences in how many units or repetitions they have experienced (Starkey, Spelke, & Gelman, 1983).

Before entering school, young children learn a good deal of informal mathematics through interacting with adults, peers, and their environments and through watching TV and playing games. Research has shown that before formal schooling begins, most children possess
informal mathematical knowledge developed from their perception of the physical world. This informal knowledge includes both conceptual and procedural knowledge of mathematics (Charlesworth, 1984; Frye, Braisby, Lowe, Maroudas, Nicholls, 1989; Gelman & Gallistel, 1978; Gelman & Meck, 1986; Ginsburg, 1982; Piaget, 1965; Sophian, 1988). They can discriminate a small set from a large set using small quantities. Young children know that "I have more marbles than Jimmy does," "Danny has more juice," etc.

Children first have to establish the number concept or a number sense from their understanding of the world (Charlesworth, 1984; Gelman & Gallistel, 1978; Gelman & Meck, 1986; Sophian, 1988). They acquire considerable knowledge about counting as well as about other types of mathematical understanding (Gelman & Gallistel, 1978; Kamii, 1982; Piaget, 1965). For example, they possess some simple notions of more or less (Gelman & Meck, 1983; Sophian, 1988), counting, and adding (Gelman & Gallistel, 1978; Ginsburg, 1982; Sophian, 1988).

Gelman and associates (Gelman & Gallistel, 1978; Gelman & Meck, 1986) have demonstrated that children as young as 3 or 4 years of age implicitly know the key principles that allow counting to serve as a vehicle of quantification. Preschoolers develop preliminary notions and skills related to addition and subtraction with five principles: (1) the one-to-one principle (every item in a display is tagged with one and only one unique tag), (2) the stable order principle (the tag must be in the same sequence across each trial), (3) the cardinal principle (the last tag used in a count sequence is the symbol for the number of items in the set), (4) the abstraction principle (any kind of object can be collected for purposes of a count), (5) the order-irrelevance principle (the objects in a set may be tagged in any sequence as long as the other counting principles are not violated).

Based upon informal mathematical knowledge of magnitude and equivalence of number, young children’s imprecise and concrete mathematical knowledge gradually becomes more
precise and abstract (Baroody, 1987; Piaget, 1965). Because learning involves building upon previous knowledge, informal knowledge plays a key role in the meaningful learning of formal mathematics, which is taught in school, which uses written symbols, and which can extend children's ability to deal with quantity (Baroody & Ginsburg, 1990). Children develop and apply informal mathematics to formal mathematics tasks because informal mathematics is personally meaningful, interesting, and useful (Baroody, 1987; Baroody & Ginsburg, 1990; Resnick, 1989).

It also has been suggested that children have their own unique ways of constructing mathematical knowledge and that, however mathematical skills, symbols, and concepts are introduced in school, young children tend to interpret and to deal with formal mathematics in terms of informal mathematical knowledge that makes concepts personally meaningful to them (Baroody, 1987; Hiebert, 1984).

Early mathematical understanding is the foundation on which children construct new knowledge. Based upon this informally acquired knowledge, children become able to understand and master school-taught mathematics (Baroody & Ginsburg, 1990; Hiebert, 1984; Piaget, 1965, 1983; Resnick, 1989). Thus, the roots of mathematical understanding extend back to early childhood, and later successful school instruction builds upon this informally learned knowledge. Therefore, mathematics education on the one hand should enhance children's early learning experiences and on the other hand should exploit informal strengths to connect new concepts with early learned knowledge (Baroody, 1987; Baroody & Ginsburg, 1990; National Council of Teachers of Mathematics [NCTM], 1989; Resnick, 1989).

Early Childhood Mathematics Education

Because educators and policy-makers are seeking to reform and revitalize mathematics curricula and instruction, changes in mathematics education must begin in the early childhood years (Campbell & Carvey, 1992). Kindergarten is perceived as the first experience in formal education for most children. When mathematics is introduced in kindergarten in such a way
that it is perceived as meaningful, understandable, and challenging, a child experiences its power. An early childhood mathematics curriculum should include a "broad range of content, emphasize the application of mathematics, be conceptually oriented, actively involve children in doing mathematics, and emphasize the development of children's mathematical thinking and reasoning abilities" (National Research Council, 1989, pp. 18-19). Mathematics education in kindergarten should be designed to develop children's mathematical concepts as well as to connect children's informal mathematical knowledge, learned from their concrete experiences, to systematic ways of thinking and problem solving. Thus, children's active participation in mathematics learning-related activities and teachers' strategies to present conflict situations to stimulate thinking are essential to promoting children's mathematical abilities.

For these reasons, educators concerned with mathematics education have suggested that early childhood mathematics curricula for young children need to include developing number sense (Baroody, 1987; Baroody, & Ginsburg, 1990; Campbell & Carvey, 1992; Fuson, 1991; Kamii, 1982; Labinowicz, 1985; National Research Council, 1989; Piaget, 1965, 1983; Resnick, 1989; Van de Walle, 1988), understanding relations (Baroody, 1987; Campbell & Carvey, 1992; Castaneda, 1987; Leushina, 1991; NCTM, 1989; Piaget, 1965), knowing conventional symbols (Baroody, 1987; Baroody & Ginsburg, 1990; Labinowicz, 1985; Resnick, 1987), and perceiving and solving problems (Campbell & Carvey, 1992; Eisenhart, Borko, Underhill, Brown, Jones, & Agard, 1993; Hiebert & Lefevre, 1986; Price, 1989).

**Developing Number Sense**

First, mathematics education for young children develops number sense. Understanding number is essential if young children are to move from concrete to abstract thinking patterns (Baroody, 1987; Baroody, & Ginsburg, 1990; Campbell & Carvey, 1992; Fuson, 1991; Kamii, 1982; Labinowicz, 1985; National Research Council, 1989; Piaget, 1965, 1983; Resnick, 1989; Van de Walle, 1988). Number sense is a flexible way of thinking about numbers (Carpenter,
1989; Resnick, 1989; Silver, 1989). Although researchers in cognitive psychology and mathematics education have not clarified the definition or a theoretical model of number sense (Greeno, 1991), an agreement regarding the characteristics of number sense is emerging.

According to Piaget (1965, 1983), children's development of number concepts allows them to create logical relations among objects. Number concepts are developed by understanding order and hierarchical inclusion. By understanding order, children can count a set of objects without skipping or repetition. By understanding inclusion, children come to understand that the number of a set of objects is the total items of individual objects. Resnick (1983) noted the importance of understanding order and hierarchical inclusion. She contended that

the major conceptual achievement of the early school years is the interpretation of numbers in terms of part and whole relationships. Within the application of a part-whole schema to quantity, it becomes possible for children to think about numbers as compositions of other numbers. The enrichment of number understanding permits forms of mathematical problem solving and interpretation that are not available to younger children (p. 114).

The NCTM (1989) suggests that children who have number sense understand the meaning of number inasmuch as they are able to define many different relations among numbers. These children also develop their own referents for use in measuring common objects and events. Children with number sense understand the meaning of number and are able to define many different relations among numbers. The development of number sense provides children flexible ways of thinking about number and numerical situations in addition to advancing children's problem-solving skills and supporting construction of enriched understandings (Campbell & Carvey, 1992; Kamii, 1982, 1990; Piaget, 1965, 1983; National Research Council, 1989; Turkel & Newman, 1988; Van de Walle, 1988).

Fischer (1990) conducted an experiment in which a kindergarten mathematics curriculum based on a part-part-whole approach was instructed in two kindergarten classes, with two other kindergarten classes serving as the control group. The curriculum was
characterized by a reliance on the counting of objects in sets, followed by verbalization of the associated total number and writing of the corresponding numerals. Results of the posttest indicated that the part-part-whole approach fostered children's development of number concept. This study demonstrated that understanding of number relations facilitated children's construction of strategies to solve addition and subtraction word problems even though addition and subtraction applications were not explicitly taught.

Understanding Relations

As children begin to solve quantity problems in their environment, they begin to construct meaning for number (Fuson, 1989). Mathematical knowledge is acquired by internalization of concepts and by continuous construction of relations among objects in the environment. The mathematics curriculum for young children should encourage both mastery of number systems and mathematical thinking. It is important for children to understand the relations between and among objects, such as number conservation, set comparison, more or less, classification, inclusion, etc. (Baroody, 1987; Campbell & Carvey, 1992; Castaneda, 1987; Leushina, 1991; NCTM, 1989; Piaget, 1965). With an understanding of the relation between and among objects, children can develop abilities to plan, predict, evaluate, address cause and-effect, generalize, and draw conclusions. These are important abilities for problem solving.

Knowing Conventional Symbols

Baroody and Ginsburg (1990) propose that young children's existing knowledge is counting-based informal mathematical knowledge, which is the basis on which children construct mathematical knowledge. In agreement with Baroody and Ginsburg, Labinowicz (1985) and Resnick (1987) also suggest that the counting-based approach is important for fostering self-regulation and a positive disposition towards mathematical learning and problem solving, as well as meaningful learning.
Mathematical knowledge is a way to express and to communicate ideas (Baroody, 1987; Campbell & Carvey, 1992; Cobb, Wood, & Yackel, 1990; Leushina, 1991; NCTM, 1989, 1991; National Research Council, 1989). Children need to be exposed to and familiar with counting systems and numerical symbols used by society so that they become able to use these cultural tools to model and to solve problems (Bruner, 1985; Campbell & Carvey, 1992; Price, 1989; Vygotsky, 1978). Researchers have different perspectives regarding the meaning and the growth of counting. Some mathematics educators suggest that counting helps young children develop number sense and also serves as a problem-solving tool before children learn formal mathematics (Baroody, 1987; Leushina, 1991). In accord with Vygotsky’s (1978) sociocultural perspective, counting systems, as well as other signs such as language, are psychological tools altering flow and structure of mental functions (Campbell & Carvey, 1992).

Children are exposed very early to the counting system by people around them. Counting familiarizes children with using numerical cultural tools with which they can construct concepts of quantity, thus developing further mathematical knowledge. From counting, children develop number sense and become ready to engage in formal mathematics learning at school (Baroody, 1987; Baroody & Ginsburg, 1990; Fuson, 1989, 1991; Labinowicz, 1985; Price, 1989; Wertsch & Tulviste, 1992).

Fuson (1989) contends that children first learn a rote sequence of number words without reference to the objects being counted and then make the transition to coordinating each number word in the sequence with an object in a set to determine the set’s cardinality. Initial attempts to carry out counting activities indicate no manifestation of implicit counting principles. However, Gelman and associates (Gelman & Gallistel, 1978; Gelman & Greeno, 1989; Gelman & Meck, 1983) suggest that even very young children have some implicit principled understanding of counting, as shown by their response to the presence of quantity in their environment. Despite differences in how an initial principled knowledge of counting is
defined, it is generally accepted that explicit knowledge of counting is a prerequisite for increasing, decreasing, and comparing quantities (Baroody, 1987; Greeno, Riley, & Gelman, 1984; Leushina, 1991; Price, 1989). Normally, the ability to count rationally enables children to solve simple word problems (Baroody, 1987; Baroody & Ginsburg, 1990; Campbell & Carvey, 1992; Gelman & Gallistel, 1978; Gelman & Meck, 1983; Labinowicz, 1985; Sophian, 1988).

According to Piaget (1965), counting systems should be introduced and emphasized only after children construct their own understanding of number, because teaching children to count prevents them from inventing their construction of relations and consequences of numbers. But Piaget (1983) agrees that providing "situations" for children to experience facilitates children's invention (Piaget, 1983). Therefore, number words and numerical sequences provided in the environment could be used to facilitate children's invention of relations. An environment rich in counting and in auditory and visual number words encourages children to become aware of number and to explore the realm of mathematics (Bredekamp & Rosegrant, 1992a, 1992b; Fuson, 1991; Resnick, 1989). Counting promotes young children's construction of mathematical knowledge by providing symbols that they can use to operate mental functioning (Vygotsky, 1987).

Children can best be prepared for formal mathematics by being helped to notice and label the numerical aspects of their environment and to learn counting (Baroody, 1987; Fuson, 1991). Because many important mathematical concepts are acquired after children can count correctly, the counting of objects and the sequence of number-words must be repeated to young children. Thus, young children can automatize the number-word sequence that gives them freedom to construct relations between/among objects, people, and events (Fuson, 1991; Resnick, 1989). To understand the number-word, counting, and cardinal meanings, young children need to be exposed to many different experiences with both addition and subtraction (Baroody, 1987; Fuson, 1991). Teachers must encourage young children in a variety of
counting tasks relating to quantity, either by visual representation of numerical systems such as written numbers or by counting aloud to automatize the sequence of number words (Baroody, 1987; Fuson, 1991; Hiebert, 1990).

Solving Problems

Young children also must develop mathematical reasoning and problem-solving competencies. If mathematics education is to foster thinking, it must focus on problem-solving tasks, because problem solving is the context in which children’s mathematical thinking develops. It is therefore essential to create a problem-solving environment from which mathematical ideas can emerge (Campbell & Carvey, 1992; Price, 1989). This strategy encourages children to identify and to solve problems in a way that makes sense to them (Campbell & Carvey, 1992; Eisenhart et al., 1993; Hiebert & Lefevre, 1986).

Young children need to be encouraged to use problem-solving approaches to investigate and understand mathematical content so that they become able to solve problems from everyday as well as mathematical situations. Children should also be encouraged to develop and apply strategies to solve a wide variety of problems and to verify and interpret results with respect to the original problem. Through these problem-solving experiences, children can acquire confidence in using mathematics meaningfully (NCTM, 1989).

Overall, the goals of young children’s development of mathematical knowledge are to promote their understanding of number, to stimulate their thinking rather than their desire to obtain correct answers, to encourage their construction of relations, and to utilize conventional numerical symbols as tools to solve mathematics-related problems. Children must also be encouraged to agree or to disagree among themselves so they can learn to reason on answers or solutions.
NCTM School Mathematics Standards

The NCTM accepts the NAEYC guidelines of developmentally appropriate practices and recommends developmentally appropriate curriculum and evaluation guidelines for early childhood mathematics. The NCTM guidelines suggest that children's mathematical understanding be built upon their experiences and existing knowledge, that the mathematics curriculum incorporate active and interactive learning, and that children be encouraged to translate concrete experiences into more abstract representations. Mathematical concepts are acquired through communication in problem-solving situations, and varied teaching strategies can be used to provide meaningful contexts for children to facilitate construction of mathematical knowledge (NCTM, 1989).

Responding to pressure for reform of mathematics education, the NCTM has published its Curriculum and Evaluation Standards for School Mathematics (NCTM, 1989) as well as its Standards for Teaching Mathematics (1991). For kindergarten through fourth grade, the NCTM assumes that the mathematics curriculum should be conceptually oriented; it should include a broad range of content and make appropriate and ongoing use of calculators and computers. Mathematics activities are varied and include estimation, number sense and numeration, whole-number operations, whole number computation, geometry and spatial sense, measurement, statistics and probability, fractions and decimals, and patterns and relations. The curriculum should emphasize the development of children's mathematical thinking and reasoning abilities as well as their application of mathematics. The curriculum should actively involve children in doing mathematics; it should be integrated with other learning activities for problem solving, communicating, reasoning, and connecting. The use of concrete objects and manipulative materials to encourage children's active construction of mathematical concepts is strongly recommended.
One year after the NCTM published the school mathematics standards, Parker and Kurtz (1990) examined educators' awareness of NCTM curriculum and evaluation standards and the agreement between these standards and classroom practices. The researchers sent a letter to 100 elementary school principals in Kansas, asking each to distribute a survey to five K-4 teachers in his/her school. Of the 500 surveys distributed throughout the state, 221 were returned. Of the teachers responding, only 39 (17.6%) reported they were familiar with the NCTM standards for school mathematics; 170 (76.9%) said they were unfamiliar with the standards, and 12 (5.4%) gave other answers.

The teachers responded in a variety of ways to the question, "How much do you stress each of the following in your teaching of mathematics?" Most stressed primarily memorization and practice and paper-and-pencil computations. In contrast to the NCTM standards, the teachers reported the least emphasis on use of calculators. The teachers also reported placing relatively little emphasis on statistics and probability and on writing about mathematics.

Results of this study indicated some trends in grades 3 and 4 towards increased use of estimation and student evaluation and decreased use of manipulating real objects. Teachers with mathematics class periods of at least 60 minutes tended to spend more time on memorization and practice, paper-and-pencil computation, and workbook exercises. However, they also placed more emphasis on cooperative work, a practice encouraged by NCTM standards. The teachers familiar with the NCTM standards stressed the practices recommended more than did other teachers. In contrast, teachers unfamiliar with the NCTM standards stressed several practices that were less encouraged in the NCTM standards, such as memorization and workbook exercises. Both groups of teachers reported satisfaction with current mathematics teaching practices. Parker and Kurtz (1990) suggested that teachers not familiar with the NCTM school mathematics standards may not be using the effective mathematics teaching methods as recommended by the NCTM.
The NCTM's professional standards for teaching mathematics (1991) suggest that in teaching mathematics, teachers need to ask questions and to stimulate children to ask questions. Effective mathematics teachers are those who help children connect their own experiences and ideas with applications of mathematics; work together to make sense of mathematics, and build confidence in their own abilities to make mathematical judgments and to reason mathematically. Thus, children are encouraged to learn to conjecture, invent, and solve problems.

**Gap between Formal and Informal Mathematics**

Research has demonstrated that children in the United States have a better understanding of informal mathematics than their peers in other countries (Song & Ginsburg, 1987; Stevenson, Lee, Stigler, 1986), but their performance in formal mathematics taught at school is lower than that of children in other countries (Husen, 1967; Stigler, Lee, Lucker, & Stevenson, 1982). Song and Ginsburg (1987) studied the development of informal and formal mathematical thinking in 315 Korean children and 538 American children, aged 4 to 8 years. The Test of Early Mathematical Ability (TEMA) (Ginsburg & Baroody, 1983) was administered individually to the children. The TEMA contains 23 items that test informal mathematical thinking (activities not involving written symbols) and 27 items that test formal mathematical thinking (activities involving symbolic mathematics taught in school). Data indicated that the American preschool children's performance in informal mathematics was better than that of the Korean children, but that by the ages of 7 and 8, American children's performance was lower than that of the Korean children in formal mathematics. Song and Ginsburg (1987) thus suggested that the low gain of American children's understanding in mathematics and conceptualization after age 7 was related to factors such as classroom practices, teacher attitudes and teaching skills, expectancies, social values, and parental assistance.
Among the factors affecting American children's mathematics performance, a gap between formal instruction and American children's existing knowledge has been noted (Baroody & Ginsburg, 1990; Song & Ginsburg, 1987). This gap is the main explanation for children's difficulty in moving from relatively concrete informal mathematical understanding to understanding of relatively abstract formal instruction (Baroody, 1987; Baroody & Ginsburg, 1990). Kindergarten children should not be regarded as possessing uniform informal mathematical knowledge and readiness to master formal mathematics (Baroody, 1987; Baroody & Ginsburg, 1990).

**Kindergarten Teachers' Classroom Practices**

Several authors argue that teachers' knowledge about how children acquire mathematical knowledge, what children can do with mathematics, and what the best way is to present mathematical problems channels teachers' decisions regarding curriculum and timing (Peterson, Fennema, Carpenter, & Loef, 1989; Romberg & Carpenter, 1986; Thompson, 1992). For example, teachers who believe that mathematics learning is an active construction within children may provide additional opportunities for children to explore and to express relations and concepts (Nespor, 1987). Teachers who value social interactions in children's internalizing alternative solutions and perspectives are more likely to provide opportunities for small-group learning activities in the classroom (Cobb, Yackel, & Wood, 1992; Yackel, Cobb, Wood, Wheatley, & Merkel, 1990).

Current concerns about kindergarten focus on the developmental appropriateness of what is being taught as well as how it is being taught. The National Association for the Education of Young Children (NAEYC) has recommended developmentally appropriate kindergarten practices across the areas of curriculum, adult-child interactions, relations between home and school, and developmental evaluation of children (Bredekamp, 1986). The NAEYC guidelines suggest that an integrated curriculum focusing on child development is best for
kindergartners (Bredekamp & Rosegrant, 1992a; Katz & Chard, 1989). Learning is promoted through free play that provides opportunities for young children to choose from different materials and activities for varying periods of time. Development is enhanced if classrooms are child focused and well organized, with teachers playing a facilitative rather than a didactic role (Howes & Olenick, 1986; Katz & Chard, 1989; Weikart & Schweihart, 1986). High-quality classrooms are those in which teachers interact with children in a responsive and informative way (Clarke-Stewart & Gruber, 1984). Kindergarten children in developmentally appropriate programs tend to be more creative and to have more positive attitudes toward later schooling (Hyson, Hirsh-Pasek, & Rescorla, 1990).

Hyson et al. (1990) developed a measure, the Classroom Practices Inventory (CPI) based upon the NAEYC guidelines for Developmentally Appropriate Practices for 4- and 5-year-olds. Through the use of the CPI, these researchers observed 10 half-day private preschools repeatedly and observed another 48 early childhood programs representing a wide range of settings, including half-day preschools, laboratory schools, day-care centers, and public/private kindergartens in Pennsylvania and Delaware. In total, the researchers observed 58 early childhood programs and conducted 3.5 observation visits per program. Data from the study indicated that programs rated more highly on positive affective characteristics and positive guidance of children were more likely to incorporate a high degree of child choice, concrete materials, and open-ended questioning in their curriculum. Further, children in developmentally appropriate programs tended to be rated as more creative and confident and less anxious. They also had more positive attitudes toward later schooling.

Bryant and colleagues (Bryant, Clifford, & Peisner, 1991) studied the developmental appropriateness of classroom practices in 103 randomly selected kindergartens across the state of North Carolina. Two observational checklists were used to evaluate the kindergartens visited. The first checklist was a modified version of the Early Childhood Environment Rating Scales.
The second was developed by the researchers for an observational measure, based on the NAEYC position statement regarding developmentally appropriate practices. During classroom visits, observers spent two to three hours in the classroom completing the two checklists. Principals and kindergarten teachers were asked to complete a questionnaire about their knowledge of and attitudes toward developmentally appropriate kindergarten practices.

The results of the Bryant et al. study indicated that only a minority (20%) of classes met or exceeded the criteria regarding developmental appropriateness. Quality of the kindergarten was related to teachers' and principals' scores on the measure of knowledge and beliefs in developmentally appropriate practices in the classrooms. There were no differences related to geographic location, school size, per-pupil expenditure, or teacher or principal education or experience. Similar results were found in other studies of kindergarten developmental classroom practices in different states (Charlesworth, Hart, Burts, & Hernandez, 1991; Hyson et al., 1990; Mayers, 1991).

In accord with the findings of Bryant et al. (1991), other researchers have demonstrated that the majority of kindergarten teachers' classroom practices are not developmentally appropriate (Charlesworth et al., 1991; Durkin, 1987; Mayers, 1991; Rusher, McGrevin, & Lambiotte, 1992). In addition, kindergarten teachers' classroom practices are influenced by external factors in addition to their own beliefs (Charlesworth et al., 1991; Durkin, 1987; Mayers, 1991; Rusher et al., 1992). The amount of control teachers have over their classroom curricula was investigated by Charlesworth et al. (1991). Actual and desired teaching practices of kindergarten teachers were compared by Mayers (1991).

Charlesworth et al. (1991) investigated kindergarten teachers' beliefs and their classroom practices in Louisiana. The researchers developed a questionnaire based upon the NAEYC guidelines for developmentally appropriate practices in early childhood education. A 27-item checklist was developed for rating developmentally appropriate practices in kindergarten
classrooms. Questionnaires concerning beliefs and practices were returned by 113 kindergarten teachers. Data indicated positive correlations between developmentally appropriate beliefs and activities, e.g., games and puzzles, manipulatives, and center selection, and between developmentally inappropriate beliefs and activities such as rote alphabet learning and writing on the lines. Teachers whose classroom practices were characterized as more developmentally appropriate described themselves as more in control of their classroom practices than did teachers whose classrooms were characterized as less developmentally appropriate. However, only 28 percent of the kindergarten teachers regarded themselves as having control over their decision-making on curricula; the majority of kindergarten teachers in this study believed that they had insufficient control over their classroom curricula and rated many of their classroom practices inappropriate.

Mayers (1991) studied 102 kindergarten teachers, 94 first-grade teachers, and 92 principals in Iowa using adapted versions of the Teacher Information Survey and the Teacher Questionnaire (Charlesworth et al., 1989) addressing teachers' beliefs and instructional classroom practices. Her study indicated that kindergarten teachers, first-grade teachers, and elementary school principals held similar belief patterns. The majority of kindergarten teachers in this study agreed with the NAEYC guidelines of developmentally appropriate practices and reported strong desires to adopt such developmentally appropriate curricula. For example, kindergarten teachers were more likely than their principals to emphasize providing opportunities for children to learn through active exploration, experimentation, and interactive processes, and to provide a greater variety of activities and materials. However, the teachers reported that they had to comply with school district requirements that did not agree with NAEYC guidelines. These findings are in accord with those of Bryant et al. (1991) and with Charlesworth et al. (1991),
Mayers found significant differences between kindergarten teachers' actual and desired classroom practices. Kindergarten teachers expressed a desire for more frequent involvement in child-centered, autonomy-oriented activities and for more opportunities for creative exploration by the children than they used in their teaching. Classroom practices, however, belied this desire. For example, kindergarten teachers used more large-group, teacher-directed instructions than they had reported they thought desirable. They allotted much time to coloring and cutting out pre-drawn forms, circling, underlining, and marking items on worksheets, using flash-cards with sight words and mathematical facts, and practicing handwriting on lines. These activities are considered inappropriate for young children, who construct knowledge and understand concepts through actively handling real objects and through direct experiences and who learn best when interacting with objects and people rather than when rote memorizing or writing assignments (Bredekamp, 1986; Kamii, 1982, 1990; Katz & Chard, 1989; Piaget, 1965, 1983).

A survey study by Rusher et al. (1992) also found disagreement between belief systems of kindergarten teachers and those of their principals. In this study, kindergarten teachers tended to disagree with a strong emphasis on academics but firmly agreed with developmentally appropriate practices such as child-centered activities. They believed that motor activities, expressive arts, and physical movement should be included in early childhood programs. These teachers perceived their school districts as favoring learning activities regarded as appropriate for elementary school children. The teachers also reported that they had less influence in curricular decisions than their principals did. This study is in accord with other research findings that teachers' classroom practices are influenced by external factors other than the teachers' own decision (Bryant et al., 1991; Charlesworth et al., 1989; Durkin, 1987; Hyson et al., 1990; Mayers, 1991). Rusher et al. (1992) suggested that, under these circumstances, kindergarten teachers often are pressured into modifying classroom practices to reflect district policies.
In summary, kindergarten teachers in general agree with researchers and other experts as to what is essential for young children. However, teachers perceive administrative pressure to adopt a more mastery- and performance-oriented model emphasizing academic skills rather than child development. For example, many kindergarten teachers teach skills of "readiness" to prepare children for entering the first grade. Thus, kindergarten teachers' classroom behaviors and expectations are not always reflective of their beliefs, but are influenced by external factors such as administrative decisions and expectations and parent beliefs and attitudes (Bryant et al., 1991; Charlesworth et al., 1991; Durkin, 1987; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992; Schowelle et al., 1979; Shepherd & Smith, 1985).

Summary

In summary, the NCTM school mathematics standards agree with the NAEYC developmentally appropriate practices in early childhood programs that mathematics learning as well as other developmental areas in early childhood need to be integrated with activities for problem solving, communicating, reasoning, and connecting experiences (Bredekamp, 1986; Bredekamp & Rosegrant, 1992a, 1992b; Campbell & Carvey, 1992; Kamii, 1990; Katz & Chard, 1989; NCTM, 1989, 1991). Kindergarten classroom practices should help children connect their informally learned mathematical knowledge with formal school-taught mathematics. Kindergarten teachers should provide opportunities for children to interact with people and concrete objects, thus promoting active learning. Mathematics-related learning opportunities are initiated by children themselves as well as facilitated by the teacher. The teacher provides a variety of mathematical concepts in kindergarten for children to explore, placing emphasis on developing number sense, understanding relations, knowing conventional symbols, and problem solving.

However, kindergarten classroom practices, influenced by external factors such as administrative decisions and expectations and parental beliefs and attitudes (Bryant et al., 1991;
Charlesworth et al., 1991; Durkin, 1987; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992; Schowelle et al., 1979; Shepherd & Smith, 1985) are pushing kindergarten children into an academics-oriented learning environment (Bryant et al., 1991; Durkin, 1987; Elkind, 1986; Hyson et al., 1990; Mayers, 1991). The majority of kindergarten teachers do not perceive their classroom practices as developmentally appropriate (Bryant et al., 1991; Charlesworth et al., 1991; Durkin, 1987; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992; Schowelle et al., 1979; Shepherd & Smith, 1985). In addition, previous findings show that the majority of kindergarten teachers are unaware of the NCTM curriculum and evaluation standards for school mathematics (e.g., Parker & Kurtz, 1990). Instead, such teachers emphasize memorization and paper-and-pencil computation and de-emphasize use of calculators and computers (Ginsburg & Baroody, 1990; Hills, 1992; Parker & Kurtz, 1990).

Research has shown that, to a slight degree, kindergarten teachers follow developmentally appropriate practices recommended in both the NAEYC's guidelines (Bryant et al., 1991; Charlesworth et al., 1991; Durkin, 1987; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992; Schowelle et al., 1979; Shepherd & Smith, 1985) and the NCTM's school mathematics standards (Parker & Kurtz, 1990). Evidently, more effort is needed to achieve the goals of both organizations.

Conclusion

Mathematical learning in the United States has been characterized by certain ineffective practices that are suspected causes of the poor achievement of American students. Among those causes, the inadequate connection between children’s formally learned mathematical knowledge and school-taught formal mathematics is a major concern (Baroody & Ginsburg, 1990; Song & Ginsburg, 1987).

Because of the limitations of previous survey studies and the lack of research on the relationships between kindergarten teachers' implementation of the NAEYC developmentally
appropriate practices and the NCTM's school mathematics standards, there is a need for more empirical knowledge of actual classroom mathematics learning. Questions such as the extent of mathematical concepts actually introduced or explored in the kindergarten, how teachers promote children to construct mathematical knowledge, how mathematical concepts are presented, and what kinds of sources are used to facilitate mathematical learning in the kindergarten classroom need to be clarified. Through use of systematic and appropriate research methods, such as an observational study, in kindergarten classrooms, findings may provide information on how kindergarten teachers are responding to the NCTM's mathematics education reform and on current mathematics teaching practices in the kindergarten.

References Cited


DEVELOPMENTALLY APPROPRIATE PRACTICES AND MATHEMATICS TEACHING AND LEARNING IN KINDERGARTEN CLASSROOMS

A paper to be submitted to the American Educational Research Journal

Kuei-Er Chung

Abstract

To examine teachers' and children's classroom behaviors related to mathematics teaching and learning in kindergartens, the time-sampling method was used to study thirty kindergarten teachers and children in their classes. Relations between developmental appropriateness scores and behaviors observed in mathematics teaching and learning were examined. Results indicated that mathematics teaching and learning were integrated with other learning activities in kindergarten. Teachers spent about one-fourth of their classroom time teaching mathematics-related activities, and children in their classes spent about one-third of their classroom time engaged in such activities. Although the use of higher cognitive distancing was less infrequent than use of low cognitive distancing across all learning activities, teachers used higher cognitive distancing during a greater proportion of mathematics teaching time than of time spent teaching nonmathematics-related activities. Children's responses to cognitive distancing reflected teachers' teaching strategies in that children spent a higher percentage of mathematics learning time than nonmathematics-related learning time responding to higher cognitive distancing. Results suggest that, to some degree, the kindergarten teachers followed the NAEYC guidelines for developmentally appropriate practices and the NCTM school mathematics standards in their classroom practices and mathematics teaching.

Introduction

Current concerns about kindergarten focus on the developmental appropriateness of what is taught as well as how it is being taught. The National Association for the Education of Young Children (NAEYC) has recommended developmentally appropriate practices across the
areas of curriculum, adult-child interactions, relations between home and school, and
assessment of children's development (Bredekamp, 1986). The NAEYC guidelines suggest that
an integrated curriculum focusing on all areas of the development of children is best for
kindergartners (Bredekamp, 1986; Bredekamp & Rosegrant, 1992). According to the NAEYC
guidelines, developmentally appropriate teaching strategies are based on knowledge of how
children learn. Children's learning is promoted through activities that emphasize age
appropriateness and individual differences. Free play that provides young children with
opportunities to choose from different materials and activities is an essential part of
developmentally appropriate practices. Development is enhanced if the classroom practices are
child-oriented, with teachers playing a facilitative rather than a didactic role (Howes & Olenick,

Hyson, Hirsh-Pasek, and Rescorla (1990) studied 58 early childhood programs, including
half-day public/private preschools, a laboratory school, day-care centers, and public/private
kindergartens. Each program was observed for an average of 3.5 visits. Data from the study
indicated that programs rated as more developmentally appropriate were more likely to include a
high degree of child choice, more concrete materials, and more open-ended questioning in their
curricula. Compared with their peers children, children in such programs were rated as more
creative, more confident, and less anxious, and they tended to express more positive attitudes
toward later schooling.

Although kindergarten teachers agree with what researchers and experts have argued is
essential for young children, their classroom behaviors and expectations have not always
reflected their beliefs (Bryant, Clifford, Peisner, 1991; Charlesworth, Hart, Burts, & Hernandez,
1991; Durkin, 1987; Mayers, 1991). Many kindergarten teachers reported, in contrast to what
they believe, that they had to adopt a more mastery and performance-oriented model
emphasizing conventional "readiness" skills to prepare children for entering the first grade.
Kindergarten classroom practices, influenced by external factors such as administrative decisions, first-grade teachers' expectations, and parental beliefs and attitudes, are pushing kindergarten children into an academics-oriented learning environment (Durkin, 1987; Elkind, 1986; Hyson et al., 1990; Mayers, 1991; Rusher, McGrevin, & Lambiotte, 1992; Schwelle, Porter, Grant, Bellie, Foden, Freeman, Knappen, Kuths, & Schmidt, 1979; Shepherd & Smith, 1985). As a result, classroom practices of most kindergartens do not meet the criteria of developmental appropriateness (Byrant, Clifford & Peisner, 1991; Charlesworth et al., 1991; Durkin, 1987; Elkind, 1986; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992; Schwelle et al., 1979; Shepherd & Smith, 1985).

NCTM Position on Early Childhood Mathematics Education

Responding to the pressure for reform of mathematics education, the National Council of Teachers of Mathematics (NCTM) has published its Curriculum and Evaluation Standards for School Mathematics (1989) as well as its Standards for Teaching Mathematics (1991). The NCTM agrees with NAEYC guidelines of developmentally appropriate practices and recommends developmentally appropriate curriculum and evaluation guidelines for early childhood mathematics. For kindergarten and first to fourth grades, the NCTM recommends that mathematics education be integrated into activities for problem solving, communicating, reasoning, and connecting. The NCTM standards suggest that children's mathematical understanding is built upon their experiences and existing knowledge, that the mathematics curriculum should incorporate active and interactive learning, and that children should be encouraged to translate concrete experiences into more abstract representations. Mathematical concepts are acquired through communication in problem solving situations. Varied teaching strategies are used to provide meaningful contexts to children to facilitate construction of mathematical knowledge.
The Need for Examination of Kindergarten Mathematics Education

Helping kindergarten children connect their informally learned mathematical knowledge to formal mathematical learning promotes their understanding (Baroody, 1987; Resnick, 1983). Results of previous studies (Song & Ginsburg, 1987; Stevenson, Stigler, Lucker, Lee, Hsu, & Kitamura, 1986) indicate that American preschool children demonstrated better understanding and application of mathematical concepts than did children in other countries. However, American children lost this advantage in subsequent years, from kindergarten to high school (McKnight, Crosswhite, Dossey, Kifer, Swafford, Travers, & Cooney, 1987; Song & Ginsburg, 1987; Stevenson, Stigler, Lee, Lucker, Kitamura, & Hsu, 1995; Stevenson, Stigler, Lee, Lucker, Hsu, & Kitamura, 1986; Stigler, Lee, Lucker, & Stevenson, 1982; Stigler, Lee, & Stevenson, 1987).

Mathematical learning in the United States has been characterized by certain ineffective practices suspected of causing the poor achievement of American students compared with their peers in other countries (Song & Ginsburg, 1987; Stevenson et al., 1985, 1986; Stigler et al., 1982, 1987). Such ineffective practices include: less time allotted for teaching and learning mathematics; less time spent on effective teaching, such as direct teaching, the use of manipulatives and real-world problems; and more inappropriate behaviors during mathematics learning time.

Stevenson and associates (Stevenson et al., 1985; Stevenson et al., 1986; Stigler et al., 1982; Stigler et al., 1987) have studied first-grade and fifth-grade children’s mathematical performances and teachers’ classroom practices in Japan, Taiwan, and the United States. Data were collected in three representative cities in each of these three countries. Twenty first-grade classrooms and 20 fifth-grade classrooms in each city were observed during mathematics classes. The teachers and individual children were studied.
Data indicated that American teachers allotted less time for teaching and learning mathematics than did teachers in Japan and Taiwan. Stigler et al. (1987) estimated that, in the first grade, American children spent 2.9 hours a week in learning mathematics, whereas Chinese children spent 4 hours and Japanese children spent 5.8 hours a week in mathematics. On average, American first-graders spent 32 minutes a day learning mathematics at school. American children in elementary school demonstrated more inappropriate behaviors during mathematics learning-related activities such as being out of seat, being off-task, and interacting inappropriately with peers. The researchers suggested that American students’ inferiority in mathematics performance was related to their spending less time on learning mathematics and having fewer opportunities to engage in either manipulating concrete objects or solving real-world problems.

Chung (1990) surveyed 336 first-grade teachers about their beliefs and classroom practices regarding mathematics learning and teaching in Taiwan and in the United States. The American teachers in this study reported that they used more effective practices in their mathematics classes than did the teachers in Taiwan. For example, American teachers reported that they allotted more time to teaching mathematics, used more manipulatives, and used more time for direct teaching than the Chinese teachers did. The amount of time allotted to mathematics teaching and learning reported by the Chinese teachers was consistent with the amount of time required by their Ministry of Education; it was, however, significantly less than the mathematics learning time observed by Stevenson and associates (Stigler et al., 1987). Other results of Chung’s study were contradictory to those of Stevenson and associates (Stevenson et al., 1986; Stigler et al., 1987). The researcher suggested that there might be cultural differences between teachers in these two countries in evaluating their own beliefs and classroom practices. For example, Chinese teachers might have underreported the time they
actually allotted for teaching mathematics to avoid violating the requirements of the Ministry of Education.

The lower levels of American students' mathematical achievement may also be attributed to a gap between formal school mathematical instruction and children's existing knowledge (Baroody & Ginsburg, 1990; Song & Ginsburg, 1987). Children obtain their informal mathematical understanding through interactions between their thoughts and experiences with materials and people (Baroody, 1987; Bredekamp, 1986; Kamii, 1990; Katz & Chard, 1989). To understand more abstract mathematical knowledge, children needs connections to link their concrete experience to formal mathematical instruction (Baroody, 1987; Baroody & Ginsburg, 1990). For example, young children understand the underlying concept of more or less comparing two sets; they often use counting to solve many of these numerical problems. These conceptual ideas acquired from concrete experience can be tied to more abstract procedures, such as adding and subtracting, to enhance children's understanding of formal mathematics taught at school (NCTM, 1989).

Song and Ginsburg (1987) studied the development of informal and formal mathematical thinking of children in Korea and in the United States. The Test of Early Mathematical Ability (TEMA) (Ginsburg & Baroody, 1983) was administered individually to 315 Korean children and 538 American children, aged 4 to 8 years. Twenty-three items for testing informal mathematical thinking involved no written symbolism; the other 27 items for formal mathematical thinking involved written and symbolic mathematics taught in school. Results indicated that preschool children in the United States demonstrated better understanding of informal mathematics than did their Korean peers. But by the ages of 7 and 8 years, in formal mathematics, American children had lost their earlier advantage.

Recently, professional groups have emphasized the connections between children's informal mathematical understanding and school mathematical instruction. For example, the
National Council of Teachers of Mathematics (NCTM, 1989, 1991) has recommended practical methods and strategies for uses in teaching young children mathematics. The NCTM (1989) standards for school mathematics suggest that

In grades K-4, the study of mathematics should include opportunities to make connection so that children can link conceptual and procedural knowledge; relate various representations of concepts or procedures to one another; recognize relationships among different topics in mathematics; use mathematics in other curriculum areas; and use mathematics in their daily lives (p. 32).

The majority of kindergarten teachers, however, are unaware of the NCTM standards. Parker and Kurtz (1990) surveyed kindergarten through fourth grade teachers' understanding of the NCTM school mathematics standards. Results showed that the majority of kindergarten teachers were unaware of the effective teaching strategy of connecting children's experiences to mathematics. Further, teachers reported that they taught mathematics as an isolated subject instead of integrating mathematics with other learning activities. These teachers reported that they used conventional methods such as memorization and drills to teach mathematics (Parker & Kurtz, 1990). Parker and Kurtz's survey study was, however, unable to describe the actual practices of mathematical teaching and learning in kindergarten.

Considerable attention has been paid to first- and second-graders' mathematical learning in school (Anderson, Brubaker, Alleman-Brookes, & Duffy, 1985; Cobb, Wood, & Yackel, 1990; Song & Ginsburg, 1987; Stevenson et al., 1986; Stigler et al., 1987; Stigler et al., 1982; Yackel, Cobb, Wood, Wheatley, & Merkel, 1990; Yackel, Cobb, & Wood, 1991). Others have studied preschoolers' mathematical understanding (Gelman & Gallistel, 1978; Gelman & Meck, 1983; Kamli, 1982; Sophian, 1988). The major concerns of kindergarten mathematics education have focused on how children develop an understanding of specific mathematical concepts, such as the development of the concept of proportion (Offenbuch, Gruen, & Caskey, 1984) and of representation skills in reasoning (Mims, Cantor, & Riley, 1983).
The NCTM school mathematics standards agree with the NAEYC guidelines on developmentally appropriate practices in early childhood programs that mathematics learning as well as other developmental areas in early childhood need to be integrated in activities for problem solving, communicating, reasoning, and connecting experiences (Bredekamp, 1986; NCTM, 1989, 1991). Nevertheless, few research studies have documented kindergarten teachers' practices relating to mathematical learning or the relations between developmentally appropriate kindergartens and mathematics teaching or learning classroom practices. Because of the limitations of previous studies, the contradictions in their results, the teachers' unawareness of effective mathematical teaching methods, and the lack of information about actual classroom practices relating to mathematical teaching and learning, there is a need for more studies that document actual classroom mathematics learning in kindergarten. A careful examination of young children's mathematics learning and teachers' classroom practices in the kindergarten is necessary for implementation of the NAEYC developmentally appropriate practices and the NCTM school mathematics standards. Based upon such information, connections between children's informally learned mathematical understanding and school mathematical instruction in kindergarten can be enhanced.

**Review of Methodology**

The majority of previous observational studies of mathematics education in the classroom have focused on the relations between teachers' classroom behaviors and children's performance (Anderson et al., 1985; Brophy & Good, 1986). Others have focused on interactions between the teacher and child or between/among children in small groups in problem-solving situations in primary grades (Carpenter & Fennema, 1991; Cobb, Wood, & Yackel, 1990; Cobb, Yackel, & Wood, 1992; Yackel et al., 1990, 1991).

To investigate the implementation of NAEYC guidelines on developmentally appropriate practices and NCTM standards for school mathematics, an observational study can avoid the
disadvantages inherent in survey reports, which may not indicate what is actually occurring in the kindergarten. An observational study concerning mathematics teaching and learning in the kindergarten classroom would provide useful information regarding children's mathematical learning in the context of teachers' actual classroom practices.

Because mathematics involves abstract concepts, understanding of mathematics requires children to move from concrete to more abstract representations. To assist children in their construction of more abstract knowledge, the teacher's role is to help the child differentiate between attributes of objects, people, and events (Piaget, 1963, 1983; Vygotsky, 1978). With adults assistance, children should have opportunities to seek multiple attributes of an object and relations between/among objects, people, and events (Piaget, 1983; Sigel, 1970, 1981, 1986, 1990; Vygotsky, 1978).

Both NAEYC's guidelines on developmentally appropriate practices and NCTM's standards on school mathematics (Bredekamp, 1986; NCTM, 1989, 1991) are based upon the theories of Piaget and Vygotsky. According to Piaget (1983), teaching strategies can bring children into conflicting cognitive situations that demand the child’s active mental operations to construct relations between concrete experiences and more abstract representations, a process through which children acquire their mathematical knowledge. Vygotsky's theory (1978, 1987) suggests that teachers' interactive and communicative strategies bring about changes in children’s thinking patterns and help children to learn. Through interactions, children are encouraged to construct new understandings of the relations among objects, people, and events; their zones of proximal development are expanded. According to Vygotsky (1978), the zone of proximal development is defined as the distance between a child’s actual developmental level and the higher level of potential development. By presenting cognitive conflicts (Piaget, 1983) and through scaffolding (Vygotsky, 1978), the teacher demands that children be involved in active thinking. The teacher's role in children’s mathematical learning is to tailor the context
and to connect children's existing skills and knowledge to new events and situations, thereby
guiding children to develop their skills and ability according to what they already know (Cobb et

Sigel has developed a model of cognitive distancing strategies based on Piaget's and
theory that cognitive conflict embedded in a social context functions in connecting children's
transition from one developmental stage to another (Piaget, 1963). In agreement with
Vygotsky's theory that children's competence is determined by their interactions with a more
competent adult (Vygotsky, 1987), the model of cognitive distancing also emphasizes the
concept that adults' scaffolding strategies assist children to understand actual situations and
applications of useful tools for solving problems. The model of cognitive distancing teaching
strategies has been used as an effective means of facilitating young children's connection, or
their construction of links between concrete experience and abstract concepts (Cataldo, 1977;
Cocking, 1977; Cocking & Copple, 1979; Copple, Sigel, & Saundres, 1984; Pellegrini, Brody, &
Sigel, 1985; Pellegrini, McGillicuddy-Deiisi, & Sigel, 1986; Pellegrini et al., 1990; Sigel &
Cocking, 1977; Sigel, Secrist, & Forman, 1973). According to the cognitive distancing model,
three levels of mental operational demand occur. Low-level distancing occurs when the child is
required to label (e.g., "What is this?") to produce information (e.g., "Where did you go
yesterday?"), to describe/define (e.g., "Tell me about its color"), to demonstrate (e.g., "Show
me how to do it"), and to observe (e.g., "Look at this dinosaur"). Medium-level distancing
occurs when the child is required to sequence (e.g., "First do this, then this."), to reproduce
(e.g., "Make one like this"), to describe/infer similarities and differences (e.g., "How are they
different?"), and to classify (e.g., "Which go together?"). High-level distancing occurs when the
child is required to plan (e.g., "What would you like to do with this box?") evaluate (e.g., "Do
you think this will work?"), generalize (e.g., "Have you seen anything like this before?")
conclude (e.g., "What was going on there?"), and state cause-effect relationships, (e.g., "Why
does it become like this?") (Flaugher & Sigel, 1980; also see Appendix D). The medium- and
high-level distancing strategies in Sigel's model are in accord with teaching strategies

According to Sigel (1970, 1986, 1990) and associates (Cataldo, 1977; Cocking &
Copple, 1979; Rosner, 1978; Sigel et al., 1973; Sigel & Saunders, 1977), teachers' cognitive
distancing strategies facilitate creation of distance between child and object. This distance
requires the child to represent an experience. During the process of forming representation, the
child distances him/herself from the here and now. The experience is transformed into a
representation through existing knowledge or through anticipation of intention. Such a
transforming process, from concrete objects to representation, leads the child to develop

Sigel and his colleagues have demonstrated that the teacher's cognitive distancing
strategies are related to children's representational competence and achievement in mathematics
and in reading (Cataldo, 1977; Cocking & Copple, 1979; Rosner, 1978; Sigel et al., 1973). In
their experimental preschools for disadvantaged children aged 2 1/2 to 4 1/2, these researchers
emphasized cognitive distancing teaching strategies. Compared with children in regular
programs, children in the cognitive distancing programs performed at significantly higher levels
on tasks involving anticipation of consequences, reconstruction, and understanding of causal
relations (Cocking, 1977; Sigel et al., 1973) as well as Piaget's conservation tasks (Sigel &
Cocking, 1977). Two years after leaving the cognitive distancing programs at the end of first
grade, these children were performing at a higher level in reading and mathematics on the
Stanford Early School Achievement Test, compared with the children in the control group
(Cataldo, 1977).
Investigating parents' teaching strategies in terms of cognitive distancing, Pellegrini and colleagues (Pellegrini et al., 1985) found that parents adjusted their teaching strategies to children's level of competence in specific tasks and varied their teaching strategies according to task. Similar results were found in the mother-child joint reading task (Pellegrini et al., 1990). Mothers used different teaching strategies in reading different genres of books with their young children, whose ages ranged between 3 years 7 months and 5 years. They also used more teaching strategies in reading expository books than in reading narrative books. Children's participation level was greater around the expository than around the narrative texts. Mothers showed more competence in the familiar context (familiar expository book) by successfully using more high cognitive distancing strategies with their children; the use of such distancing interactions was positively related to their children's involvement in the task.

Objectives of the Study

The purpose of the present study was to examine mathematics teaching and learning in kindergarten. The first goal was to examine the relations between the amount of time used for cognitive distancing strategies and the developmental appropriateness of kindergartens. The second goal was to compare children's participating behaviors in mathematics-related learning activities with their behaviors in nonmathematics-related learning activities. A final goal was to examine the relations between teachers' teaching behaviors and children's participating behaviors.

It was predicted that kindergarten teachers whose practices were more developmentally appropriate would more frequently demonstrate effective strategies to facilitate mathematical learning than would those whose practices were less developmentally appropriate. Compared with less developmentally appropriate kindergartens, more developmentally appropriate kindergartens would more often have mathematics integrated with other activities rather than taught as an isolated subject. Teachers would more frequently demonstrate cognitive distancing
strategies and monitoring behaviors to facilitate children's construction of mathematical understanding in more developmentally appropriate kindergartens. Such teachers also would more often demonstrate positive interactions with their children to promote children's disposition towards mathematics.

It was also predicated that children in more developmentally appropriate kindergartens would more frequently engage in mathematics-related learning activities than children not in these programs. Such children would demonstrate appropriate participating behaviors during mathematics activities, such as initiating learning-related conversations, responding to teacher's and peers' statements, and working independently. They would also have more opportunities to express their mathematical understanding in response to teachers' cognitively stimulating requests.

Methodology

Subjects

The present study of classroom observations was conducted in 30 Iowa public kindergartens; no more than one kindergarten was selected from a given school district. All 30 kindergartens met five days a week. Half were all-day kindergartens, and half were half-day programs. The majority of teachers in half-day kindergartens (80%) taught two sessions, one in the morning and one in the afternoon, except for three who taught only one session (in the morning). Average class size was 20, with a range of 9 to 30 children. Three kindergartens had fewer than five girls in their classes. Whenever possible, six boys and six girls in each classroom were randomly selected for the study. Because of the small class size of several kindergartens and the absence of the randomly selected children, some children were observed on more than one visit.

Previous results (Bryant et al., 1991, Charlesworth et al., 1991) have indicated that the majority (about 80%) of the kindergarten teachers did not perceive their practices as
developmentally appropriate. To ensure a sufficient number of more developmentally appropriate programs, 14 of the subject kindergartens were randomly selected from those nominated by supervisors of student teaching, professors of early childhood education, and the local area educational agency consultants (see Appendix A for a description of the nomination process). In total, 30 kindergarten teachers and children in their classrooms were observed.

Instruments

Kindergarten Teacher Survey

The Kindergarten Teacher Survey was designed to collect demographic information about observed kindergartens and teachers. The survey concerns class size, teacher aides, kindergarten curriculum guides, time allotment for subject areas, familiarity with NAEYC guidelines and NCTM standards for school mathematics, and their engagement in teaching, e.g., related in-service training, etc. (see Appendix C).

Assessment Profile for Early Childhood Programs

To evaluate the degree of kindergartens' developmentally appropriate practices, the Assessment Profile for Early Childhood Programs (Assessment Profile) was used. The Assessment Profile is an observation checklist developed by Abbott-Shim and Sibley (1992) for assessing developmentally appropriate practices. It includes five subscales: Learning Environment, Scheduling, Curriculum, Interacting, and Individualizing; these include 87 criteria scored either "Yes" (observed), or "No" (not observed). The subscale measuring Learning Environment contains 17 categories dealing with classroom materials and classroom arrangement. The subscale measuring Scheduling contains 15 items dealing with the activity plan and variety of activities. The Curriculum subscale contains 22 categories related to multicultural awareness, variety of teaching strategies, independent learning, and individualization. The Interacting subscale contains 15 items focusing on teacher attitudes towards children, teacher responsiveness, guidance techniques, and children's reaction to the
classroom climate. The Individualizing subscale contains 18 items to measuring the use of child assessment upon which the curriculum plan was based, in order to identify and to meet special needs of individual children.

The Assessment Profile was used to collect data through observation of physical characteristics and interactions in the classroom, records reviews, and teacher interviews. The total possible score of the Assessment Profile is 87, one positive score from each of the 87 items (see Appendix C).

According to Abbott-Shim and Sibley (1992), the Assessment Profile has been used in many research projects involving preschools and daycare centers by a wide range of early childhood professionals, including early childhood trainers, program administrators, teachers, resource and referral staff, and professors of early childhood education. The content of the Assessment Profile is consistent with the National Academy of Early Childhood Accreditation Criteria. The internal consistency of the Assessment Profile, examined by Cronbach's coefficient alpha and the Spearman-Brown corrected split-halves respectively, are as follows: Learning Environment .87 and .92, Scheduling .79 and .81, Curriculum .87 and .97, Interacting .98 and .99, Individualizing .97 and .98, based on studies in 401 preschool programs (Abbott-Shim, Neel, & Sibley, 1992). No published data on using the Assessment Profile in kindergarten has been reported.

Kindergarten Classroom Profile

To assess kindergartens' mathematics education, the Kindergarten Classroom Profile was developed for the current study to identify teachers' and children's behaviors related to mathematics teaching and learning. Two coding systems were developed for observations of children and of teachers. A time-sampling method incorporating presence or absence of predetermined categories of behavior was used. Mutually exclusive and exhaustive items of chosen behavior categories were based on previous informal observations of kindergarten
classrooms, the NCTM professional standards for teaching mathematics (NCTM, 1991a), and Sigel's model of distancing teaching strategies (Flaugher & Sigel, 1980; Sigel, 1970, 1986, 1990). The observation procedure for the Kindergarten Classroom Profile was adopted from an unpublished manual used in a previous classroom observational study (Stigler et al., 1987). A coding manual was developed for the Kindergarten Classroom Profile (see Appendix D).

Teacher behavior studied included 29 categories in five groups: (A) teacher orientation, (B) activity type, (C) teaching behavior, (D) interaction, and (E) activity source. Group A, teacher orientation, describing with whom the teacher works, included: (1) whole class, (2) group, (3) individual child, and (4) others. Group B, activity type, included: (1) mathematics taught as an isolated subject, (2) mathematics integrated with other activities, (3) literacy and literacy-related activities, (4) activities related to other developmental areas, and (5) others. Group C, teaching behavior, included: (1) low-level cognitive distancing, (2) medium-level cognitive distancing, (3) high-level cognitive distancing, (4) monitoring children's participation, and (5) others. Group D, interaction, included: (1) positive, (2) neutral, (3) negative, and (4) others. Group E, activity source, included: (1) manipulatives, (2) foods, (3) media/audiovisual materials, (4) people, (5) books, (6) computers, (7) calculators, (8) games, (9) writing/drawing materials, (10) workbooks/worksheets, and (11) others (Appendix D).

Teachers' low, medium, and high cognitive distancing strategies were defined as those of Flaugher and Sigel (1980) (also see Appendix D). Teachers' monitoring behavior was defined as physically responding to children's behavior, such as contacting, smiling, listening to children, or recording children's verbalizations.

To assess how children engaged in mathematics learning-related activities, each child's behaviors were evaluated in terms of 29 categories in four groups: (A) child orientation, (B) activity type, (C) classroom behavior, and (D) activity source. Group A, child orientation, describing with whom the child interacts, was categorized as: (1) whole class, (2) group, (3)
teacher, (4) peer, and (5) alone. Group B, activity type, used the same categories as for teacher observations. Group C, classroom behavior, was categorized as 8 items: (1) initiating learning-related conversations, problems, and questions to others, (2) responding to teacher’s low-level cognitive distancing, (3) responding to teacher’s medium-level cognitive distancing, (4) responding to teacher’s high-level cognitive distancing, (5) responding to peers in learning-related conversations, (6) working alone appropriately, (7) other appropriate, task-related behavior, and (8) others. Group D, activity source, used the same categories as for teacher observations. Children’s low-level cognitive distancing responses include behaviors such as attending, observing, and describing. These types of behaviors were in response to teacher’s low cognitive distancing. Behaviors in response to teacher’s medium cognitive distancing, such as classifying, inferring similarities or differences, counting, etc., were coded as responses to medium cognitive distancing. Responses to high cognitive distancing include giving reasons, assessing situations, making conclusions, etc. (see Appendix D).

**Procedures**

The procedure of obtaining the final list of kindergartens and subjects was affected by consideration of the design of the study and the school district superintendents, teachers, and parents. Detailed information about the procedure for recruiting subject kindergartens is included in Appendix A. In total, 43 school districts were recruited; 30 kindergarten teachers, each from a different district, agreed to participate. The following describes the observer reliability and the classroom observations on the Assessment Profile and the Kindergarten Classroom Profile.

**Phase I**

**Inter-rater Reliability.** To obtain observer reliability, trial observations in kindergarten classrooms that were not included in the study were conducted before observing the selected kindergartens. Observations using the Assessment Profile for Early Childhood Programs...
(Assessment Profile) were evaluated by two raters, both of whom had teaching certificates in early childhood program and had taught kindergartens previously. One month before the research started, these two raters were trained by the third researcher, who had attended reliability training at the institution at which the Assessment Profile was developed. The inter-rater reliability was based upon the formula: \[ \text{AGREEMENT} = 1 - \frac{(A - B)}{(A + B)} \] suggested by Emmer and Millett (1970). The expression \( \frac{(A - B)}{(A + B)} \) is calculated by obtaining the difference between the two raters' scores and then dividing the difference by the sum of the raters' scores. In this formula, the A term is always the larger number. The reliability of the Assessment Profile between these two raters was .92 at the beginning, .95 in the middle, and .98 at the end of the observations. One rater evaluated 16 kindergartens, the other 14.

The observations based on the Kindergarten Classroom Profile were conducted by the third researcher of this study. Trial observations using the Kindergarten Classroom Profile had also been conducted for more than six weeks before data collection started in the kindergartens not included in the study.

Phase II

Observations Using Assessment Profile. To assess developmentally appropriate practices, each classroom was rated by use of the Assessment Profile by one rater. A minimum of two hours was needed to complete the Assessment Profile in each classroom. Items to be answered by the teacher or documents to be examined were presented before children arrived, during recess time, or after the class was over. In general, it took about 15 to 20 minutes to complete the interview. To avoid disrupting the classroom activities and the teachers' or children's orientations, the observer tried to minimize the interactions initiated by the class members.

Observations of Kindergarten Classroom Profile. Each observation period of the Kindergarten Classroom Profile was composed of four blocks of child observations and four
blocks of teacher observations. Two boys and two girls were randomly selected and observed during each visit. Only one child was observed during each block of observations. During the observational periods, each child was observed for four successive 15-second intervals, with each interval followed by a 15-second interval for coding the observed behaviors. During each period, the first child was observed in the first block; the second block was allocated to observing the teacher, followed by the observations of the second child. A tape recorder with earphone was used to guide the observer through the timing sequence of observations. Each child was observed for 24 15-second intervals to yield a total of 6 minutes of observations during each visit. In total, child observations in each classroom lasted 72 minutes. Each teacher was observed for 288 15-second intervals to yield a total of 72 minutes of observations (see Appendix C).

To observe teachers' and children's behaviors regarding mathematics education, each kindergarten classroom was scheduled for three visits. The researcher stayed in the classroom for either the entire morning or the entire afternoon during a school day. Observations occurred during free-choice time, small-group time, large-group time, and transitions. Outdoor time and activities not in the classroom were not recorded. The aim of each visit was to complete 96 intervals of teacher observations and 96 intervals of child observations.

Observation Time. Both the evaluation of the Assessment Profile and observations based on the Kindergarten Classroom Profile began in the last week of September, 1993, after school had been in session for at least four weeks. The two observers evaluating developmental appropriateness on the Assessment Profile worked independently in different kindergartens. Observations based on the Kindergarten Classroom Profile in each kindergarten were conducted on different days of the week. Depending on the schedule of each kindergarten, at least one of the Kindergarten Classroom Profile observations was conducted in the morning and at least one in the afternoon, except for observations of three teachers who
taught only in the morning. The second cycle of observations were conducted after all 30 classrooms had been visited once; the third visit was conducted in the following weeks. In total, data collection required a total of 16 weeks.

Results

General information about the teachers in the present study was obtained from the Kindergarten Teacher Survey. To answer the questions of the study, Pearson product-moment correlation coefficients were computed to assess the relations between scores of kindergarten developmental appropriateness as measured by the Assessment Profile for Early Childhood Programs (Assessment Profile) and the frequencies observed on the Kindergarten Classroom Profile.

Demographics

Table 1 presents demographic information obtained from the Kindergarten Teacher Survey. The average length of total teaching experience of the teachers was 16 years; the average length of kindergarten teaching experience was 11 years. The majority of the teachers (93%, n = 28) held licensure in elementary education. A few teachers (17%, n = 5) reported that their school districts required certain amounts of time to be spent on different subject areas or gave them guidelines for specific subject areas. For example, one teacher reported that she was required to teach literacy for at least 60 minutes a day and mathematics 30 minutes a day.

Sixty-three percent (n = 19) of the kindergarten teachers reported that they were quite familiar with the developmentally appropriate practices guidelines recommended by the National Association for the Education of Young Children (NAEYC). Only 27% (n = 8) of the kindergarten teachers reported that they were quite familiar with the school mathematics standards recommended by the National Council of Teachers of Mathematics (NCTM). Teachers who reported that they were more familiar with NAEYC guidelines also reported they were more familiar with NCTM's school mathematics standards ($r = .41, p < .05$). Teachers who had
Table 1
Demographic Information on Kindergarten Teachers

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>Standard Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Educational Levels:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.A./B.S.</td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B.A./B.S. + College Credits</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.A./M.S.</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>M.A./M.S. + College Credits</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Teaching Certificates:</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elementary Education</td>
<td>28</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Childhood Education</td>
<td>9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Early Childhood Special Education</td>
<td>0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teaching Endorsements</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Class Size</strong></td>
<td>30</td>
<td>20.0</td>
<td>5.0</td>
</tr>
<tr>
<td><strong>Teaching Aides (hours/week)</strong></td>
<td>30</td>
<td>7.8</td>
<td>12.7</td>
</tr>
<tr>
<td><strong>Volunteers (hour/week)</strong></td>
<td>30</td>
<td>1.9</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Years of Teaching Experience</strong></td>
<td>30</td>
<td>15.7</td>
<td>7.0</td>
</tr>
<tr>
<td><strong>Years of Teaching Kindergarten</strong></td>
<td>30</td>
<td>11.0</td>
<td>6.9</td>
</tr>
<tr>
<td><strong>Familiarity with NAEYC Developmental Appropriateness Guidelines (4 = QUITE FAMILIAR; 1 = NEVER HEARD OF)</strong></td>
<td>30</td>
<td>3.5</td>
<td>0.8</td>
</tr>
<tr>
<td><strong>Familiarity with NCTM School Mathematics Standards (4 = QUITE FAMILIAR; 1 = NEVER HEARD OF)</strong></td>
<td>30</td>
<td>3.0</td>
<td>0.7</td>
</tr>
<tr>
<td><strong>In-service Training Hours Related to Pk-4th Grades</strong></td>
<td>30</td>
<td>37.3</td>
<td>50.5</td>
</tr>
<tr>
<td><strong>In-service Training Hours Related to Teaching Pk-4th Grade Mathematics</strong></td>
<td>30</td>
<td>9.4</td>
<td>16.1</td>
</tr>
</tbody>
</table>

N = 30

participated in more college courses as in-service training within the past year reported greater familiarity with the NCTM school mathematics standards ($r = .49$, $p < .01$).

**Developmentally Appropriate Practices in Kindergarten**

The developmental appropriateness of kindergartens was measured by the Assessment Profile. Because no weighted scores of kindergartens on the Assessment Profile had been
reported, scores on the Assessment Profile were reported as the percentages of possible scores. Table 2 indicates the mean raw scores and mean percentages of the total Assessment Profile score and the subscores received by the kindergarten teachers. The average score was 64%, with a range of 29% to 84%. Kindergarten teachers received the highest percentage scores on the Interacting subscale and the lowest scores on the Scheduling subscale. The reliabilities of the Assessment Profile scores in the present study, estimated by Cronbach's coefficient alpha, were as follows: Learning Environment, .88; Scheduling, .90; Curriculum, .86; Interacting, .87; and Individualizing, .48. These results are consistent with those of previous studies of early childhood programs (Abbott-Shim et al., 1992), except that the coefficient alpha of the Individualizing subscale was lower than those of the other subscales and was also lower than that reported by Abbott-Shim et al. (1992). The reliability of the Assessment Profile total score examined by Cronbach's coefficient alpha was .93 in the present study. Therefore, the total Assessment Profile score was used as a measure of the developmental appropriateness of kindergartens.

Table 2
Rating Scores on Assessment Profile for Early Childhood Programs

<table>
<thead>
<tr>
<th>Subscales</th>
<th>Mean (Items)</th>
<th>Standard Deviation (Items)</th>
<th>Total Items (Total Possible Scores)</th>
<th>% of Possible Scores</th>
<th>Cronbach's Coefficient Alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Learning Environment</td>
<td>10.4</td>
<td>4.4</td>
<td>17</td>
<td>61</td>
<td>.88</td>
</tr>
<tr>
<td>Scheduling</td>
<td>6.5</td>
<td>3.3</td>
<td>15</td>
<td>43</td>
<td>.90</td>
</tr>
<tr>
<td>Curriculum</td>
<td>14.0</td>
<td>4.8</td>
<td>22</td>
<td>64</td>
<td>.86</td>
</tr>
<tr>
<td>Interacting</td>
<td>13.0</td>
<td>3.0</td>
<td>15</td>
<td>87</td>
<td>.87</td>
</tr>
<tr>
<td>Individualizing</td>
<td>11.7</td>
<td>1.8</td>
<td>18</td>
<td>65</td>
<td>.48</td>
</tr>
<tr>
<td>Total Score</td>
<td>55.5</td>
<td>12.8</td>
<td>87</td>
<td>64</td>
<td>.93</td>
</tr>
</tbody>
</table>

N = 30
Classroom Behaviors

The frequency of each observed behavior based on the Kindergarten Classroom Profile was multiplied by 15 seconds and then divided by 60 to compute the total time in minutes of teachers' teaching behaviors and children's participating behaviors. Because teachers' high and medium cognitive distancing behaviors occurred infrequently, these two teaching behaviors were combined in one category designated as "higher cognitive distancing behavior". Thus, higher cognitive distancing strategies are similar to those effective teaching strategies as recommended by the NCTM school mathematics standards. Likewise, children's responses to teachers' higher cognitive distancing behavior were computed as responses to either high or medium cognitive distancing behavior on the part of the teacher. When cognitive distancing behavior occurred during an observational interval in which mathematical concepts was presented, either as a distinct subject or integrated with other activities, it was computed as teachers' cognitive distancing in mathematics-related activities. Other learning activities were coded as nonmathematics-related activities.

Teachers' Behaviors

Teachers' classroom behaviors are summarized in Table 3. In all classroom learning activities, including mathematics-related and nonmathematics-related learning activities, teachers spent an average of 31% (22 of 72 minutes) of the observation time using low cognitive distancing strategies (e.g., asking children to observe, label, identify, define, demonstrate, etc). They spent an average of 24% (17 minutes) of the observation time using higher cognitive distancing strategies (e.g., inviting children to sequence, predict, evaluate, plan, generalize, etc). Kindergarten teachers differed greatly in use of higher cognitive distancing; ranging from 13% to 50% of the total observation time.

Teachers spent an average of 25% (18 minutes) of the time monitoring children's participation: walking around the class, interacting with children, writing words dictated by
Nonteaching behavior was recorded when the teacher was not interacting with children, such as when there was no eye contact or when the teacher was engaging in her own business (e.g., out of classroom, working on administrative tasks, or talking with parents/other staff, etc.). In total, kindergarten teachers spent an average of 79% (57 minutes) of their class time on teaching in all classroom learning activities and 21% (15 minutes) on nonteaching behaviors in the kindergarten (see Table 3).

The total teaching time included time spent using low and higher cognitive distancing strategies, as well as monitoring children's learning. Kindergarten teachers who spent more time on teaching spent more time using higher cognitive distancing strategies ($r = .56, p < .001$); they also allotted more time to teaching mathematics-related activities ($r = .38, p < .05$). The frequency of teachers' higher cognitive distancing behaviors was correlated with the amount of time they spent teaching mathematics ($r = .49, p < .01$).

Children's Behaviors

Children's classroom behaviors are summarized in Table 4. Kindergarten children's classroom behaviors reflected their teachers' teaching strategies. Children's class participating behaviors were computed as time spent in learning-related activities. Participating behaviors included initiating learning-related conversations (e.g., presenting problems, asking questions, or asking for help), responding to the teacher's low cognitive distancing (e.g., observing, describing, etc.) or higher cognitive distancing strategies (e.g., classifying, evaluating, etc.), responding to peers, and working independently. Children's other appropriate classroom behaviors, such as helping to clean up, waiting for the teacher to check their work, or walking around in the room, and their inappropriate behaviors, such as kicking, throwing objects, or inappropriate interactions with peers, were not included as class participating behaviors. The combination of classroom-appropriate behaviors not related to learning and inappropriate classroom behaviors was computed as "other classroom behaviors".
Table 3
Kindergarten Teachers' Classroom Behaviors In 72 Minutes of Observations

<table>
<thead>
<tr>
<th>All Learning Activities</th>
<th>Mean (Minutes)</th>
<th>Standard Deviation (Minutes)</th>
<th>% of 72-Minute Observation Time</th>
<th>% of Mathematics-Related Teaching Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Higher Cognitive Distancing</td>
<td>17</td>
<td>6.5</td>
<td>24</td>
<td></td>
</tr>
<tr>
<td>Low Cognitive Distancing</td>
<td>22</td>
<td>5.7</td>
<td>31</td>
<td></td>
</tr>
<tr>
<td>Monitoring</td>
<td>18</td>
<td>5.7</td>
<td>25</td>
<td></td>
</tr>
<tr>
<td>Total Teaching Time</td>
<td>57</td>
<td>5.9</td>
<td>79</td>
<td></td>
</tr>
<tr>
<td>Total Nonteaching Time</td>
<td>15</td>
<td>5.9</td>
<td>21</td>
<td></td>
</tr>
<tr>
<td>Mathematics-Related Activities</td>
<td>Mean (Minutes)</td>
<td>Standard Deviation (Minutes)</td>
<td>% of 72-Minute Observation Time</td>
<td>% of Mathematics-Related Teaching Time</td>
</tr>
<tr>
<td>Higher Cognitive Distancing</td>
<td>7</td>
<td>4.0</td>
<td>10</td>
<td>39</td>
</tr>
<tr>
<td>Low Cognitive Distancing</td>
<td>6</td>
<td>2.2</td>
<td>8</td>
<td>33</td>
</tr>
<tr>
<td>Monitoring</td>
<td>5</td>
<td>2.9</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td>Total Teaching Time</td>
<td>18</td>
<td>6.6</td>
<td>25</td>
<td>100</td>
</tr>
<tr>
<td>Nonmathematics-Related Activities</td>
<td>Mean (Minutes)</td>
<td>Standard Deviation (Minutes)</td>
<td>% of 72-Minute Observation Time</td>
<td>% of Nonmathematics-Related Teaching Time</td>
</tr>
<tr>
<td>Higher Cognitive Distancing</td>
<td>9</td>
<td>4.2</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td>Low Cognitive Distancing</td>
<td>16</td>
<td>5.8</td>
<td>22</td>
<td>43</td>
</tr>
<tr>
<td>Monitoring</td>
<td>12</td>
<td>4.0</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>Total Teaching Time</td>
<td>37</td>
<td>7.1</td>
<td>51</td>
<td>100</td>
</tr>
</tbody>
</table>

N = 30
1 Including mathematics-related and nonmathematics-related activities.

In all classroom learning activities, including mathematics-related and nonmathematics-related activities, kindergarten children spent an average of 40% of the 72-minute observation time responding to teachers' low cognitive distancing and an average of 11% of the time responding to higher cognitive distancing. The range of the percentages of responding to higher...
Table 4
Kindergarten Children's Classroom Behaviors in 72 Minutes of Observations

<table>
<thead>
<tr>
<th>All Learning Activities¹</th>
<th>Mean (Minutes)</th>
<th>Standard Deviation (Minutes)</th>
<th>% of 72-Minute Observation Time</th>
<th>% of Mathematics-Related Learning Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>8</td>
<td>4.0</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>29</td>
<td>6.8</td>
<td>40</td>
<td></td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>1</td>
<td>1.0</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>7</td>
<td>2.5</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Work Independently</td>
<td>16</td>
<td>5.7</td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>61</td>
<td>3.8</td>
<td>85</td>
<td></td>
</tr>
<tr>
<td>Other Classroom behaviors</td>
<td>11</td>
<td>3.2</td>
<td>15</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Mathematics-Related Activities</th>
<th>Mean (Minutes)</th>
<th>Standard Deviation (Minutes)</th>
<th>% of 72-Minute Observation Time</th>
<th>% of Mathematics-Related Learning Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>4</td>
<td>2.6</td>
<td>6</td>
<td>19</td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>7</td>
<td>4.9</td>
<td>10</td>
<td>33</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>1</td>
<td>0.7</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>3</td>
<td>1.8</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Work Independently</td>
<td>6</td>
<td>3.4</td>
<td>9</td>
<td>29</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>21</td>
<td>7.0</td>
<td>29</td>
<td>100</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Nonmathematics-Related Activities</th>
<th>Mean (Minutes)</th>
<th>Standard Deviation (Minutes)</th>
<th>% of 72-Minute Observation Time</th>
<th>% of Non-Mathematics-Related Learning Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>4</td>
<td>2.6</td>
<td>6</td>
<td>10</td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>21</td>
<td>6.3</td>
<td>29</td>
<td>54</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>1</td>
<td>1.6</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>4</td>
<td>1.6</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Work Independently</td>
<td>9</td>
<td>4.9</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>39</td>
<td>7.5</td>
<td>54</td>
<td>100</td>
</tr>
</tbody>
</table>

N = 30
¹ Including mathematics-related and nonmathematics-related activities.
cognitive distancing was from 5% to 32% of children's total participating time and the range of the percentages of responding to low cognitive distancing was from 29% to 68%. Children spent an average of 10% of the time initiating learning-related conversations, two percent of the time responding to their peers, and 22% of the time working independently. In total, kindergarten children spent an average of 85% (61 minutes) of their class time participating in learning-related activities and 16% of the time in other classroom behaviors (see Table 4).

**Relations between Developmentally Appropriate Practices and Teachers' Classroom Behaviors**

To test the first hypothesis, that kindergartens whose practices were more developmentally appropriate would demonstrate effective teaching strategies in teaching mathematics more frequently than would those whose practices were less developmentally appropriate, correlations between the scores of kindergarten developmental appropriateness as measured by the Assessment Profile for Early Childhood Programs (Assessment Profile) and teachers' classroom behaviors were examined. Both the frequency and percentage of time teachers spent in teaching were examined. The percentage of teachers' total teaching time was obtained by dividing the frequency of teaching behaviors by the total 288 observation intervals. The percentage of each of the teaching behaviors in mathematics-related activities was obtained by dividing the frequency of each of the teaching behaviors by the frequency of mathematics-related activities. The percentage of each of the teaching behaviors in nonmathematics-related activities was obtained by dividing the frequency of each of the teaching behaviors by the frequency of nonmathematics-related activities. The correlations between the Assessment Profile scores and both the frequency and percentage of time spent in classroom behaviors were similar. Table 5 shows the correlations between the Assessment Profile scores and the frequency of teachers' classroom behaviors.
Table 5

Correlations between Developmental Appropriateness Scores on Assessment Profile and Frequencies of Kindergarten Teachers' Classroom Behaviors

<table>
<thead>
<tr>
<th>CLASSROOM BEHAVIORS</th>
<th>DEVELOPMENTAL APPROPRIATENESS SCORES ON ASSESSMENT PROFILE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teachers' Behaviors</td>
<td>Learning Environment</td>
</tr>
<tr>
<td>All Classroom Learning Activities¹</td>
<td></td>
</tr>
<tr>
<td>Higher Cognitive Distancing</td>
<td>.03</td>
</tr>
<tr>
<td>Low cognitive Distancing</td>
<td>.02</td>
</tr>
<tr>
<td>Monitoring</td>
<td>.12</td>
</tr>
<tr>
<td>Mathematics-Related Activities</td>
<td></td>
</tr>
<tr>
<td>Higher Cognitive Distancing</td>
<td>.06</td>
</tr>
<tr>
<td>Low Cognitive Distancing</td>
<td>.18</td>
</tr>
<tr>
<td>Monitoring</td>
<td>.19</td>
</tr>
<tr>
<td>Nonmathematics-Related Activities</td>
<td></td>
</tr>
<tr>
<td>Higher Cognitive Distancing</td>
<td>-.03</td>
</tr>
<tr>
<td>Low Cognitive Distancing</td>
<td>-.03</td>
</tr>
<tr>
<td>Monitoring</td>
<td>.05</td>
</tr>
</tbody>
</table>

N = 30.

* * p < .01.

¹ Including mathematics-related and nonmathematics-related activities.

The amount of time teachers spent on monitoring children's participation in all classroom learning activities was correlated with the score on the Scheduling subscale of the Assessment Profile (r = .44, p < .01) (see Table 5). Teachers who had classroom activities planned and whose classroom activities were varied were more likely to spend their teaching time supervising and supporting children's participation in classroom activities. Such teachers were also more likely to encourage and support children's learning. Teachers rated higher on the Scheduling subscale were also more likely to spend time monitoring children's participation in mathematics-related activities and nonmathematics-related activities. No significant correlations were found between the amount of time teachers spent on using higher cognitive distancing or
low cognitive distancing strategies and the degree to which kindergartens’ practices were developmentally appropriate.

Relations between Developmentally Appropriate Practices and Children’s Classroom Behaviors

To test the second hypothesis, that children in more developmentally appropriate kindergartens would more frequently participate in mathematics learning-related activities than would those not in such programs, correlations between the degree of kindergartens’ developmental appropriateness measured by the Assessment Profile and children’s classroom behaviors were examined. Both frequency and percentage of children’s participating behaviors were used to calculate the correlations. The percentage of children’s total participating time was obtained by dividing the frequency with which children participated in learning activities by the 288 observation intervals. The percentage of each of the participating behaviors in mathematics-related learning was obtained by dividing the frequency of each of the participating behaviors by the frequency of mathematics-related activities. The percentage of each of the participating behaviors in nonmathematics-related learning was obtained by dividing the frequency of each of the participating behaviors by the frequency of nonmathematics-related learning activities. The correlations between the Assessment Profile scores and both the frequency and percentage of time children spent in classroom behaviors were similar. Table 6 shows the correlations between the Assessment Profile scores and the frequency of children’s classroom behaviors.

All Learning Activities

Children in more developmentally appropriate kindergartens were more frequently engaged in learning-related activities. The total amount of time children engaged in all classroom learning activities, including mathematics-related and nonmathematics-related activities, was significantly correlated with the total Assessment Profile score ($r = .54$, $p <$
and with scores on Curriculum ($r = .50, p < .01$), Interacting ($r = .46, p < .01$), and Individualizing ($r = .39, p < .05$) subscales.

In all classroom learning activities, the amount of time children spent in initiating learning-related conversations was correlated with the Assessment Profile total scores ($r = .52, p < .01$) and the subscores on Learning Environment ($r = .42, p < .05$), Curriculum ($r = .54, p < .01$), and Interacting ($r = .41, p < .05$) (see Table 6). Children in more developmentally appropriate kindergartens more frequently demonstrated behaviors such as asking questions, offering suggestions, presenting problems, or asking for help from the teacher or peers.

Significant correlations were found between the amount of time children spent in initiating conversations and the amount of time they spent responding to their peers ($r = .52, p < .01$). The amount of time children spent in initiating learning-related conversations was correlated with the amount of time children worked independently in all learning activities ($r = .51, p < .01$) and in exploring mathematics learning-related activities independently ($r = .75, p < .001$).

**Mathematics-Related Activities**

Significant correlations between the Assessment Profile scores and the percentage of time children participated in classroom learning activities indicated that children in the kindergartens rated higher on the Curriculum ($r = .39, p < .05$) and Interacting ($r = .36, p < .05$) subscales were more likely to initiate learning-related conversations in mathematics-related activities. These results suggest that children whose teachers demonstrated more developmentally appropriate practices in adopting curriculum and interacting strategies were more likely to initiate learning-related conversations such as asking questions and offering comments and suggestions. A significant negative correlation was found between teachers' score on the Interacting subscale and the amount of time children spent in responding
Table 6
Correlations between Assessment Profile Scores and Frequencies of Kindergarten Children's Classroom Behaviors

<table>
<thead>
<tr>
<th>CLASSROOM BEHAVIORS</th>
<th>DEVELOPMENTAL APPROPRIATENESS SCORES ON ASSESSMENT PROFILE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Learning Environment</td>
</tr>
<tr>
<td>All Learning Activities</td>
<td></td>
</tr>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>-.47**</td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>.16</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.32</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.41*</td>
</tr>
<tr>
<td>Work Independently</td>
<td>.12</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>.33</td>
</tr>
<tr>
<td>Mathematics-Related Activities</td>
<td></td>
</tr>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>-.28</td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>.05</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.24</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.13</td>
</tr>
<tr>
<td>Work Independently</td>
<td>.18</td>
</tr>
<tr>
<td>Nonmathematics-Related Activities</td>
<td></td>
</tr>
<tr>
<td>Respond to Higher Cognitive Distancing</td>
<td>-.46**</td>
</tr>
<tr>
<td>Respond to Low Cognitive Distancing</td>
<td>.14</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.25</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.46**</td>
</tr>
<tr>
<td>Work Independently</td>
<td>.01</td>
</tr>
</tbody>
</table>

N = 30. * p < .05; ** p < .01; *** p < .001.
1 Including mathematics-related and nonmathematics-related activities.
to teachers' higher cognitive distancing (see Table 6). These results suggest that teachers who more frequently initiated interactions with children or spent time managing classroom behaviors were less likely to use higher cognitive distancing in teaching mathematics. Children in such teachers' classes had fewer opportunities to respond to higher cognitive distancing and thus were less likely to respond to higher cognitive distancing.

**Nonmathematics-Related Learning Activities**

The frequency of children's responses to teachers' low cognitive distancing behaviors on nonmathematics-related learning activities was correlated with the Interacting subscore on the Assessment Profile ($r = .38, p < .05$). Children's initiating behaviors in nonmathematics-related activities were correlated with the total Assessment Profile score ($r = .58, p < .001$); and with the subscores on Learning Environment ($r = .46, p < .01$), Scheduling ($r = .42, p < .05$), and Curriculum ($r = .51, p < .01$) (see Table 6). A significant correlation was found between the Individualizing subscore and children's initiating behaviors in nonmathematics-related learning activities expressed as a percentage of time ($r = .38, p < .05$). Children in kindergartens whose teachers demonstrated more developmentally appropriate practices in focusing on individual children's needs and interests were more likely to initiate learning-related conversations in nonmathematics-related activities.

**Responding to Cognitive Distancing**

In all classroom learning activities, the amount of time children spent responding to their teachers' higher cognitive distancing was negatively correlated with the total score ($r = -.45, p < .01$) and with the following Assessment Profile subscales: Learning Environment ($r = -.47, p < .01$); Curriculum ($r = -.47, p < .01$); Interacting ($r = -.51, p < .01$) (see Table 6). Kindergarten children whose teachers were rated higher on their developmentally appropriate practices were less likely to respond to their teachers' cognitive distancing in all learning-related
activities. Similar results were found both in mathematics-related and nonmathematics-related activities (see Table 6).

The amount of time children spent responding to teachers' higher cognitive distancing in all learning activities was negatively correlated with the Interacting subscale score ($r = -.51, p < .01$) (see Table 6). The amount of time children spent responding to their teachers' higher cognitive distancing in nonmathematics-related learning activities was negatively correlated with the total Assessment Profile scores ($r = -.52, p < .01$) and with the subscale scores for Learning Environment ($r = -.46, p < .01$), Curriculum ($r = -.47, p < .01$), and Interacting ($r = -.42, p < .05$) (see Table 6). A negative correlation was found between time spent by children in responding to their teachers' higher cognitive distancing and the Individualizing subscore ($r = .38, p < .05$) when time was expressed as the percentage of time rather than the amount of time.

**Comparison of Teaching Behaviors in Mathematics-Related and Nonmathematics-Related Activities**

**Teaching Time**

To compare teachers' classroom behaviors in mathematics-related and nonmathematics-related activities, the percentages of total teaching time spent on the two kinds of activities were examined. Kindergarten teachers spent 25% of the 72-minute observation time teaching mathematics-related activities and 51% of the observation time teaching nonmathematics-related activities (see Table 3). Based on the amount of learning time scheduled in their classrooms (approximately 100 minutes for half-day kindergartens and 180 minutes for all-day kindergartens), half-day kindergarten teachers taught mathematics approximately 2.1 hours a week and taught nonmathematics-related activities approximately 4.3 hours a week, and teachers in all-day kindergarten spent approximately 3.8 hours a week teaching mathematics-related activities and approximately 7.7 hours a week teaching nonmathematics-related activities.
(see Table 7). Compared with previous studies of first-grade mathematics classroom practices (Chung, 1990; Stigler et al., 1987), the present study indicated that teachers in all-day

Table 7
Number of Hours Each Week Spent in Mathematics and Nonmathematics-related Activities: Comparison of Three Studies

<table>
<thead>
<tr>
<th>Methods</th>
<th>Observations</th>
<th>Survey</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Subjects</td>
<td>First Grade (N = 20)</td>
<td>First Grade (N = 136)</td>
<td>Kindergarten (N = 30)</td>
</tr>
<tr>
<td>Mathematics-Related</td>
<td>2.9</td>
<td>3.3</td>
<td>3.8</td>
</tr>
<tr>
<td>Non-Mathematics-Related</td>
<td>Not Applicable</td>
<td>Not Applicable</td>
<td>7.7</td>
</tr>
</tbody>
</table>

kindergartens spent a greater amount of time teaching mathematics and their children spent more time participating in mathematics-related activities.

Cognitive Distancing Behaviors

During mathematics-related activities, kindergarten teachers spent 39% and 33% of the time on higher cognitive distancing and low cognitive distancing behaviors respectively. They spent 24% and 43% of their nonmathematics-related teaching time on higher cognitive distancing and low cognitive distancing respectively. Kindergarten teachers used higher cognitive distancing during more of their mathematics teaching time than of their nonmathematics-related activities. In contrast, they spent a higher percentage of nonmathematics-related teaching time than of mathematics teaching time using low cognitive distancing (see Table 3).
Mathematics Activities Integrated and Encouraged

Mathematics teaching in kindergarten was integrated with other learning activities most of the time. The total amount of time spent on mathematics teaching and learning was integrated with other learning-related activities ($r = .96, p < .001$) (see Table 8). Kindergarten teachers seldom taught mathematics as a separate subject.

Observed positive and neutral interactions were computed as positive interactions to examine the classroom learning climate. Positive and neutral interactions between the teacher and children were highly correlated with mathematics teaching time ($r = .99, p < .001$) (see Table 8). Mathematics teaching in kindergarten was presented in a positive and pleasant atmosphere. Teachers encouraged mathematics learning and refrained from negative verbalizations such as criticism or threats. Positive and neutral interactions between the teacher and children were also highly correlated with nonmathematics-related teaching time ($r = .98, p < .001$) (see Table 8).

Table 8

Relationships among Mathematics Teaching Time, Integration of Mathematics with Other Activities, and Positive Interactions in Teaching

<table>
<thead>
<tr>
<th>Mathematics Integrated with Other Learning Activities</th>
<th>Total Time Spent in Mathematics Teaching and Learning</th>
<th>Positive and Neutral Interactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r = .96^{***}$</td>
<td>$.96^{***}$</td>
<td>$.92^{***}$</td>
</tr>
<tr>
<td>Total Time Teaching Mathematics-Related Activities</td>
<td>$r = .96^{***}$</td>
<td>$r = .99^{***}$</td>
</tr>
<tr>
<td>Total Time Teaching Nonmathematics-Related Activities</td>
<td>$r = .67^{***}$</td>
<td>$r = .98^{***}$</td>
</tr>
</tbody>
</table>

$N = 30$; $^{***} p < .001$.  


Comparison of Children's Learning Behaviors in Mathematics-Related and Nonmathematics-Related Activities

Participating Time

To compare kindergarten children's learning behaviors in mathematics-related and nonmathematics-related activities, the percentages of total participating time on mathematics-related and nonmathematics-related activities were examined. Kindergarten children spent 29% of the 72-minute observation time participating in mathematics-related learning activities and 54% of the time participating in nonmathematics-related activities (see Table 4). According to the scheduled learning time in kindergarten classrooms, children in half-day kindergartens spent approximately 2.4 hours a week participating in mathematics-related learning activities and approximately 4.5 hours a week in nonmathematics-related learning activities; those in all-day kindergartens spent approximately 4.4 hours a week participating in mathematics-related activities and approximately 8.1 hours a week participating in nonmathematics-related learning activities. Estimates from child observations indicated slightly more time spent in both mathematics-related and nonmathematics-related activities, compared with estimates based on observations of teachers.

Responding to Cognitive Distancing

Children spent the same amount of total class time (4 minutes each) responding to higher cognitive distancing in mathematics-related and in nonmathematics-related learning activities. Expressed as the percentages of time, however there was a marked difference in time spent responding to higher cognitive distancing in mathematics-related than in nonmathematics-related activities. Kindergarten children spent 19% of their mathematics-related learning time and only 10% of nonmathematics-related learning time responding to teachers' higher cognitive distancing. Conversely, they spent a higher percentage of nonmathematics-related learning time than of mathematics-related learning activities responding to low cognitive distancing (see Table 4).
Responding to Peers, Initiating Conversations, and Working Independently

On the average, children spent little time (1 minute) responding to their peers, either in mathematics-related or in nonmathematics-related activities. Children spent a slightly higher percentage of mathematics-related learning time than of nonmathematics-related learning time initiating conversations and working independently.

In summary, there were no significant differences in terms of the number of minutes kindergarten children's spent responding to teachers' higher cognitive distancing in mathematics-related and in nonmathematics-related learning activities. Children responded more frequently to their teachers' low cognitive distancing in nonmathematics-related learning activities than in mathematics-related learning activities. However, children spent a higher percentage of mathematics-related learning time than of nonmathematics-related learning time responding to higher cognitive distancing. They also spent higher percentages of mathematics-related learning time initiating conversations, responding to peers, and working independently than they did in nonmathematics-related learning time (see Table 4).

Relations between Teachers' Behaviors and Children's Behaviors

Kindergarten children's classroom behaviors were closely related to their teachers' teaching behaviors (see Table 9). Similar results were found in the correlations between teachers' and children's classroom behaviors expressed as the frequency of behaviors and as the percentage of time. Table 9 indicates the correlations examined with the frequency of behaviors.

All Learning Activities

In all classroom learning activities, the amount of time children engaged in learning activities was correlated with the amount of time their teachers spent in teaching ($r = .48, p < .01$). Kindergarten children whose teachers spent more time teaching (i.e., monitoring and using low and higher cognitive distancing) were more frequently involved in classroom activities
(i.e., initiating conversations, working independently, responding to peers, and responding to low and higher cognitive distancing). The amount of time teachers' spent on using low cognitive distancing was correlated with the amount of time children spent on responding to teachers' low cognitive distancing ($r = .58, p < .001$). The amount of time teachers spent on monitoring children's learning behaviors was correlated with the amount of time children spent initiating learning-related conversations ($r = .46, p < .05$) and working independently ($r = .43, p < .01$). Children whose teachers spent more time on child-directed activities were more likely to initiate learning-related conversations. They also had more opportunities to explore classroom activities independently; that is, they were more likely to have opportunities to construct their own understanding. The amount of time teachers spent monitoring children's learning behaviors was negatively correlated with the amount of time children responded to low cognitive distancing ($r = -.49, p < .01$). Kindergarten children whose teachers spent more time monitoring in the class were less likely to respond to their teachers' teaching behaviors; they were less likely to have opportunities to follow the teachers' directions and to observe the teachers' demonstrations (see Table 9).

**Mathematics-Related Activities**

The amount of time children participated in mathematics-related activities was correlated with the amount of time teachers spent in using both higher ($r = .75, p < .001$) and low cognitive distancing ($r = .70, p < .001$) in teaching mathematics. Kindergarten children whose teachers more often demonstrated cognitive distancing strategies were more likely to have opportunities to participate in mathematics-related activities. The amount of time children responded to higher cognitive distancing was correlated with the amount of time teachers demonstrated higher cognitive distancing ($r = .46, p < .01$) and the amount of time children responded to low cognitive distancing in learning mathematics ($r = .74, p < .001$). Kindergarten children's participating behaviors in learning mathematics reflected their teachers'
teaching behaviors. Kindergarten children whose teachers used more cognitive distancing in the classroom were more likely to participate actively in learning activities. Children whose teachers used more cognitive distancing (both higher and low) in teaching mathematics were also more likely to respond to their teachers' higher and low cognitive distancing (see Table 9). The amount of time teachers spent on teaching mathematics was correlated with the amount of time children spent responding to both higher ($r = .51, p < .01$) and low cognitive distancing ($r = .68, p < .001$). Kindergarten children whose teachers spent more time teaching mathematics were more likely to respond to both higher and low cognitive distancing in learning mathematics (see Table 9).

Nonmathematics-Related Activities

In nonmathematics-related learning activities, children's participating behaviors were correlated with their teachers' teaching behaviors similarly to the relationships for mathematics-related activities (see Table 9). Significant correlations were found between the amount of time teachers spent in using low and higher cognitive distancing and the amount of time children responded to low and higher cognitive distancing in nonmathematics-related learning activities (see Table 9). The amount of time teachers spent in monitoring children's learning in all classroom learning activities was correlated with children's initiating conversations ($r = .38, p < .05$) and working independently ($r = .52, p < .01$). The amount of time teachers spent in monitoring children's learning was correlated with the amount of time children initiated learning-related conversations ($r = .59, p < .001$). Other correlations between kindergarten teachers' and children's classroom behaviors are indicated in Table 9.
Table 9  
Correlations between Frequencies of Teachers' Teaching Behaviors and Children's Learning Behaviors

<table>
<thead>
<tr>
<th>Children's Learning Behaviors</th>
<th>Teachers' Teaching Behaviors</th>
<th>Mathematics-Related Activities</th>
<th>Nonmathematics-Related Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>All Learning Activities¹</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>HCD</td>
<td>LCD</td>
<td>MONI</td>
</tr>
<tr>
<td>Respond to HCD</td>
<td>.32</td>
<td>.38*</td>
<td>.10</td>
</tr>
<tr>
<td>Respond to LCD</td>
<td>.01</td>
<td>**</td>
<td>-.49</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.09</td>
<td>-.03</td>
<td>.25</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.06</td>
<td>-.09</td>
<td>.46*</td>
</tr>
<tr>
<td>Work Independently</td>
<td>-.13</td>
<td>-.29</td>
<td>.43**</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>.23</td>
<td>.13</td>
<td>.18</td>
</tr>
<tr>
<td>Mathematics-Related Activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respond to HCD</td>
<td>.27</td>
<td>.47**</td>
<td>.31</td>
</tr>
<tr>
<td>Respond to LCD</td>
<td>.37*</td>
<td>-.01</td>
<td>.25</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.03</td>
<td>.01</td>
<td>.17</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.00</td>
<td>-.05</td>
<td>.21</td>
</tr>
<tr>
<td>Work Independently</td>
<td>.09</td>
<td>-.11</td>
<td>-.03</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>.45**</td>
<td>.29</td>
<td>.03</td>
</tr>
<tr>
<td>Nonmathematics-Related Activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Respond to HCD</td>
<td>.20</td>
<td>-.09</td>
<td>-.14</td>
</tr>
<tr>
<td>Respond to LCD</td>
<td>-.32</td>
<td>.59**</td>
<td>-.28</td>
</tr>
<tr>
<td>Respond to Peers</td>
<td>.06</td>
<td>-.01</td>
<td>.23</td>
</tr>
<tr>
<td>Initiate Learning-Related Conversations</td>
<td>.13</td>
<td>-.09</td>
<td>.38*</td>
</tr>
<tr>
<td>Work Independently</td>
<td>-.22</td>
<td>-.26</td>
<td>.52**</td>
</tr>
<tr>
<td>Total Participating Time</td>
<td>-.30</td>
<td>-.26</td>
<td>.15</td>
</tr>
</tbody>
</table>

N = 30.  * p < .05;  ** p < .01;  *** p < .001.  
¹ Including mathematics-related and nonmathematics-related activities. 
HCD = Higher Cognitive Distancing; LCD = Low Cognitive Distancing; MONI = Monitoring; TTT = Total Teaching Time.
Relations between Teachers' Characteristics and Degree of Developmental Appropriate Practices

Table 10 shows Pearson's product-moment correlation coefficients for the Assessment Profile scores and the characteristics of the kindergartens and the teachers. In agreement with previous results (Bryant et al., 1991), results of the present study demonstrated that the type of program (all-day or half-day kindergartens), class size, school size, and geographic location were not related to the extent of developmentally appropriateness in the kindergarten.

Nominated teachers in this study were rated higher than average on their Assessment Profile total scores ($r = .49$, $p < .01$) and on the Learning Environment ($r = .42$, $p < .05$), Curriculum ($r = .46$, $p < .01$), and Interacting ($r = .51$, $p < .01$) subscores. Kindergarten teachers in the school districts requiring specific lengths of time for specific subjects were more likely to receive higher rating scores on the Scheduling subscale of the Assessment Profile ($r = .36$, $p < .05$). Teachers with more years of kindergarten teaching experience received higher Assessment Profile total scores ($r = .41$, $p < .05$) and higher subscores for Learning Environment ($r = .46$, $p < .01$) and Curriculum ($r = .40$, $p < .05$). Teachers with more experience in teaching kindergarten were better able to implement developmentally appropriate practices. Teachers reporting greater familiarity with the NAEYC developmental appropriateness guidelines were more likely to receive higher Assessment Profile total scores ($r = .43$, $p < .01$), and higher subscores for Learning Environment ($r = .49$, $p < .01$) and Interacting ($r = .42$, $p < .01$). Teachers reporting greater familiarity with the NCTM school mathematics standards were more likely to receive higher scores on the Interacting subscale ($r = .37$, $p < .05$).

Teachers reporting greater familiarity with the NAEYC developmentally appropriate practices guidelines or the NCTM school mathematics standards were more effective in interacting with children. Such teachers were more likely to encourage children's participation in learning activities and to stimulate children's thinking. The number of hours kindergarten teachers attended in-service training was correlated with their scores on the Individualizing subscale of
Table 10
Correlations between Kindergarten Teacher Survey Results and Developmental Appropriateness Scores on Assessment Profile

<table>
<thead>
<tr>
<th>Survey Results</th>
<th>Learning Environment</th>
<th>Scheduling</th>
<th>Curriculum</th>
<th>Interacting</th>
<th>Individualizing</th>
<th>Total Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nomination</td>
<td>.42*</td>
<td>.06</td>
<td>.49**</td>
<td>.51**</td>
<td>.22</td>
<td>.49**</td>
</tr>
<tr>
<td>District Requirement of Subject Areas</td>
<td>.10</td>
<td>.36*</td>
<td>.16</td>
<td>.03</td>
<td>.19</td>
<td>.22</td>
</tr>
<tr>
<td>Years of Teaching Kindergarten</td>
<td>.46**</td>
<td>.06</td>
<td>.40*</td>
<td>.27</td>
<td>.19</td>
<td>.41*</td>
</tr>
<tr>
<td>Familiarity with NAEYC Developmental Appropriateness Guidelines</td>
<td>.49**</td>
<td>.12</td>
<td>.23</td>
<td>.42*</td>
<td>.35</td>
<td>.43**</td>
</tr>
<tr>
<td>Familiarity with NCTM School Mathematics Standards</td>
<td>.15</td>
<td>-.13</td>
<td>.27</td>
<td>.37*</td>
<td>.20</td>
<td>.23</td>
</tr>
<tr>
<td>In-Service Training Hours</td>
<td>.09</td>
<td>-.14</td>
<td>.17</td>
<td>.31</td>
<td>.44**</td>
<td>.19</td>
</tr>
</tbody>
</table>

N = 30. * p < .05; ** p < .01.

the Assessment Profile (r = .55, p < .05). Teachers who attended more hours of in-service training, including professional conferences, workshops, seminars, and college courses relating to prekindergarten to fourth-grade topics, were more likely to demonstrate developmentally appropriate practices to meet the interests and needs of the individual children in the class.

Relations between Teachers’ Characteristics and Classroom Behaviors in Mathematics-Related Activities

Table 11 shows a significant correlation between the amount of time children spent in participating in mathematics-related learning activities and the type of program (r = .37, p < .05); children in all-day kindergartens spent more time participating in mathematics-related learning activities than those in half-day kindergartens. The number of hours teachers attended in-service training related to pre-kindergarten to fourth grade topics was correlated with the observed frequency of teachers’ higher cognitive distancing behaviors in teaching mathematics.
(r = .44, p < .01) and with the amount of time children participated in mathematics-related learning activities (r = .23, p < .05) (see Table 11). Teachers who had spent more time attending in-service training-related activities were more likely to use higher cognitive distancing in teaching mathematics and children in those teachers' classes were more likely to participate in mathematics-related learning activities. No significant correlations were found between class size and kindergarten mathematics class practices.

Table 11
Correlations between Kindergarten Teacher Survey Results and Frequencies of Classroom Behaviors in Mathematics-Related Activities

<table>
<thead>
<tr>
<th>Survey Result</th>
<th>Teachers' Teaching Behaviors in Mathematics-Related Activities</th>
<th>Children's Participating Behaviors in Mathematics-Related Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Higher Cognitive Distancing</td>
<td>Low Cognitive Distancing</td>
</tr>
<tr>
<td>All-Day/Half-Day Program</td>
<td>.33</td>
<td>.22</td>
</tr>
<tr>
<td>in-Service Training Hours Related to Pk-4th Grade</td>
<td>.44**</td>
<td>-.10</td>
</tr>
</tbody>
</table>

N = 30. * p < .05; ** p < .01.

Discussion
The discussion will begin with a review of the objectives and hypotheses as well as a comparison of findings relative to the predictions made. The purpose of the present study was to examine mathematics teaching and learning in kindergarten. The first objective was to examine the relations between the degree of kindergarten's developmentally appropriate practices and the amount of time used for cognitive distancing strategies. The second objective was to compare children's participating behaviors in mathematics-related learning activities with their behaviors in nonmathematics-related learning activities. A final objective was to examine the relations between teachers' teaching behaviors and children's participating behaviors.
Relations between Developmentally Appropriate Practices  
and Teachers' Classroom Behaviors

The first objective of this study was to examine the degree of kindergarten's developmentally appropriate practices and the amount of time used for cognitive distancing strategies. It had been predicted that kindergarten teachers whose practices were more developmentally appropriate would more frequently demonstrate more effective strategies to facilitate mathematical learning than would those whose practices were less developmentally appropriate. Results indicated that no scores on the Assessment Profile were correlated with the amount of time teachers spent using higher or low cognitive distancing to teach mathematics. The degree to which kindergarten teachers practiced developmental appropriateness did not affect their use of cognitive distancing strategies, their integrating of mathematics into other learning activities, or their attitudes of interacting with children. These results may be attributed to the difference in emphasis between the Assessment Profile (which measures child-directed and child-initiated learning) and observations of teaching skills and of children's responses to teaching behaviors. Although the NAEYC and the NCTM both agree on the need for developmentally appropriate practices in kindergarten, they stress different aspects (Bredekamp, 1986; NCTM, 1989, 1991). The NAEYC concept of developmental appropriateness in kindergarten places more emphasis on child-centered and child-directed approaches that encourage children's initiatives and active involvement in activities, and items of the Learning Environment subscale of the Assessment Profile emphasize the importance of materials being accessible to the children without adult assistance (Abbott-Shim & Sibley, 1992). The NCTM's standards for school mathematics emphasize teachers' professional skills in stimulating children's thinking and in providing opportunities for children to link their concrete experiences in solving everyday problems to more abstract mathematical thinking (NCTM, 1989; 1991).
Most of the teachers involved in this study integrated mathematical concepts with other learning activities. They spent about one-fourth of their class time teaching mathematics-related activities and their children spent about one-third of their classroom time participating in mathematics-related activities. Across all learning activities, including mathematics-related and nonmathematics-related activities, teachers demonstrated positive interactions with their children. These results suggest that kindergarten teachers followed both the NAEYC guidelines and the NCTM school mathematics standards and that they positively encouraged their children to participate in classroom activities.

A significant correlation was found between the amount of time teachers spent monitoring children’s participation in all classroom learning activities (including both mathematics-related and nonmathematics-related learning activities) and the score on the Scheduling subscale of the Assessment Profile. This result suggests that teachers who planned a variety of classroom activities for their children and followed their activity plan were more likely to supervise children’s participation. Such teachers were more responsive in meeting children’s needs and interests to support children’s self-discovery and exploration in classroom activities. These practices agreed with the NAEYC guidelines of developmentally appropriate practices (Bredekamp, 1986) and with Piaget’s theory that teachers function as facilitators who provide stimulating environments that allow children to construct their own knowledge (Piaget, 1963, 1983).

Relations between Developmentally Appropriate Practices and Children’s Classroom Behaviors

To examine the degree of kindergarten’s developmentally appropriate practices and the amount of time used for cognitive distancing strategies, children’s classroom participating behaviors were examined. It was predicted that children in more developmentally appropriate kindergartens would more frequently engage in mathematics-related learning activities than those in less developmentally appropriate kindergartens. Such children would more frequently
respond to teachers' cognitive distancing strategies. In addition, children in more developmentally appropriate kindergarten would more frequently initiate learning related conversations and respond to peers' statements. They would also spend more time exploring classroom materials as well as activities. No significant positive correlations were found between the Assessment Profile scores and the amount of time children spent in responding to teachers' cognitive distancing and other participating behaviors in mathematics-related activities. The negative correlation between the Interacting subscale score of the Assessment Profile and the frequency of children responding to teachers' higher cognitive distancing indicated that children whose teachers more frequently initiated interactions with them had fewer opportunities to respond to higher cognitive distancing and thus were less likely to respond to such distancing in mathematics-related learning activities. These results may be attributed to the difference in emphasis between the Assessment Profile (which measures child-directed and child-initiated learning) and observations of teaching skills and of children's responses to teaching behaviors.

The degree of teachers' demonstrating developmentally appropriate practices in adopting curriculum and interacting with children affected children's initiating learning-related conversations in mathematics-related activities when expressed as percentages. Results supported the prediction that children in more developmentally appropriate kindergartens would spend more time initiating conversations such as asking questions and offering suggestions in mathematics-related activities, than would children in less developmentally appropriate kindergartens. Results indicated that children in more developmentally appropriate kindergartens spent more time initiating learning-related conversations and participating in all classroom activities, including mathematics-related as well as nonmathematics-related activities. Such children more frequently responded to their peers' statements and spent more time working alone. Thus, results suggest that children whose teachers demonstrated more developmentally
appropriate practices in curriculum and interacting strategies were more likely to initiate learning-related conversations, respond to peers' statements, and explore classroom activities independently in mathematics-related activities. Such children were also more likely to have opportunities to construct their own mathematical understanding.

Overall, children in more developmentally appropriate kindergartens had more freedom to choose activities and to interact with people and classroom materials according to their own interests. These results indicated that children in kindergartens whose practices were more in accord with the NAEYC guidelines for developmentally appropriate practices more frequently involved in self-initiated learning.

According to the NAEYC guidelines (Bredekamp, 1986) as well as other educators (Kamii, 1985; Katz & Chard, 1989), a developmentally appropriate kindergarten provides more free play time for children to explore the environment. Under the NAEYC guidelines, teachers using developmentally appropriate practices spend considerable time monitoring children's participation and responding to children's initiatives in learning. They facilitate children's self-initiated learning by providing materials and verbal encouragement to extend the level of learning. Based upon their knowledge of children's abilities and experiences, teachers bring problems or create cognitive conflicts to stimulate children's thinking. Therefore, children in developmentally appropriate kindergartens have more opportunities to initiate interaction with peers, materials, and the teacher during free play time.

In addition to the difference in emphasis between the Assessment Profile on child-directed learning and the Kindergarten Classroom Profile observations on children's responses to teachers' teaching behaviors, the lack of awareness of free play time as an opportunity to promote children's thinking may be responsible for the negative correlation between the Assessment Profile scores and the frequency with which children responded to teachers' higher cognitive distancing. A few of the teachers involved in the present study did not take
advantage of children's free play time as an opportunity to facilitate children's learning; these teachers' nonteaching behavior occupied 21% of the observation time, ranging from 10% to 51%. They frequently used children's free play time for preparing class activities or administrative reports, activities that were recorded as nonteaching-related behaviors. These results agreed with findings of Stigler et al. (1987), who reported that, in 13% of their classroom time, American first- and fifth-grade teachers did not engage in teaching but instead engaged in activities such as doing administrative tasks in the classroom.

Teaching and Learning in Mathematics-Related and Nonmathematics-Related Activities

The second objective of the study was to compare children's participating behaviors in mathematics-related learning activities with their behaviors in nonmathematics-related learning activities. Results showed that kindergarten children's learning time reflected teachers' teaching time. The amount of time kindergarten teachers spent in teaching mathematics-related activities was about half as great as the amount of time they spent in teaching nonmathematics-related activities. Similarly, the amount of time kindergarten children spent in participating in mathematics-related activities was about half the amount of time they spent in participating in nonmathematics-related learning activities.

The estimated numbers of hours that teachers spent in teaching mathematics and that children spent in learning mathematics in all-day kindergartens were greater than those indicated by previous results for first-grade children (Chung, 1990; Stigler et al., 1987). The greater times for all-day kindergartens than for first grade may reflect different methods of data collection. The present study included children's free play time, in which activities related to mathematical concepts were recorded as mathematics-related learning time. For example, playing with legos and other countable objects or measurable materials was recorded as a mathematics-related activity. Activities such as reading a book relating to number concepts or identifying and practicing writing number words were also recorded as mathematics teaching or
learning time. Including activities that occurred during free play time may also be the reason that the amount of time kindergarten children engaged in mathematics-related learning activities was slightly greater than the amount of time teachers spent in teaching mathematics-related activities.

**Teachers' Cognitive Distancing and Children's Responses**

The third objective of this study was to examine the relations between teachers' teaching strategies and children's responses to their teachers' teaching strategies. Kindergarten teachers in this study varied markedly in their use of cognitive distancing; their children also demonstrated a great range in responding to teachers' cognitive distancing. In mathematics-related as well as nonmathematics-related learning activities, the amount of time teachers spent in using higher cognitive distancing was correlated with the amount of time children spent in responding to cognitive distancing. Similar results were observed for low cognitive distancing. These results support Vygotsky's theory that teachers match children's experiences and existing knowledge to promote learning (Leushina, 1991; Vygotsky, 1978). The better the teacher can scaffold the situation, the more children can follow and respond to the teacher.

In all learning activities, kindergarten teachers spent less time using higher cognitive distancing strategies than using low cognitive distancing strategies; as a result, children responded more frequently to teachers' low cognitive distancing than to higher cognitive distancing strategies. Teachers spent a higher percentage of mathematics-related teaching time than of nonmathematics-related teaching time using higher cognitive distancing. Conversely, they spent a higher percentage of nonmathematics-related teaching time than of mathematics teaching time using low cognitive distancing. Reflecting their teachers' teaching behaviors, kindergarten children spent more of their nonmathematics-related learning time responding to their teachers' low cognitive distancing strategies and spent a higher percentage of their mathematics-related learning time than of their nonmathematics-related learning time responding
to their teachers' higher cognitive distancing strategies. One possible explanation is that the abstract nature of mathematics makes mathematics teaching and learning require more higher cognitive distancing than is required for teaching and learning nonmathematics-related activities. More research is needed to support or refute this suggestion.

Another possible explanation for the relatively infrequent use of higher cognitive distancing strategies in kindergarten may be related to teachers' emphasis on "basic skills" in kindergartens. For example, teachers spent a great amount of time teaching the alphabet, phonics, numbers, and reading to children (Durkin, 1987) as suggested in the criteria for elementary school effectiveness (Villanova, Gauthier, Proctor, Shoemaker, Freedman, Lappart, & Waterman, 1993). Kindergarten teachers in the current study frequently used low cognitive distancing to teach children these "basic skills" in a large group, which may be attributed to the pressure to attain academic readiness in kindergarten (Bryant et al., 1991; Charlesworth et al., 1991; Mayers, 1991; Rusher et al., 1992).

Research has demonstrated that the use of higher cognitive distancing is related to teachers' familiarity with the context of the task and their knowledge of children's experiences and existing knowledge (Cobb et al., 1990; Pellegrini et al., 1985, 1990). The infrequent use of higher cognitive distancing in kindergarten suggests that teachers may perceive other teaching strategies as more appropriate for their children or that teachers may be unaware of the effective teaching strategies recommended by the NCTM standards. Teachers in the present study reported that they were more familiar with the NAEYC guidelines than with the NCTM's school mathematics standards, a finding in accord with the results of Parker and Kurtz's study (1990) of kindergarten to fourth-grade teachers. Parker and Kurtz suggested that teachers not familiar with the NCTM mathematics standards did not demonstrate effective mathematical teaching strategies as recommended by the NCTM. The present study suggests that teachers who are not familiar with the NCTM mathematics standards may not use effective teaching
strategies to facilitate children's mathematics learning as outlined in the NAEYC guidelines of developmentally appropriate practices. Nevertheless, mathematics education in kindergarten was integrated with other learning activities and occurred in pleasant classroom interactions most of the time. Kindergarten teachers in this study positively encouraged children to participate in mathematics-related as well as nonmathematics-related learning activities. These findings demonstrate that the kindergarten teachers followed, to some degree, developmentally appropriate practices as recommended by both the NAEYC guidelines (Bredekamp, 1986) and the NCTM standards (NCTM, 1989, 1991).

**Developmentally Appropriate Practices in Kindergarten**

This study was designed to examine the relations between the degree of kindergartens' developmentally appropriate practices and classroom behaviors. The extent to which practices were developmentally appropriate varied among kindergartens. The mean of the total Assessment Profile score was 64%, with a range from 29% to 84%. These results agreed with findings of previous investigators, who reported that classroom practices of the majority of kindergartens were not developmentally appropriate (Bryant et al., 1991; Charlesworth et al., 1991; Hyson et al., 1990).

Kindergarten teachers in this study received the lowest scores (43%) on the Scheduling subscale of the Assessment Profile. They did not receive positive scores on at least 53% (n = 8) of the items on the Scheduling subscale if they had no written time schedule posted. Teachers scored higher on the Scheduling subscale if their school districts had minimum requirements on the amount of time for specific subject areas. It is suspected that posting of written schedules might also be required in those districts.

This study followed the instructions of the Assessment Profile (Abbott-Shim et al., 1992); kindergarten teachers who had no children with special needs in their classes automatically received positive scores on 22% (4 items) of the Individualizing subscale. These
included items such as "Activities are modified to allow successful participation of child" and "Notes from individual parent conferences regarding their child's developmental progress and classroom experiences are available." On the other hand, teachers with no special needs children in their classes received lower scores on the majority of items (at least 10 items) of the Individualizing subscale. For example, these teachers tended to receive negative scores on items such as "Child portfolios are available and contain entries that are current within one week" and "Classroom skill chart(s) is used to summarize the level of skill development for the class". Therefore, the internal consistency of the Individualizing subscale was lower than has been reported previously (Abbott-Shim et al., 1992).

Results suggested that the amount of free play time may greatly affect the degree of a kindergarten's developmental appropriateness. If the teacher allowed more free play time and the children were free to explore the materials and activities in the classroom, the kindergarten was usually rated as developmentally appropriate in the Learning Environment and Curriculum subscales of the Assessment Profile. Children in such programs demonstrated more initiating behaviors and had more opportunities to interact with the teacher and peers. Their teachers spent more time monitoring children and facilitating learning. However, teachers were not identified as using cognitive distancing if they failed to use free play time to stimulate children's thinking or to facilitate learning. Those teachers were identified as not involved in teaching for a significant proportion of the time. Instead, they were involved in such tasks as preparing activities or doing administrative tasks in the class. As a result, their children also spent less time participating in learning-related activities and less time interacting with the teacher, peers, and classroom materials. These classroom practices were in conflict with the recommendations of both the NAEYC (Bredekamp, 1986) and the NCTM (NCTM, 1989, 1991).
Conclusion

From the results of the present study, it can be concluded that, to some degree, kindergarten teachers have followed both the NAEYC guidelines and the NCTM school mathematics standards. The teachers spent about one-fourth of their class time teaching mathematics-related activities, whereas children spent about one-third of their class time learning mathematics. As would be expected, children in all-day kindergartens spent more time learning mathematics than those in half-day kindergartens and had more time to interact with the teacher, peers and classroom materials. Teachers integrated mathematical concepts with other learning activities most of the time rather than teaching it as an isolated subject. In addition, mathematics teaching and learning occurred in a pleasant atmosphere almost all of the time. Kindergarten teachers positively encouraged children to participate in mathematics-related activities, and negative interactions were seldom found in the kindergarten. In accord with the NCTM school mathematics standards that recommend using higher cognitive distancing in teaching mathematics (NCTM, 1989, 1991), kindergarten teachers spent a higher percentage of time using higher cognitive distancing in teaching mathematics-related activities than in teaching nonmathematics-related activities.

Specifically, the present study has produced information on two aspects of classroom practices in kindergartens. First, developmentally appropriate practices in kindergarten are related to children’s active participation in classroom activities; children in more developmentally appropriate kindergartens more frequently initiate learning-related conversations and have more opportunities to interact with people and materials in the classroom. Second, kindergarten children’s classroom behaviors reflect their teachers’ teaching behaviors. Kindergarten teachers who agree with Piaget’s theory that children learn better through self-exploration in the environment are more likely to follow the developmentally appropriate practices recommended by the NAEYC. Such teachers are more likely to provide developmentally appropriate activities
for children to explore and thus may spend more time monitoring children's participation. Children in those teachers' classes are more likely to have freedom to choose activities according to their own interests; they may also have more opportunities to interact with the teacher, peers, and classroom materials to construct their own mathematical understanding.

On the other hand, teachers who emphasize Vygotsky's theory that teaching and learning occur during social transmission through communicative speech (Vygotsky, 1978) and that teachers' teaching strategies in connecting children's experiences and existing knowledge can promote children's learning through interactions (Baroody, 1987; Sigel, 1970, 1986, 1990; Vygotsky, 1978) may demonstrate more cognitive distancing that matches children's abilities and experiences. These teachers may demonstrate more cognitive distancing to request children's mental operations and to transmit social tools, such as numerical symbols and counting systems. When teachers' teaching strategies match children's experiences and abilities, children are more likely to respond to their teachers. Results of the present study indicate that children's responses to their teachers' cognitive distancing are related to their teachers' use of cognitive distancing.

This study has demonstrated that the majority of kindergarten teachers infrequently used higher cognitive distancing. Because kindergarten children's learning behaviors reflected teachers' teaching behaviors, children's responses to higher cognitive distancing in all learning activities occurred infrequently. These results may reflect the fact that kindergarten teachers understand children's experiences and abilities and match their teaching strategies to children. Although the NCTM standards recommend the use of higher cognitive distancing as effective strategies in teaching mathematics, it may not necessarily be better to emphasize higher cognitive distancing strategies in kindergarten; it may be more important for the teacher to match children's developmental levels in terms of balancing their use of cognitive distancing, allowing children to engage actively in constructing their own understanding.

Most of the time, mathematical concepts are presented in problem-solving situations in kindergarten. Nevertheless, the use of higher cognitive distancing occurs infrequently, and a gap may still exist between children’s informal mathematical knowledge and formal school-taught mathematical concepts. The connections of children’s concrete experience and existing knowledge in kindergarten need to be emphasized in mathematics-related activities as well as in other learning-related activities (Baroody, 1987; Baroody & Ginsburg, 1990; Bredekamp, 1986; Piaget, 1963, 1983; Sigel, 1970, 1986, 1990; Vygotsky, 1978). To encourage mathematics learning, teachers need to encourage communication, connections and reasoning as recommended by the NCTM (NCTM, 1989, 1991).

Results indicate that children in all-day kindergartens spend more time learning mathematics and have more time to construct their own mathematical understanding through their self-initiatives and self-exploration than children in half-day programs. More than 30% (n = 5) of the half-day kindergarten teachers offered unsolicited comments to the effect that they did not have sufficient time to involve their children in child-initiated and child-directed learning activities. Because of perceived lack of time in half-day kindergartens, these teachers adopted a more structured model of classroom practices that did not allow children freedom to initiate learning. Several kindergartens involved in this study were in the process of changing their programs into all-day kindergartens so their children would have more time for free play. However, allotting more time to free play may result in a higher percentage of nonteaching time, if the teachers fail to perceive free play as a time for facilitating children’s learning. Teachers, policy-makers, and school administrators need to be aware of the possibility of using free time for tasks other than facilitating learning.
This study suggests that teachers' teaching experience and familiarity with the NAEYC developmentally appropriate practices guidelines are related to the degree of appropriateness of their classroom practices. Moreover, in-service training promotes teachers' understanding and ability to use higher cognitive distancing in teaching mathematics effectively. Therefore, emphasizing developmentally appropriate practices and effective teaching strategies in teacher education and in-service training may enhance teachers' abilities to promote children's development in all areas, including their disposition toward mathematics.

References Cited


GENERAL CONCLUSIONS

The aims of this dissertation were to (1) examine existing literature on young children's acquisition of mathematical knowledge, (2) examine existing literature on current classroom practices in kindergarten, and (3) investigate actual classroom practices relating to mathematics education. The first two aims were accomplished and presented in the two literature reviews. The third aim was achieved by conducting an observational study, results of which are presented in the research article.


The second literature review focuses on current classroom practices in kindergarten. One of the most consistent findings is that kindergarten classroom practices and strategies are contradictory to what the NAEYC has recommended as developmentally appropriate (Bryant, Clifford, & Peisner, 1991; Charlesworth, Hart, Burts, Hernandez, 1991; Hyson, Hirsh-Pasek, & Roscorla, 1990; Mayers, 1991; Rusher, McGreven, & Lambotte, 1992) and to what the NCTM has suggested as effective in teaching mathematics (Parker & Kurtz, 1990). To develop young children's ability in using mathematics and their disposition toward mathematics, new directions of early childhood mathematics education have been suggested. Early childhood mathematics
should include: (1) developing number sense, (2) promoting understanding of relations between/among objects, event, and people, (3) knowing conventional symbols, and (4) integrating mathematical concepts in problem-solving situations.

These two literature reviews can be summarized as follows: Children construct mathematical understanding through searching for meanings of their experiences. To facilitate children's learning, teachers need to provide various activities for children to explore and to stimulate children's thinking. Both NAEYC (Bredekamp, 1986) and NCTM (NCTM, 1989, 1991) agree that early childhood mathematics education needs to be integrated into developmentally appropriate activities. Research has shown that classroom practices of the majority of kindergartens do not meet the NAEYC developmentally appropriate practices guidelines (Bryant et al., 1991; Charlesworth et al., 1991; Hyson et al., 1990; Mayer, 1991; Rusher et al., 1992) and that kindergarten teachers are not aware of effective teaching skills and curriculum for teaching mathematics recommended by the NCTM (Parker & Kurtz, 1990). External pressure is an important factor affecting teachers' classroom practices (Bryant et al., 1991; Charlesworth et al., 1991; Hyson et al., 1990; Mayers, 1991; Rusher et al., 1992).

The research paper examines actual kindergarten mathematics classroom practices. Three objectives of the study were to (1) examine the relations between the amount of time used for cognitive distancing strategies and the developmental appropriateness of kindergarten classrooms, (2) compare teachers' and children's classroom behaviors in mathematics-related activities with their behaviors in nonmathematics-related learning activities, and (3) examine the relations between teachers' teaching behaviors and children's participating behaviors. Using a time-sampling method, thirty kindergarten teachers and children in their classrooms were studied. The teachers responded to the Kindergarten Teacher Survey, which seeks demographic information as well as information on teachers' familiarity with the NAEYC's guidelines on developmentally appropriate practices (Bredekamp, 1986) and the NCTM's (NCTM, 1989,
school mathematics standards. The Assessment Profile for Early Childhood Programs (Abbott-Shim & Sibley, 1992) was used to evaluate the degree to which kindergartens’ practices were developmentally appropriate. The Kindergarten Classroom Profile was used to identify teachers’ and children’s behaviors related to mathematics teaching and learning.

As had been predicted, results indicated that the degree of a kindergarten’s developmental appropriateness was correlated with children’s participation in all classroom activities but was not correlated with the teacher’s cognitive distancing behaviors. No positive correlations were found between scores on the Assessment Profile and the teachers’ observed cognitive distancing based upon the Kindergarten Classroom Profile. These findings were incompatible with the prediction that teachers whose classroom practices were more in accord with the NAEYC developmentally appropriate guidelines would more often demonstrate higher cognitive distancing in teaching mathematics. The contradiction may be attributed to the different emphasis of these two instruments. The Assessment Profile focused on child-directed and child-initiated learning and measured broader categories of the classroom practices, whereas the teacher observations on the Kindergarten Classroom Profile dealt more specifically with teachers’ teaching strategies.

The most significant difference in kindergartens’ classroom practices was in the amount of free play time. If the teacher allotted more time to free play and the children were free to explore the materials and activities in the classroom, the kindergarten was usually rated as developmentally appropriate in the Learning Environment and Curriculum subscales of the Assessment Profile. Children in such programs demonstrated more initiative behaviors. They were also more likely to initiate interactions with the teacher, peers, and classroom materials. Such children spent more time in their self-initiated learning and in constructing their own understanding of mathematics. These results support Piaget’s (1963, 1983) perspective that teachers are facilitators who support children’s self-initiated and self-directed learning behaviors.
Teachers with a Piagetian perspective may spend more time monitoring children's participation and facilitating learning during free play time. Such teachers may also spend more time using cognitive distancing strategies to stimulate children's thinking.

Kindergarten teachers spent a higher percentage of time using higher cognitive distancing in teaching mathematics than in teaching other activities and a higher percentage of time using low cognitive distancing in teaching nonmathematics-related activities than in teaching mathematics. Kindergarten children, responding to their teachers' classroom behaviors in learning, spent a higher percentage of the time responding to higher cognitive distancing while learning mathematics than while engaged in nonmathematics-related activities and a higher percentage of time responding to teachers' low cognitive distancing in nonmathematics-related activities than in mathematics-related learning activities. In general, higher cognitive distancing occurred infrequently across all classroom learning activities. As a result, kindergarten children were not able to respond frequently to teachers' higher cognitive distancing.

Results support Vygotsky's (1978) theory that teachers' scaffolding behaviors assisted children's involvement in learning activities. The frequency of children's responses to higher and low cognitive distancing was correlated with the frequency of teachers' use of higher and of low cognitive distancing, respectively. These results suggest that teachers match children's experience and ability in teaching mathematics and that, as a result, children are able to respond to their teachers teaching strategies. Moreover, the amount of time children spent in mathematics-related activities was correlated with teachers' use of higher cognitive distancing and of low cognitive distancing. Similar results were found in nonmathematics-related activities.

Results indicated that the classroom practices of a majority of the kindergartens were not rated as developmentally appropriate, although most of the teachers reported that they were quite familiar with the NAEYC's guidelines on developmentally appropriate practices.
Developmentally appropriate practices in kindergarten may have been limited by kindergarten teachers' and school administrators' misinterpretations of the NAEYC's developmental appropriateness guidelines and by external pressures from peers and administrators. Teachers with more years of experience in kindergarten teaching or with a record of more participation in in-service training related to teaching pre-kindergarten to fourth-grade topics were rated higher on their use of developmentally appropriate practices.

Kindergarten teachers were less familiar with the NCTM's school mathematics standards than with the NAEYC's guidelines. Teachers reporting participation in more hours of in-service training within the past year reported that they were more familiar with the NCTM's mathematics standards than those who had spent less time attending in-service training. Teachers not familiar with the NCTM mathematics standards may fail to use effective teaching strategies to facilitate children's mathematics learning as outlined in the NAEYC guidelines of developmentally appropriate practices.

Nevertheless, kindergarten teachers followed, to some degree, developmentally appropriate practices as recommended by both the NAEYC and the NCTM standards. For example, kindergarten teachers positively encouraged children to participate in mathematics-related activities. Mathematical teaching and learning in kindergarten was integrated into other learning-related activities. Teachers spent a higher percentage of mathematics teaching time than of nonmathematics teaching time using higher cognitive distancing. As a result, children also spent a higher percentage of mathematics learning time than of nonmathematics learning time responding to cognitive distancing.

Limitations of the Study and Future Implications

This study has provided quantitative information about actual classroom practices in mathematics teaching and learning in kindergarten. Teachers' teaching behaviors and children's participating behaviors were described. However, there are several limitations to this study.
First, the present study used a nomination procedure in which 47% of kindergartens were recruited to ensure sufficient numbers of more developmentally appropriate kindergartens. Results indicated that nominated teachers demonstrated a higher degree of developmental appropriateness in their classrooms than nonnominated teachers. Although there were no significant correlations between nominated teachers and their classroom behaviors related to teaching mathematics, these teachers might not be representative of kindergarten teachers and their classroom behaviors might not be typical of other kindergartens in the United States. Future study on developmentally appropriate practices and mathematics classroom practices may consider use of more representative groups than the present study used.

Second, this study used a time-sampling method to collect data and alternated the observations of the teacher and children; this method did not reveal direct interactions between the teacher and the individual child with whom the teacher was working. During data collecting time, the teacher was frequently demonstrating cognitive distancing to a child not studied. An event sampling, in which observations focus on the child with whom the teacher interacts, may provide useful information on how teachers use cognitive distancing to match children’s developmental levels and how children respond to cognitive distancing according to their developmental status. Thus, information on another aspect of kindergarten’s mathematics education can be obtained.

Third, results suggested that teachers of all-day kindergarten allotted more time for mathematics-related activities in the class and spent more time using higher cognitive distancing than teachers of half-day kindergartens. Children in all-day kindergartens may have more time for free play to explore the classroom activities as well as more time for formal activities. This study, which classified classroom activities in content areas, did not examine the structure of classroom activities (e.g., child-initiated or teacher-directed). Children’s classroom participating behaviors, such as initiating learning-related conversations and responding to teachers’ and
peers' statements, may be related to the structure of classroom activities. Both the NAEYC and the NCTM recommend adoption of an integrated curriculum for kindergarten mathematics teaching and learning. Future research on kindergarten classroom practices should place particular emphasis on structure of classroom activities such as teacher-directed or child-initiated activities, in addition to content of classroom activities.

Finally, the present study recorded children's class participating behaviors as their responses to peers and to teachers' low and higher cognitive distancing, their initiation of learning-related conversations, and their independent work. Children's nonverbalized constructing behaviors were not included. The extent of children's cognitive engagement in classroom activities remains unknown. Moreover, the study did not determine whether a child was responding to low cognitive distancing or daydreaming when the child was sitting quietly in the class without verbally expressing himself/herself. Further research is needed to describe children's cognitive engagement in classroom activities and their nonverbal classroom behaviors related to learning.

References Cited


ACKNOWLEDGMENTS

I am grateful to my committee, Dr. Thomas Andre, Dr. Joan Herwig, Dr. Janet Sharp, and Dr. Dahlia Stockdale, for their continuous support of my doctoral program, including their stimulating classes, their practical and constructive guidance, and especially for their sharing of knowledge.

To my major professor, Dr. Susan Hegland, no written statement can express my appreciation of all she has done. She has shown me what a scholar should be as well as how to conduct a scientifically sound study and how to report it with intellectual honesty. I appreciate her patience, enthusiasm, and fast understanding. She has encouraged me to participate in various activities I would not otherwise have dared to try. She interrupts her own work and promptly responds to my questions and problems. I owe Dr. Hegland many thanks.

I thank Kathy Shelly and Dr. Robert Strahan of the Statistics Department for their assistance with programming and the interpretation of data.

I wish to thank the Iowa State University Department of Human Development and Family Studies, which supported this research and my graduate study. I thank all of the faculty and staff, for their support and consideration.

To all the kindergarten teachers and children who participated in this study, I offer my thanks. Without their support, this study would have been impossible.

To my family, I am heartily thankful for their believing in me. To my mother, my gratitude is immeasurable. Several times, she flew thousands of miles to give me moral and practical support. My two wonderful sons, Hsin-Han and Hsin-Wei, have been responsibly taking care of themselves as well as their mother. If it were not for their patience and understanding, the stress of being a single mother in graduate school would have been overwhelming. I thank them for being with me at the front line.
APPENDIX A:

PROCEDURES FOR RECRUITING SUBJECTS
PROCEDURES FOR RECRUITING SUBJECTS

The present study of classroom observations was conducted in 30 Iowa kindergartens. To obtain a study population that was at least somewhat representative of the population of Iowa kindergartens, no more than one kindergarten from each school district was selected. Populations of the school districts selected were from 742 to 31,052; 60% (n = 17) of the districts had fewer than 5,000 people, 20% (n = 6) had more than 10,000 and the remaining 20% (n = 7) had a population between 5,001 to 9,999. The school enrollments were from 116 to 4,819 students; 60% (n = 17) had fewer than 1,000 students in the district, and 20% (n = 6) had more than 3,000 students. This was a typical population distribution in Iowa (Department of Education, 1993). Fourteen of the subject kindergartens were randomly selected from those nominated to ensure a sufficient number of more developmentally appropriate programs. The others were randomly selected. All 30 subject kindergartens met five days a week. Half of them were all-day programs and half were half-day. Teachers of the subject kindergartens were observed. Because of the small percentage of male kindergarten teachers in Iowa, no male teachers were included in this study. Ideally, six boys and six girls with normal English communication skills were randomly selected for observations in each classroom. Average class size was 20 children, but three kindergartens had fewer than 12 children in their classes. Because of the small class size, some children were repeatedly studied. In total, 30 kindergarten teachers and children in their classrooms were involved in this study.

To ensure that a sufficient number of more developmentally appropriate programs was included, a list of criteria of developmentally appropriate practices derived from the Assessment Profile for Early Childhood Programs was used to select more developmentally appropriate kindergartens for classroom observation. The criteria included (1) Learning environment: The classroom materials supported a variety of learning experiences (e.g., a variety of concrete
objects/manipulatives were accessible to children); and the arrangement of classroom space encourages children to work independently (e.g., learning centers). (2) Scheduling: Children had at least one hour cumulatively to choose and to guide their own activities every day; the teacher had daily time to work with the whole group and with small groups of three to eight children. (3) Curriculum: Alternative teaching techniques were used to facilitate learning (e.g., the teacher demonstrated, gave directions, and asked questions); children were encouraged to guide their own learning actively (e.g., the teacher invited children to compare, to solve problems, to predict outcomes, and/or to manipulative materials). (4) Interacting: The teacher engaged children in conversations; children seemed happy and involved in activities. (5) Individualizing: At least two developmental assessments were completed annually for each child.

The supervisors of student teaching, the professors of early childhood education at Iowa State University, and the Area Educational Agency consultants in early childhood education were asked to nominate developmentally appropriate kindergartens. The nomination was based on the criteria to select teachers whose practices were more developmentally appropriate from school districts of Area Education Agencies Five, Six, and Eleven in Iowa. These three Area Education Agencies were within 90 miles of Ames, Iowa, and included 80 school districts in 17 counties.

Following approval of the study by the Iowa State University Human Subjects Committee, the superintendents of 61 school districts with everyday kindergartens in the target 17 counties were contacted by mail to request permission for a kindergarten teacher and children in his/her district to participate in the study. The mailing to every identified school superintendent included a cover letter explaining the study (Appendix B), a response form (Appendix B), and a self-addressed, stamped return envelope. These superintendents were asked to return the response form to give their permission for their kindergarten teachers and
children to participate in the study or to indicate that they did not want their teachers involved in the study.

The final list of 43 potential school districts with superintendents' permissions was used for sampling 30 kindergartens, no more than one from one school district. The design was to have an equal number of all-day everyday kindergartens and half-day everyday kindergartens, and of nominated and nonnominated teachers. Each of the 30 teachers from these school districts was sent a letter (Appendix B) explaining the observation and asked to return the response form (Appendix B) to indicate their approval also. Subjects who did not respond to the request within two weeks received a postcard reminder followed by telephone calls. If the teacher from a school district declined to participate, the request was sent to another kindergarten teacher of the same school or the same school district to ensure the subjects were balanced between all-day and half-day programs and between nominated and nonnominated teachers. Fourteen teachers of the 30 kindergartens participated in this study were selected from those nominated as more developmentally appropriate. The other 15 kindergartens were selected from the nonnominated school districts. Numbers were well balanced between all-day and half-day programs. All parents/guardians of children in these 30 kindergartens were sent a letter explaining the observation (Appendix B) and asking for their permission to observe their child in the classroom (Appendix B). Very few parents (less than 1%) refused to have their children involved in this study.
APPENDIX B: CORRESPONDENCE
July 19, 1993

Dear District Superintendent:

I am a doctoral candidate in the Department of Human Development and Family Studies with an emphasis on Early Childhood Education at Iowa State University. Because Iowa has been well known for its quality education, I am interested in conducting an observational research study in the kindergartens of Iowa. This research, which is part of my doctoral program, is under the direction of Dr. Susan Hegland, Dr. Thomas Andre, Dr. Joan Herwig, Dr. Janet Sharp, and Dr. Dahlia Stockdale. We hope this study will provide insights into kindergarten programs and practices.

Your school district is one of a small number of Iowa school districts being asked to participate in this study. We are inviting one school from each of these districts to be involved. We are seeking your approval to include in this study one kindergarten from your school district. We will select and contact the teacher and parents/guardians of individual children directly.

To understand classroom practices in kindergarten, the teacher and children in each classroom will be observed. The observer will not have any direct interactions with the teacher or children during the observation. To obtain the general information, a questionnaire requiring about 10 minutes to complete will be given to the teacher and collected by the observer after the visits.

Information gained will be confidential. The names of school districts, teachers, and children will remain anonymous. Data will be analyzed and reported in reference to the state, and no reference will be made to individual teachers, individual children, individual schools, or individual school districts. Results of the study will be presented in my dissertation, in journals, and at professional meetings.

If you have any objection to our contacting the teacher and parents in your school district to participate in this study, please let us know by returning the enclosed permission form in the stamped, addressed envelope provided by August 2, 1993.

Thank you in advance for your support of this study. If you have any questions, please contact us at (515) 296-8167.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
The purpose and the general nature of the research procedures have been explained to me. If the teacher and children in my school district participate in this study, I understand that any questions regarding the study will be answered. I understand that the teacher and children will not be identified by name and all information will be kept confidential. Finally, I understand that the teachers and the children are free to withdraw from the study at any time and that I am free to withdraw my permission for the school district.

__________ I am NOT willing for my school district to participate in this study.

Superintendent's Signature __________________________ Name of School District __________________________

Date ________________

Chung/Hegland Research
August 23, 1993

Dear Ms. __________:

I am a doctoral candidate in the Department of Human Development and Family Studies with an emphasis on Early Childhood Education at Iowa State University. Because Iowa has been well known for its quality education, I am interested in conducting an observational study in the kindergartens of Iowa in order to learn more about kindergarten education in Iowa as well as in the United States. This research, which is part of my doctoral program, is under the direction of Dr. Susan Hegland, Dr. Joan Herwig, Dr. Dahlia Stockdale, Dr. Thomas Andre, and Dr. Janet Sharp. We hope this study will provide insights into kindergarten programs and practices.

You are one of a small number of Iowa kindergarten teachers being asked to participate in this study. We have the approval of the Iowa State University Human Subject Committee and of your school superintendent. Your involvement with this study will expand our knowledge about current kindergarten classroom practices.

This study will be started in October 1993. The teacher and children whose parents/guardians have not denied permission will be randomly selected to be involved in the study. There will be four visits in each program. The observer will stay in the classroom for about 2 hours watching the teacher and the subject children. There will be no direct interaction between the observer and the class members during the observation. Activities not held in the classroom will not be included. You also will be given a questionnaire asking for general information about you and your classroom. It will take you about 10 minutes to complete the questionnaire, which will be collected by the researcher at the last visit. A short interview (about 15 minutes) will be requested in order to better understand your program.

Information gained will be confidential. The names of school districts, teachers, and children will remain anonymous. Data will be analyzed and reported in reference to the state, and no reference will be made to individual teachers, individual children, individual schools, or individual school districts. Results of the study will be presented in my dissertation, in journals, and at professional meetings.

If you agree to be involved in this study, please return the enclosed permission form in the stamped, addressed envelope provided.

Thank you in advance for your support of this study. If you have any questions, please contact us at (515) 296-8167.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
Department of Human Development and Family Studies
Iowa State University
Ames, Iowa 50011-1030

TEACHER PERMISSION FOR STUDY
OF KINDERGARTEN CLASSROOM PRACTICES

The purpose and the general nature of the research procedures have been explained to me. If children in my class and I participate in this study, I understand that any questions regarding the study will be answered. I understand that the children and I will not be identified by name and all information will be kept confidential. Finally, I understand that the children and I are free to withdraw from the study at any time.

___________ I am WILLING to participate in this study.

___________ I am NOT willing to participate in this study.

Teacher's Signature __________________________ Name of School District __________________________

Date __________________________

School Telephone Number: __________________________

Best time to call: __________________________

(If you prefer us to call you at home, please indicate your home number and best time to call __________________________).

Please also include your program schedule and a list of children's names and general information (i.e., birthday/age and sex) if you agree to participate in this study. Thank you.

Chung/Hegland Research
September 6, 1993

Dear Ms. __________:

A few days ago we sent you a letter to request your participation in the 1993-94 Iowa Kindergarten Classroom Observational Study. This study is to learn about Iowa's kindergarten programs and practices.

If you have already returned the permission form, we thank you for your help. If you have not done so, please complete the permission form and return it in the stamped envelope that was provided.

If you agree to participate in this study, please return the permission form with your weekly schedule, and a list of children's names and their birthdays. Please also indicate any children with communication difficulties. If you have lost the form, but are willing to participate in the study, please let us know. We will send you a new one. If you are not teaching kindergarten this year, please give the letter and permission form to another kindergarten teacher in your school.

Thank you for your thoughtful assistance.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
September 13, 1993

Dear Ms. ________:

Thank you for agreeing to participate in the 1993-94 Iowa Kindergarten Classroom Observational Study. I appreciate your support of this study and will contact you by phone soon.

I would also like to thank you for the list of children's names and other information. Please send your daily schedule or a sample of your weekly activity plan, so I may have some ideas before I call you to plan the visits. Please indicate any children with communication difficulties in the class.

Enclosed are ___ copies of parent permission forms and letters to send home with children. Please collect the parent permission forms and return them to us with your activity schedule in the stamped envelope.

Thank you for your thoughtful assistance.

Hope you have a productive year.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
September 13, 1993

Dear Parents/Guardians:

I am a doctoral candidate in the Department of Human Development and Family Studies with an emphasis on Early Childhood Education at Iowa State University. Because Iowa has been well known for its quality education, I am interested in conducting an observational study in the kindergartens of Iowa. In order to make the results of this study as useful as possible to teachers and teacher educators, it is very important for each child in the class to participate in the study. Therefore, I would appreciate having your permission to involve your child in this study.

This study has been reviewed and approved by the Iowa State University Human Subjects Committee, the superintendent of the school district and the teacher of your child’s class. Your child’s class is one of a small number of Iowa kindergartens invited to participate in this study.

This study will be started in October 1993. The teacher and children randomly selected from each classroom will be included in the observation. There will be four visits in each program. The observer will stay in the classroom for about two hours watching the teacher and the subject children. There will be no direct interaction between the observer and the class members during the observation.

Information gained will be confidential. The names of school districts, teachers, and children will remain anonymous. Data will be analyzed and reported in reference to the state, and no reference will be made to individual teachers, individual children, individual schools, or individual school districts. Results of the study will be presented in my dissertation, in journals, at professional meetings, and to schools that participate.

Participation in this study is voluntary, and you may withdraw your child at any time. If you have any objection to our observing your child, please return the permission form to your child’s teacher before September 18, 1993.

Thank you in advance for your support of this study.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
Department of Human Development and Family Studies  
Iowa State University  
Ames, Iowa 50011-1030  
515-294-4616  

PARENT/GUARDIAN PERMISSION FOR STUDY  
OF KINDERGARTEN CLASSROOM PRACTICES

The purpose and the general nature of the research procedures have been explained to me. If my child participates in this study, I understand that any questions related to the study will be answered. I understand that my child will not be identified by name and all information will be kept confidential. Finally, I understand that I am free to withdraw my child from the study at any time.

_____ I am NOT willing to let my child, ___________________________ participate in this study.

Parent’s/Guardian’s Signature ___________________________ Name of School District ___________________________
Date ___________________________
September 27, 1993

Dear Superintendent:

Thank you for supporting the 1993-94 Iowa Kindergarten Classroom Observational Study.

In your school district, Ms. __________ has been selected and has agreed to participate in this study. I am looking forward to visiting your district and the kindergarten.

As I said in my first letter, the names of your school district, the teacher, and the children will be kept confidential. I will report only group analyses of my observations.

If you have any concerns or questions about this study, please feel free to call me at (515) 296-8167, or leave a message at (515) 294-3040.

Sincerely,

Kuei-Er Chung
Doctoral Candidate

Susan M. Hegland, Ph.D.
Major Professor in Charge of Research
KINDERGARTEN TEACHER SURVEY 1993-94

We are interested in your school, kindergarten program, and curriculum. Please feel free to add your comments or thoughts that will help us understand your program.

1. How many children are currently enrolled in your classroom?
   SESSION ONE _____; SESSION TWO (if applicable) _____

2. Do you have a teacher aide?
   1 = YES
   2 = NO

3. If you have a teacher aide, how many hours per week? __________. Describe what the aide does.

4. Do you have a volunteer?
   1 = YES
   2 = NO

5. If you have a volunteer(s), how many hours per week? __________. How many volunteers? Describe what the volunteer(s) does while she/he is working in your classroom.

6. Does your school district require a specific length of time for specific subject areas?
   1 = YES;
   LANGUAGE/LITERACY _______ MINUTES/DAY _______ DAYS/WEEK.
   MATHEMATICS ________ MINUTES/DAY ________ DAYS/WEEK.
   2 = NO

7. Years of teaching experience, including this year: __________

8. Years of kindergarten teaching experience, including this year: __________
9. Circle your highest level of education completed:
   1 = B.A./B.S.
   2 = B.A./B.S. + _____ CREDITS.
   3 = M.A./M.S.
   4 = M.A./M.S. + _____ CREDITS.
   5 = OTHER (identify credits and degree of school)

10. Your teaching licensure is (circle all those that apply):
    1 = #102 (formerly #10) ELEMENTARY (K-6)
    2 = #103 (formerly #53) PRE-KINDERGARTEN/KINDERGARTEN (PK-K)
    3 = #106 EARLY CHILDHOOD EDUCATION (0-3RD)
    4 = #223 (formerly #09) EARLY CHILDHOOD SPECIAL EDUCATION
    5 = TEACHING ENDORSEMENTS
    6 = OTHER (specify)

11. Circle one number to indicate how familiar you are with the developmentally appropriate practice guidelines recommended by the National Association for the Education of Young Children (NAEYC)?
    1 = QUITE FAMILIAR
    2 = SOMEWHAT FAMILIAR
    3 = HAVE HEARD ABOUT IT, BUT NOT FAMILIAR
    4 = NEVER HEARD ABOUT IT

12. Circle one number to indicate how familiar you are with the school mathematics standards recommended by the National Council of Teachers of Mathematics (NCTM)?
    1 = QUITE FAMILIAR
    2 = SOMEWHAT FAMILIAR
    3 = HAVE HEARD ABOUT IT, BUT NOT FAMILIAR
    4 = NEVER HEARD ABOUT IT
13. Indicate the appropriate number of workshops, seminars, and conferences concerning pre-kindergarten to fourth grade topics attended since June 30, 1992 (not including regular staff meetings).

1 = WORKSHOPS/SEMINARS SUCH AS AEA, SCHOOL DISTRICT INSERVICE TRAINING ____________ ATTENDANCE HOURS

2 = COLLEGE COURSES ___________ CREDIT HOURS

3 = PROFESSIONAL CONFERENCES ____________ ATTENDANCE HOURS

14. Were any of the workshops, seminars, and conferences that you have attended since June 30, 1992 (see question 13) related to mathematics education?

1 = YES; ___________ HOURS

2 = NO

15. Were any of the workshops, seminars, and conferences that you have attended since June 30, 1992 (see question 13) related to teaching of language/literacy?

1 = YES; ___________ HOURS

2 = NO

16. What is your most effective strategy (e.g., methods & activities) in teaching mathematics to kindergarten children?

17. What is your most effective strategy (e.g., methods & activities) in teaching language/literacy to kindergarten children?

18. How do you adjust your teaching strategies in mathematics from fall to spring semester?

19. How do you adjust your teaching strategies in language/literacy from fall to spring semester?

Thank you very much.
ASSESSMENT PROFILE
FOR EARLY CHILDHOOD PROGRAMS

Martha Abbott-Shim, Ph.D
Annette Sibley, Ph.D.

RESEARCH VERSION
Assessment Profile for Early Childhood Programs

Clarification of Terms

Learning Environment

A. Items A.1. through A.10 must have a minimum of three (3) different types of materials available to score a "Yes." If three, four, or five types of materials are accessible, then circle the corresponding number in the "Yes" column. If more than five types of materials are accessible in any category circle 5. Note that five (5) different puzzles would be considered one (1) type of material. Puzzles, legos, and peg boards would be considered three (3) different types of materials. Accessible refers to the location of materials in a manner that the child is able to comfortably reach and the child has permission to use the material without adult assistance.

A.1. Self explanatory.

A.2. Self help materials are materials that encourage the development of skills that permit the child to care for self and environment such as dressing frames or dolls that provide experience in learning to zip, button, lace, etc., a watering can that provides experience with caring for plants, a small broom and dust pan for sweeping after art projects or snacks, etc. Note that housekeeping props for imaginative play should not be counted for this item. For example, a wooden iron and ironing board, encourage dramatic play but not the development of ironing skills and therefore these props would not be counted in this item.


A.5. The focus of this item is on science materials that provide the child an opportunity to experiment and manipulate materials. Therefore, display items that cannot be manipulated should not be counted, such as a bird's nest on display. If a pet is present, count it only if the children have an opportunity to feed or otherwise care for the pet and/or there is evidence of active observation of the pet—such as charting the eating, sleeping, growth patterns of the pet. If a pet is present but there is no evidence of active involvement beyond passive observation, do not include the pet in the count.


A.7. Self explanatory.

A.8. Self explanatory.

A.9. A minimum of three (3) different types of materials for a minimum of three (3) different cultures must be represented to score this item "Yes."

A.10. Count repeating labels as only one (1) type of printed language. For example, if the children's cubbies, chairs, and/or places at tables are all labeled with the children's names, this labeling system is one example of printed language. Similarly if the lego bin and the shelf where the legos are stored are labeled "legos" this system is one example of printed language.
### Learning Environment

<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>A.</td>
<td>Classroom materials support a variety of learning experiences.</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>1. At least 3 different types of small muscle/manipulative materials are accessible to children (such as lego, board games, puzzles).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>2. At least 3 different types of self help materials are accessible to children (such as tissue, broom &amp; dustpan, dressing frames/dolls, sponge &amp; pail, watering can).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>3. At least 3 different types of art materials are accessible to children without adult assistance (such as clay, paint, scissors, paste).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>4. At least 3 different types of drama/role play materials are accessible to children without adult assistance (such as dishes, blocks, puppets).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>5. At least 3 different types of science materials that involve manipulation and experimentation are accessible to children without adult assistance (such as magnets, magnifying glass, pets, scales, natural materials).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>6. At least 3 different types of math materials are accessible to children without adult assistance (such as number puzzles, dominoes, blocks, abacus).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>7. At least 3 different types of language materials are accessible to children without adult assistance (such as variety of types of books, listening station, puppets, flannel board, writing paper and pencils).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>8. At least 3 different types of nutrition/health materials for manipulation are accessible to children without adult assistance (such as food cards, toothbrush, body part puzzles/flannel board pieces, plastic food for all four food groups, health related books).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>9. At least 3 different types of materials that represent varying cultures and ethnic backgrounds are accessible to children without adult assistance (such as books, pictures/personal photographs, music/songs, games, toys, clothing, materials, and/or food).</td>
<td>3</td>
</tr>
<tr>
<td>O</td>
<td>10. At least 3 different types of printed language are displayed in the classroom (such as labels on objects, names on cubbies, pictures with captions, child drawings with written captions).</td>
<td>3</td>
</tr>
</tbody>
</table>
Assessment Profile for Early Childhood Programs

Clarification of Terms

Learning Environment

B.1. Partitions that form physical boundaries may be walls, shelves, a free-standing bulletin board, etc. that serve to physically separate learning/activity areas within the classroom. Visual separations, boundaries or labels, such as rugs, tape lines, hanging signs, do not qualify. At least three (3) activity areas must be present in the classroom and each area must have at least three (3) partitions or physical separations.

B.2. Conceptually related materials refers to materials that support the child's learning in a specific conceptual area such as art, science, math, etc. The focus of this item is on the organization of conceptual learning areas as evidenced by the collection of various related learning materials. For example, in support of learning about artistic concepts, a variety of materials may be grouped together and might include paint and paper, collage materials and paste, art books and sample works of an artist. Note that science materials might be grouped together and also include books, although scientific in nature, and possibly paint and paper if prisms, rainbows, and color is being studied.

B.3. Accessible refers to the presence of materials in a location that a child is able to reach. Accessibility also refers to the freedom of the child to access materials. The child must be able to reach and allowed to use materials to score this item "Yes."

B.4. Organized manner refers to the arrangement of learning materials that allows the child clear visibility of individual materials. Different types of learning materials should be individually displayed on a shelf or table, if stacked, no more than two (2) items high and not one in front of the other. This item should be scored on the basis of the dominant mode in the classroom. It is best to determine the dominant mode by counting the individually displayed materials versus the number of materials stacked three (3) or more high and/or one in front of the other. Note that if puzzles are arranged on a puzzle rack it is acceptable if the bottom puzzle can be pulled out for visibility without unstacking all the puzzles above.

B.5. Places where materials belong may be labeled with pictures, symbols, words, or a combination of these options. Note that this item focuses on the presence of a system of labeling and should be scored on the basis of the dominant mode within the classroom. If the labeling system is predominantly present but appears that it is not used — and this is characteristic of the classroom in general, this item would be still be scored "Yes" and item A.4. would be scored "No."

C.1. A solitary area where one or two children may choose to work alone may be a "reading corner" or an area set out of the way of central classroom activity. The focus of this item is on the option for a child to be involved in an activity alone or with one other child. It is not a "time-out" or punitive place. If this work place is not apparent during observation time, it is acceptable to ask the teacher, "Do children sometimes choose to work alone, or with one other partner, on a project or activity?" If "Yes," ask "Will you describe when this happens and where they work in the classroom."

C.2. The intent of this item is that child-made work products are displayed and represent individual child effort. These products should be displayed at a child's comfortable eye level, which is considered to be approximately adult shoulder height and below. This item is evidence of how the classroom reflects the child as an individual. If the classroom displays are predominantly teacher work or commercially produced posters at child eye level and minimal child work, score this item "No." Note that work samples displayed at the end of string that hangs from the ceiling and is above adult head level would not be considered to be at the child's eye level.
<table>
<thead>
<tr>
<th>Standards &amp; Criteria</th>
<th>Method</th>
<th>Observations</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>B. Arrangement of classroom space encourages child independence.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. At least three (3) partitions are used to form physical boundaries and definition for at least three (3) learning areas.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2. Conceptually related materials are organized together (such as art, manipulatives).</td>
<td>O</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>3. Materials for child use are accessible so that children can reach them without adult assistance.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Materials are displayed in an organized manner.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Places where materials belong are labeled.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C. Classroom reflects the child as an individual.</td>
<td>O,R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. An area exists in the room where one or two children may choose to work alone.</td>
<td>O</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Children’s work is displayed at the child’s eye level.</td>
<td>O</td>
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</tbody>
</table>
Clarification of Terms

Scheduling

A.1. Written time schedule refers to a general outline of the times and activities of the classroom. The time schedule reflects the overall structure of the day's activities. This schedule may represent a daily schedule of activities or weekly. The schedule must be posted to score "Yes" on this item.

A.2. Lesson plans are specific activity/learning plans. Lesson plans provide detailed information about learning content and will specify a topic and possibly activity procedures, materials to be used, children who will participate, etc. These documents may be posted or in the teacher's files. Score this item "Yes" only if lesson plans are available for at least two (2) previous weeks and therefore reflect the continuity of lesson planning over a period of time.

A.3. Learning materials and supplies for activities are ready for use at the time the activity is scheduled. Children do not have to wait while teachers gather and/or prepare materials.

B. Note that B.1. through B.8. are scored on the basis of information contained in the posted, time schedule referenced in A.1. If a written time schedule is not posted, score "No" for items B.1. through B.8.

B.1. Quiet activities refers to scheduled activities in which the children will be seated and stationary.

B.2. Active activities refers to scheduled activities in which the children move about the classroom or outdoors. The focus of this item is on balance between quiet and active activities. It is not necessary for the schedule to reflect a pattern of quiet—active—quiet—active, etc. However, if the schedule is most frequently characterized by a series of two (2) to three (3) quiet activities before an opportunity to move about is scheduled—or vice versa—score this item "No."

B.3. Outdoor activities refer to opportunities for large muscle activity and fresh air. If physical education (P.E.) is indicated on the schedule, ask the teacher to clarify where their activity takes place.

B.4. A minimum of one hour for children to choose and direct their own activities should be reflected in the classroom schedule and may be referred to as free time, discovery time, learning center time, or individual activities. If reading the schedule is unclear, it is appropriate to ask the teacher to explain the posted schedule of activities. The one hour may be divided in a series of smaller time frames but must cumulatively represent one hour in the classroom. Playground time is not included in the hour, nor is arrival or departure times when all children are not present. One hour of child directed opportunity must be reflected in the schedule within the active program learning time.

B.5. A minimum of one hour of teacher directed time follows the same guidelines as child directed time in B.4. This hour may be divided in segments, must occur during active program learning time when all children are present, and during classroom time—excluding playground time. During this hour the teacher may be guiding the learning of the full group, a small group, and/or an individual child.

B.6. Individual instructional time must be reflected on the written schedule to score this item "Yes." A teacher may work individually with one or two children even though this time is not reflected on the written schedule. If the teacher's individual instructional time is not reflected on the written schedule, score this item "No."

B.7. A small group is a group of three (3) to eight (8) children. If group size is difficult to determine from the written schedule, ask the teacher to clarify the number of children involved in the activities noted on the written schedule.

B.8. Whole group refers to the total classroom population. If group size is difficult to determine from the written schedule, ask the teacher to clarify the number of children involved in the activities noted on the written schedule.

C. Items C.1. through C.4. should be scored on the basis of activities and practices observed during the data collection period.

C.1. See B.1.
C.2. See B.2.
C.4. See B.8.
<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td>A. Scheduling and planning occur.</td>
<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td>O,D</td>
<td>1. Written time schedule is posted.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2. Written lesson plans for previous weeks are available in files.</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>3. Teacher has materials and supplies prepared in advance.</td>
<td></td>
</tr>
<tr>
<td>B. Written schedule reflects variety of activities (if schedule is not available, mark Criteria 1 through 8, &quot;No&quot;).</td>
<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td>D</td>
<td>1. Quiet activities (such as seated work, a story time, art and manipulative).</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2. Quiet activities usually follow active activities.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>3. Outdoor activities.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>4. At least one hour, cummulatively, for children to choose and guide their own activities.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>5. At least one hour, cummulatively, when the Teacher selects and guides the children's activities.</td>
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<tr>
<td>D</td>
<td>6. Daily time when Teacher works individually with one or two children.</td>
<td></td>
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<tr>
<td>D, R</td>
<td>7. Daily time when Teacher works with a small group of three to eight children.</td>
<td></td>
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<tr>
<td>D, R</td>
<td>8. Daily time when Teacher works with the whole group of children.</td>
<td></td>
</tr>
<tr>
<td>C. Classroom activities reflect variety.</td>
<td></td>
<td>Yes/No</td>
</tr>
<tr>
<td>O</td>
<td>1. Quiet activities (such as seated work, a story time, art and manipulatives).</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>2. Quiet activities usually follow active activities.</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>3. Daily time when Teacher works with a small group of three to eight children.</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>4. Daily time when Teacher works with the whole group of children.</td>
<td></td>
</tr>
</tbody>
</table>

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Assessment Profile for Early Childhood Programs

Clarification of Terms

Curriculum

A.1. Encourages refers to the teacher's efforts to incorporate vocabulary from a variety of different languages in multicultural activities and experiences, to positively invite vocabulary sharing and comparisons, and involve the children's home language when different languages are represented amongst the children in the class.

A.2. Resource information may be represented in reference books, magazines, travel brochures, etc. and represents information sources that the teacher can refer to in planning activities to expand the multicultural knowledge and experiences of the children.

A.3. Holidays are culture specific and refer to special times when usual daily routines are altered and specific rituals or traditional experiences are planned. Non-traditional holidays may be national holidays or holidays that honor people or non-religious events such as Presidents' Day or Martin Luther King Day.

B.1. Self explanatory.

B.2. Teacher demonstrates a specific sequence of steps for children to follow in working on an activity.

B.3. Activities provide opportunities for children to manipulate materials and/or express their responses with a physical action (such as clapping, following directions to "Simon Says").

B.4. The focus of this item is on the opportunity for the child to work alone or with other children in an activity that reinforces the development of a skill or knowledge which the teacher has previously addressed. The follow-up activity must allow the child some opportunity for choosing how to carry it out. For example, a teacher has led an activity on quantities of "more than" and "less than" using picture cards and pennies for a sorting task. The materials that were used for the activity, or other similar materials, are available for the child to independently work with at a later time. To score this item, following a teacher led activity, observe about the classroom for evidence of materials that are available for child use that reinforces the concepts of the lesson or activity; or observe to see if the teacher makes available the materials used in the activity.

B.5. Factual questions have specific, pre-defined answers, such as "What two colors when mixed together make green?"

B.6. Problem-solving questions are open-ended questions that do not have specific, pre-determined answers, but have instead multiple, plausible answers.

B.7. Self explanatory.

C.1. The focus of this item is on the process of activities versus products or outcomes of activities. Emphasis is on the opportunities that the teacher provides for children to experiment with activities, ideas, and materials and to seek out information about cause and effect relationships, consequences, and solutions to problems. For example, children may be invited to analyze a story and recommend and/or predict outcomes— or, children may be involved in predicting the outcome of mixing different colors of paint and then experimenting with color mixing.

C.2. The emphasis of this item is on the purposefulness of the materials to teach abstract concepts. For example, marbles can be used to teach abstract concepts of quantity, but the presence of marbles does not indicate that they are used for this purpose unless supporting materials (labeled cards or containers) are present that indicates the marbles are sorted, matched, or counted to illustrate differences in quantity.
<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A. Teacher fosters multicultural sensitivity and appreciation.</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Teacher encourages multilingual vocabulary awareness and appreciation.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>2. Teacher has resource information about a variety of cultures, including those cultures represented in the classroom.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O.R</td>
<td>3. During the year, traditional and non-traditional holiday celebrations and activities are planned and represent more than one culture.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>B. Alternative teaching techniques are used to facilitate learning.</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. Directions are given in clear understandable terms.</td>
<td></td>
<td></td>
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<tr>
<td>O</td>
<td>2. Some activities are demonstrated in an organized sequence of small steps.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>O</td>
<td>3. Children are encouraged to actively participate in activities.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>O</td>
<td>4. Teacher lead activities are followed up with independent child-directed opportunities to master specific skills, either through materials or additional activities.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>5. Children are asked questions that require remembering specific facts (such as who, what, when questions).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>6. Children are asked questions that are open-ended or problem-solving (such as why, how, what if questions).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>7. Teacher engages children in language activities (such as reading, story telling, language games).</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td></td>
<td>C. Children are encouraged to be active in guiding their own learning.</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>1. Teacher invites children to compare, solve problems, predict outcomes, and/or manipulate materials to test solutions and predictions.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>O</td>
<td>2. Children are given opportunities to manipulate and experiment with concrete materials that illustrate or teach abstract concepts (such as shape, size, weight, color, quantity).</td>
<td>Yes</td>
<td>No</td>
<td></td>
</tr>
</tbody>
</table>

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Assessment Profile for Early Childhood Programs

Clarification of Terms

Curriculum

C.3. The focus of this item is on the teacher incorporating children's spontaneous ideas into discussions.

C.4. The focus of this item is on the teacher incorporating children's spontaneous ideas into activities.

C.5. Self explanatory.

C.6. As children complete a teacher directed activity, they are free to choose another activity and are not required to wait until the full group has finished before going on to another activity.

D.1. This item focuses upon the match between an activity and the skill level of the child and is determined by the level of the involvement of the children. If a majority of the children appear to be engaged in teacher led activities with focused attention and able to accomplish and reach completion of the task, then score this item "Yes." However, score this item "No" if children are clearly unable to perform the steps of teacher led activities, seem either to complete activities rapidly, appear restless and disinterested, and unable to reach completion of the activity—or complete the activity rapidly with apparent ease.

D.2. Self explanatory.

D.3. Modification refers to procedural or material variation within an activity to accommodate differing skill levels of the children. For example, a counting activity may be varied so that some children count larger quantities (counting 10 to 20) while others count smaller quantities (1-10); some children may write captions on their art work using invented spelling, while others dictate their caption for the teacher to record.

D.4. Written communication refers to the child's efforts to form words, letters, or numbers to share information. The emphasis is on communication of information not drilled penmanship.

D.5. Self explanatory.

D.6. Child assessment information from developmental checklists or portfolio entries is referenced as the basis for designing activities for individual children that focus on specific skill needs or interests.
<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>3. Children spontaneously offer suggestions, ideas and interests and the Teacher incorporates them in discussions.</td>
</tr>
<tr>
<td>O, R</td>
<td>4. Children spontaneously offer suggestions, ideas and interests and Teacher incorporates them into learning activities (such as child is allowed to experiment with materials in alternative uses, an activity is supplemented with additional materials to support child’s ideas, new activities are planned and implemented).</td>
</tr>
<tr>
<td>O</td>
<td>5. All children are allowed opportunities to select their own activities and materials from among all the classroom options.</td>
</tr>
<tr>
<td>O</td>
<td>6. Children are allowed to choose a new activity upon completion of an activity the Teacher has selected and guided.</td>
</tr>
<tr>
<td>D</td>
<td>Curriculum is individualized.</td>
</tr>
<tr>
<td>O</td>
<td>1. Teacher led activities focus on specific skills the child is currently mastering and is neither too difficult nor too simple.</td>
</tr>
<tr>
<td>O</td>
<td>2. Children are allowed to work at their own pace so that those who work quickly are allowed to proceed within the activity or to new activities and those who work slowly are allowed ample time to complete the activity.</td>
</tr>
<tr>
<td>O</td>
<td>3. Activities that involve children of differing skill levels are modified to accommodate variation within the group.</td>
</tr>
<tr>
<td>O</td>
<td>4. Teacher acknowledges and praises the child’s attempts at written communication (such as invented spelling for labels and captions to drawings).</td>
</tr>
<tr>
<td>O</td>
<td>5. Teacher writes words dictated by children to describe an experience or picture.</td>
</tr>
<tr>
<td>O, R</td>
<td>6. Information from completed child assessments is used to design activities that facilitate the development of specific skills.</td>
</tr>
</tbody>
</table>
Assessment Profile for Early Childhood Programs

Clarification of Terms

Interacting

A. The emphasis for items A.1. through A.4. is on the teacher's initiation. Each item should be scored on the basis of the dominant style or mode of the interactions initiated by the teacher.
A.1. Self explanatory.
A.2. Self explanatory.
A.3. This item focuses on the humor and playfulness of the interactions initiated by the teacher as indicated by smiling or laughing.
A.4. Conversation refers to the exchange of ideas and information between the teacher and child but has an air of informality and reciprocal dialogue, it is conversational in nature versus instructional.

B. The emphasis for items B.1 through B.3. is on the teacher’s responsiveness. Each item should be scored on the basis of the dominant style or mode of the interactions between teacher and children.
B.1. Self explanatory.
B.2. Acknowledge refers to the teacher’s verbal response which may be a simple response such as “okay” or “yes” or it may be an elaboration of the child’s statement—rephrasing and including the child’s words or questioning to encourage the child to elaborate. Acknowledge may also refer to a non-verbal, physical response such as a nod of the head, a smile, or a rub on the child’s back.
B.3. Acknowledge is clarified under item B.2. above. Child’s emotions refers to any affective expression from a child and may be vocal (such as laughing or crying), verbal (such as “I don’t like you”), or physical (such as angrily striking another child or lying limp on the floor and rubbing eyes during a story time or smiling and hugging the teacher upon arrival).

C. For items C.1. through C.4., if undesirable behavior is not observed, score the item “Yes.”
C.1. Verbally intervenes is any verbal response the teacher makes towards a child that stops undesirable behavior. Undesirable behavior is any child behavior that is disruptive to an activity and/or harmful to the child’s own person, others, or the environment. Undesirable is defined in terms of the impact of the child’s behavior on self, others, and environment. If the teacher’s verbal intervention is scolding or critical then score this item “Yes” and score item C.5. “No.” If the verbal intervention serves to redirect the child’s behavior to desired behavior, then score this item “Yes” and item C.4. is scored “Yes.”
C.2. Consequences refers to natural cause and effect relationships such as “If you leave your art project on the floor someone might step on it.” Consequences may also refer to the action that will be taken if undesirable behavior persists. This may be considered a warning but must be stated without critical tone and no more than two (2) times. If consequences are restated more than two times for the same undesirable behavior, the statement of consequences becomes critical in tone and threatening—therefore score this item “No” and score C.5. “No.”
C.3. Consequences in this item refers to consequences that are under the control of the teacher such as “If you continue to disturb John, I will ask you to leave the circle.” Consistency refers to the implementation of the consequence in a timely manner so that when the undesirable behavior occurs the consequence follows immediately. For example, the child is asked to leave as soon as the child disturbs John again. If the consequence is to happen at a later time, the teacher informs the child(ren) that the consequence (such as withdrawing a privilege) will be implemented and then follows through when the time comes.
C.4. Redirect refers to the teacher’s efforts to guide the child’s attention and/or behavior towards desired actions. For example, if a child is pounding on a truck with a block, the teacher may redirect the undesirable pounding to desirable constructing behavior by joining the child and beginning to build a road and bridge using the block and the truck and involving the child.
C.5. Negative verbalizations refers to any comments that are critical in nature and includes critical tones. Negative verbalizations may be overtly hostile such as “That’s a dumb thing to do” or subtle, such as “You’re a big boy, now stop crying, boys don’t cry.” or “You’re not being a very good friend when you hit her.”

D. Score items D.1. through D.3. on the basis of the dominant sounds and interactions of the classroom.
D.1. Self explanatory.
D.2. Cooperation refers to child interactions with each other, the teacher, and the classroom environment such as taking turns and exchanging conversation and materials without conflict. Cooperation in this item is not intended to rely solely on compliance with the teacher’s rule. Interactions among children is of equal importance. For example, children who are obeying the rules to be quiet and sit still while waiting for lunch is not sufficient evidence to score this item “Yes.”
## Interacting

<table>
<thead>
<tr>
<th>Standards &amp; Criteria</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Teacher initiates positive interactions with children.</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Teacher initiates positive physical gestures (such as smiles, hugs, pats, holds).</td>
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<tr>
<td>2. Teacher initiates positive verbal interactions (such as praise and acknowledgement).</td>
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<tr>
<td>3. Teacher engages children in laughter and smiling through verbal exchanges and/or playful games and activities.</td>
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<tr>
<td>4. Teacher engages children in conversations (such as personal experiences, ideas, plans).</td>
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<tr>
<td><strong>B. Teacher is responsive to the children.</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Child is allowed to speak to the Teacher without interruption.</td>
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<tr>
<td>2. Child’s statements are acknowledged with a verbal response or a physical gesture.</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>3. Child’s emotions are acknowledged with a verbal response or a physical gesture.</td>
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</tr>
<tr>
<td><strong>C. Teacher positively manages children’s behavior.</strong></td>
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<td></td>
</tr>
<tr>
<td>1. Teacher verbally intervenes to stop undesirable behavior — or undesirable behavior does not occur.</td>
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<tr>
<td>2. Consequences for undesirable behavior are briefly stated without critical tone — or it is not necessary to state consequences.</td>
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</tr>
<tr>
<td>3. Consequences are implemented with consistency — or it is not necessary to implement consequences.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Undesirable behavior is redirected to desirable behavior — or undesirable behavior is not observed.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Teacher refrains from negative verbalizations (such as yelling, criticizing, scolding, threatening, sarcasm).</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>D. Children appear to be happy and involved in activities.</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1. Children are smiling and laughing freely.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Children are cooperating and sharing.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Children are handling materials.</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Assessment Profile for Early Childood Programs

Clarification of Terms

Individualizing

A.1. A portfolio is an individual child’s file folder that the teacher maintains and must include all of the following: child work samples, a checklist indicating the child’s skill level, descriptive teacher notations of observations of child behavior and/or progress.

A.2. Entries refer to child work samples, skill checklists, and/or teacher notations. At least one of these entries must be current within the past week.

A.3. Two child assessments must be completed annually and must occur with a minimum of four (4) months between them.

B.1. Classroom chart refers to an organizational chart that provides space for the names of the children in the classroom, a sequence, scale, or checklist of developmental skills and a place to record the level of each child’s progress in this sequence. All areas of development (cognitive, language, social, and physical) must be included on the chart or series of charts. This item is concerned only with the availability of a written system of organizing information about skill development across the children in the class.

B.2. This item focuses on the use of the classroom skill chart. It is most likely that such summaries would be available in a series of charts and represent a teacher’s working system for organizing and matching activities and children. The chart must be completed and contain notations current within the week. It is not necessary that these charts be posted.

B.3. Grouping refers to gathering together a set of children for the purpose of a specific learning activity. Grouping is intended to be flexible, changing composition based upon skill level and a match to a specific learning activity. The emphasis in this item is on the purposeful match in grouping of children and matching of activity and skill levels. Accurate scoring for this item will require asking the teacher to describe how the classroom chart(s), or summarizing system, is used. If no classroom summary chart(s) is available or used, score this item “No.”

B.4. The focus of this item is on the application of the classroom summary chart in activity planning. Specific activities (which may be reflected in lesson plans) should correspond to specific skills of the children in the class. It may be necessary for the teacher to describe the match or correspondence between the summary system and activities.

B.5. Opportunity to evaluate refers to the children’s own perspective and analysis of their work efforts and products versus the teacher’s verbal evaluation (i.e. “that’s beautiful”) or written evaluation (i.e. smiling face, check mark, number or letter grade on the child’s paper). For example, the children are invited to compare their work products, to select their best and explain why each child views it as their best.

C.1. Procedure refers to the series of actions a teacher initiates when concerned that a child in the class may have a special need. For example, the teacher may request a conference with parents and determine next steps, document the concern on a report form, request an observation or evaluation of the child, etc. Special needs are any special considerations that a child may have and may be developmental, physical, emotional, medical, social, etc. Special needs may be permanent conditions, such as diabetes, or temporary, such as a broken leg.

C.2. Written description refers to any written documentation that provides information about the special considerations a child may require. This documentation may be provided by parents, administrator, resource personnel, etc. If the teacher indicates that there is not currently a child with special needs enrolled in the class, ask the teacher if previously there have been children with special needs and if so what written information provided.

D.1. Included in ongoing activities refers to the involvement of a child with special needs in the routine activities of the classroom.
### Individualizing

<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>1</td>
</tr>
<tr>
<td><strong>A. Child assessment occurs systematically.</strong></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>D</td>
<td>1. A portfolio is available for each child which includes child work samples, skill checklists, anecdotal/narrative reports.</td>
<td></td>
</tr>
<tr>
<td>D, R</td>
<td>2. Child portfolios are available and contain entries that are current within one week.</td>
<td></td>
</tr>
<tr>
<td>D, R</td>
<td>3. A minimum of two developmental assessments for each child are completed annually.</td>
<td></td>
</tr>
<tr>
<td><strong>B. Child assessment is used for planning individualized learning experiences.</strong></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>D</td>
<td>1. Classroom chart(s) for summarizing children's developmental skills is available and comprehensive including all developmental areas: cognitive, language, social, physical.</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>2. Classroom skill chart(s) is used to summarize the level of skill development for the class.</td>
<td></td>
</tr>
<tr>
<td>D, R</td>
<td>3. Information from classroom skill chart(s) is used for grouping children by skill.</td>
<td></td>
</tr>
<tr>
<td>D, R</td>
<td>4. Information from classroom skill chart is used for planning specific activities.</td>
<td></td>
</tr>
<tr>
<td>O, D, R</td>
<td>5. Children have opportunities to evaluate their own work and the Teacher accepts child's self-assessment.</td>
<td></td>
</tr>
<tr>
<td><strong>C. Teacher has a system for identifying special needs.</strong></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>R</td>
<td>1. Teacher has a procedure for seeking advice and referrals for children suspected of having special needs.</td>
<td></td>
</tr>
<tr>
<td>D, R</td>
<td>2. Teacher receives written description of a child's specific, special needs.</td>
<td></td>
</tr>
<tr>
<td><strong>D. Teacher is able to make provisions in the classroom for children with special needs.</strong></td>
<td></td>
<td>Yes No</td>
</tr>
<tr>
<td>O</td>
<td>1. Child is included in ongoing activities of the group — or child with special needs is not currently enrolled.</td>
<td></td>
</tr>
</tbody>
</table>

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Assessment Profile for Early Childhood Programs

Clarification of Terms

Individualizing

D.2. Modified refers to any adaptation in the procedures, and materials, or physical setting of an activity that may be necessary to accommodate children with special requirements.

D.3. Adequate provisions refers to physical accommodations made in classroom arrangement and furnishings to provide for physical special needs (such as wide pathways for a walker or leg braces, higher table or desk for wheel chairs, etc.)

E.1. The focus of this item is on the communication between Parent and Teacher when a child with special needs is enrolled in the class and receiving services or treatment for these needs (such as speech therapy, eye or hearing exams).

E.2. Calendar refers to the teacher’s planning calendar. The projected schedule refers to weeks and/or months that the teacher has plans for parent conferences. Parent conferences are individual meetings with the parents, or guardians, of the children in the class.


E.4. Notes refers to the teacher’s written notations regarding information shared from teacher/parent conferences. These notations may refer to new information regarding the child, concerns discussed, or decisions made, etc.

E.5. Parent initiated communication may be either written or verbal.
<table>
<thead>
<tr>
<th>Methods</th>
<th>Standards &amp; Criteria</th>
<th>OBSERVATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>O</td>
<td>2. Activities are modified to allow successful participation of child — or child with special needs is not currently enrolled.</td>
<td>Yes</td>
</tr>
<tr>
<td>O</td>
<td>3. Adequate provisions for space and equipment have been made to accommodate particular handicaps — or child with special needs is not currently enrolled.</td>
<td>Yes</td>
</tr>
<tr>
<td>E</td>
<td>Conferences with individual parents are regularly planned.</td>
<td>Yes</td>
</tr>
<tr>
<td>R</td>
<td>1. Teacher discusses progress and status of the child's special needs with parents at least once a month — or child with special needs is not currently enrolled.</td>
<td>Yes</td>
</tr>
<tr>
<td>D, R</td>
<td>2. Teacher keeps a calendar with projected schedule of parent conferences.</td>
<td>Yes</td>
</tr>
<tr>
<td>D, R</td>
<td>3. Individual parent conferences are scheduled following child assessments and occur at least 2 or more times during the year.</td>
<td>Yes</td>
</tr>
<tr>
<td>D</td>
<td>4. Notes from individual parent conferences regarding their child's developmental progress and classroom experiences are available.</td>
<td>Yes</td>
</tr>
<tr>
<td>R</td>
<td>5. Teacher responds to parent initiated communication within 2 days.</td>
<td>Yes</td>
</tr>
</tbody>
</table>
CODING SYSTEM FOR KINDERGARTEN CLASSROOM PROFILE (TEACHER BEHAVIOR)

A. Teacher Orientation
   1. Whole class
   2. Group
   3. Individual child
   4. Others

B. Activity Type
   1. Mathematics taught as an isolated subject
   2. Mathematics integrated with other learning-related activities
   3. Literacy and literacy-related activities
   4. Activities related to other developmental areas
   5. Others

C. Teaching Behavior
   1. Low-level cognitive distancing
   2. Medium-level cognitive distancing
   3. High cognitive distancing
   4. Monitoring children's participation
   5. Others

D. Interaction
   1. Positive
   2. Neutral
   3. Negative
   4. Others

E. Activity Source
   1. Manipulatives
   2. Foods
   3. Media/audiovisual materials
   4. People
   5. Books
   6. Computers
   7. Calculators
   8. Games
   9. Writing/drawing materials
   10. Worksheets
   11. Others
CODING SYSTEM FOR KINDERGARTEN CLASSROOM PROFILE (CHILD BEHAVIOR)

A. Child Orientation
   1. Whole class
   2. Group
   3. Teacher
   4. Peer
   5. Alone

B. Activity Type
   1. Mathematics taught as an isolated subject
   2. Mathematics integrated with other learning-related activities
   3. Literacy and literacy-related activities
   4. Activities related to other developmental areas
   5. Others

C. Classroom Behavior
   1. Initiating learning-related conversations
   2. Responding to teacher’s low-level cognitive distancing
   3. Responding to teacher’s medium-level cognitive distancing
   4. Respond to teacher’s high cognitive distancing
   5. Responding to peers
   6. Working alone appropriately
   7. Other appropriate, task-relevant behaviors
   8. Others

D. Activity Source
   1. Manipulatives
   2. Foods
   3. Media/audiovisual materials
   4. People
   5. Books
   6. Computers
   7. Calculators
   8. Games
   9. Writing/drawing materials
  10. Worksheets
  11. Others
CODING SHEET FOR KINDERGARTEN CLASSROOM PROFILE (TEACHER BEHAVIOR)

Teacher Behavior (15-sec interval Time Sampling)

A. TEACHER ORIENTATION
   District School  Teacher  Program  Nomination  Visit
   1. CLASS  
   2. GROUP  
   3. INDIV.  
   4. OTHERS

B. ACTIVITY TYPE
   A  B  C  D  E
   1. MAIN  
   2. MAIN-INTERATED  
   3. LITERACY  
   4. DIV. AREAS  
   5. OTHERS

C. TEACHING BEHAVIOR
   A  B  C  D  E
   1. LOWCIG  
   2. MEDCIG  
   3. HIGH  
   4. MONITOR  
   5. OTHERS

D. INTERACTION
   A  B  C  D  E
   1. POSITIVE  
   2. NEUTRAL  
   3. NEGATIVE  
   4. OTHERS

E. ACTIVITY SOURCE
   A  B  C  D  E
   1. MANIPUL.
   2. FOODS
   3. MEDIA
   4. PEOPLE
   5. BOOKS
   6. COMPUTER
   7. CALCULATORS
   8. GAMES
   9. WRITING/DRAWING
   10. WORKSHEET
   11. OTHERS

<table>
<thead>
<tr>
<th>Numeration</th>
<th>Fraction/Decimal</th>
<th>Time</th>
</tr>
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<tbody>
<tr>
<td>Estimation</td>
<td>Seriation/Sequence</td>
<td>Money</td>
</tr>
<tr>
<td>Prediction</td>
<td>Classification</td>
<td>Comparison</td>
</tr>
<tr>
<td>Measurement</td>
<td>Spatial Sense</td>
<td>Geometry</td>
</tr>
<tr>
<td>Statistics</td>
<td>Cause/Effect</td>
<td>Patterns</td>
</tr>
</tbody>
</table>
CODING SHEET FOR KINDERGARTEN CLASSROOM PROFILE (CHILD BEHAVIOR)

Child Behavior (15-sec interval Time Sampling)

<table>
<thead>
<tr>
<th>District</th>
<th>School</th>
<th>Teacher</th>
<th>Visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Month/ Day/ Year</td>
<td>Children</td>
<td>Adults</td>
<td></td>
</tr>
</tbody>
</table>

A. CHILD ORIENTATION

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Child 1</th>
<th>Child 2</th>
<th>Child 3</th>
<th>Child 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. CLASS</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2. GROUP</td>
<td>1</td>
<td>12</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. TEACHER</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. PEER</td>
<td>3</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. ALONE</td>
<td>4</td>
<td>16</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. ACTIVITY TYPE

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Child 1</th>
<th>Child 2</th>
<th>Child 3</th>
<th>Child 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MATH</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2. MATH-INTEGRATED</td>
<td>5</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. LITERACY</td>
<td>6</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. DEV. AREAS</td>
<td>7</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. OTHERS</td>
<td>8</td>
<td>20</td>
<td></td>
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</table>

C. CLASSROOM BEHAVIOR

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Child 1</th>
<th>Child 2</th>
<th>Child 3</th>
<th>Child 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. INITIATES</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2. LOWCOG RES.</td>
<td>9</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. MEDCOG RES.</td>
<td>10</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. HICOG RES.</td>
<td>11</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. RES.TO PEER</td>
<td>12</td>
<td>24</td>
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<td></td>
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</tbody>
</table>

D. ACTIVITY SOURCE

<table>
<thead>
<tr>
<th>Activity Type</th>
<th>Child 1</th>
<th>Child 2</th>
<th>Child 3</th>
<th>Child 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. MANIPUL.</td>
<td>A</td>
<td>B</td>
<td>C</td>
<td>D</td>
</tr>
<tr>
<td>2. FOODS</td>
<td>1</td>
<td>13</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. MEDIA</td>
<td>2</td>
<td>14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. PEOPLE</td>
<td>3</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. BOOKS</td>
<td>4</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. COMPUTER</td>
<td>5</td>
<td>17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. CALCULATORS</td>
<td>6</td>
<td>18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. GAMES</td>
<td>7</td>
<td>19</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. WRITING/DRAWING</td>
<td>8</td>
<td>20</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. WORKSHEET</td>
<td>9</td>
<td>21</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. OTHERS</td>
<td>10</td>
<td>22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>12.</td>
<td>11</td>
<td>23</td>
<td></td>
<td></td>
</tr>
<tr>
<td>13.</td>
<td>12</td>
<td>24</td>
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</tr>
</tbody>
</table>
APPENDIX D:
CODING MANUAL FOR KINDERGARTEN CLASSROOM PROFILE
CODING MANUAL FOR KINDERGARTEN CLASSROOM PROFILE

Kuei-Er Chung

Department of
Human Development and Family Studies

Iowa State University
Ames, Iowa
1993-1994
GENERAL INFORMATION

This manual describes the procedure used for scheduling observations in each classroom, the observational system developed for coding the children's behavior and the system for coding the behavior of teachers.

The purpose of the observational coding manual is to describe (1) the schedule of the observations and (2) the teacher and child behavior in the kindergarten classroom in terms of mathematics curriculum, teaching strategy, classroom interaction, and learning environment. There are two components of the coding system: (1) direct observation of child behavior, and (2) direct observation of teacher behavior.

SCHEDULING OBSERVATIONS

Four children and the classroom teacher are observed during each visit. Each observational period is composed of four blocks of child observations and four blocks of teacher observations, with child observations and teacher observations alternating. That is, if the first period starts with the block of child observations, the next period starts with the teacher block. One child is observed during the block of child observations followed or proceeded by a block of teacher observations. A tape recorder with earphone will be used to guide the observer through the sequence of observations.

Although 12 children are selected, only 4 children are observed during each visit. Each child is observed for four successive fifteen-second intervals during one child block, which is followed by a fifteen-second interval for coding the observed behavior.

Each block of child observations is followed by a block of teacher observations in which teacher behavior is observed for four successive fifteen-second intervals; each of these intervals will be followed by a fifteen-second interval for coding.

Each observational period lasts 16 minutes. After each period is a two-minute break, which allows the observer to rest and to prepare for the next observational period. For example, the observer can change the coding paper or write notes for particular incidents.

The observations are conducted only during class time, not including recess or activities held outside the classroom. If children have to go to another room for music or physical education, the observations are continued when the children return to the classroom and the teacher is again in charge. Classes led by substitute teachers will not be coded. Observers are able to avoid such events by obtaining information from the teacher in advance. For each visit, six observational periods are expected, depending upon the schedule of the day.

Each child will be observed for 24 15-second intervals to yield a total of 6 minutes of observations for each child. Twelve children in each classroom will be observed, for a total of
seventy-two minutes of observation time. Each teacher will be observed for 288 15-second intervals to yield a total of 72 minutes of observations. In total, the study will involve 2160 minutes of teacher behavior and 2160 minutes of child behavior in 30 classrooms.

The observer will be at school before the class day begins, with prepared observation sheets, tape and tape recorder, and earphone. Each behavior will be recorded on a specially designed observation sheet.

At the end of each visit, the observer will summarize the mathematical concepts taught by the teacher or explored by the children. The data will be transcribed from the observation sheets and entered into the computer after the observer returns from the kindergarten classroom. The item number coded from the behavior categories will be recorded for each of the four children and for the teacher. Observer reliability will be checked before, in the middle of, and at the end of the study.

TEACHER OBSERVATIONS

The Kindergarten Classroom Profile contains two groups of behaviors to describe teachers and children. The system for coding teacher behaviors includes 29 categories, which are divided into five groups: (A) teacher orientation, (B) activity type (C) teaching behavior, (D) interaction, and (E) activity source.

The behavior is coded according to what is observed during each interval. If more than one category of behavior is observed, the one on which the greatest amount of time was spent during the interval is to be coded.

A. Teacher Orientation

The teacher can be working with (1) the whole class, (2) a group of children, (3) an individual child, or (4) others.

1. Whole class is coded when the teacher is working with the class as a whole. This most likely will be seen when the teacher is demonstrating to, giving information and directions to, and asking questions of the entire class. When the teacher is talking to one child in a large group, the whole class is observing the teacher for further direction, whole class is coded.

2. Group is coded when the teacher has divided the class into smaller groups that are working independently, rather than working with the class as a whole. This is to be coded from the teacher’s perspective. A group can be as small as two children working together with the teacher’s presence. An informal small group interacting with the teacher often is seen during children’s free-choice time. If some children in the class are divided into smaller groups and the rest are left in a larger group, it is coded as whole class when the number of children the
teacher works with is greater than half of the class. If the number of children the teacher works with is greater than one child but small than half of the class, group is coded.

3. Individual is coded when the teacher is interacting privately with one child, not when the teacher interacts with one child in the situation of a whole-class discussion or when all children are oriented towards the teacher, a situation to be coded as class. When the teacher is planning or reviewing with the child the activities concerning individuals' interest, experience, and ability, individual is coded although the whole class is oriented towards the teacher and is waiting for attention.

4. The category others is to be coded when the teacher is not interacting with any of the children. Others also is coded when the teacher is interacting with other adults, such as other staff, parents, visitors, or children not regularly enrolled in this class, such as children's siblings or children from other classes.

B. Activity Type

Classroom activities are categorized as (1) mathematics activity, (2) mathematics integrated with other activities, (3) literacy and literacy integrated with other activities, (4) activities related to other developmental areas, and (5) others. Activities in the classroom are coded according to the teacher's attempts to involve children or to respond to children's learning initiatives.

1. Mathematics activities is coded when the teacher attempts to present concepts related to quantity, number, counting, time, money, geometry, spatial sense, measurement, matches, comparison, classification, estimation, prediction, statistics, chance (probability), graphs, fractions, decimals, patterns, and relations. This category is coded when a mathematical concept is presented alone, without involving other developmental areas.

Examples:
   a. Demonstrating shapes.
   b. Asking children to group the objects.
   c. Writing number words requested by children.
   d. Showing patterns or relations to children.
   e. Asking children to identify objects.

2. Mathematics integrated with other learning-related activities is coded when a mathematical concept is introduced in activities based upon children's previous experience or extended to other learning activities, such as problem solving, reasons for solutions, etc. Usually, kindergartners are involved in mathematics activities in genuine problems presented by the teacher or in situations created by the children themselves.
Examples:

a. Verbalizing children's actions related to construction of mathematical concepts, e.g.,
   "Myna, are you trying to put more blocks on this side so the scale will be balanced?"

b. Reading to children books involving mathematical concepts.

c. Presenting problem-solving situations involving mathematical concepts, e.g., "How many glasses do we need for snack today?"

d. Showing the order of the children in the line or indicating what is common or different about their clothing.

e. Rhyming number names and concepts of shapes and patterns, etc.

f. Asking children cause-and-effect questions at the art table.

g. Counting the legos or other countable materials used in work.

Mathematics Integrated is coded when measurable or countable constructive materials are the source of the activity. For example, the teacher interacts with children using legos, rods, logs, or unit blocks to build a tower, trains, or a spaceship, etc. Activities involving cooking, play dough, water table, and sandbox also are coded as mathematics integrated.

3. Literacy and literacy integrated with other activities is coded when reading, writing, and language arts are involved. Activities such as alphabet recognition, word naming, auditory/visual discrimination, writing, rhyming, listening, defining, and analyzing sounds and spellings are coded as this category. Other activities related to showing the usefulness of reading ability, relations between spoken and written words, and explaining language of instruction also are coded as literacy related. When a book related to science or to social studies is read to the child, literacy is coded.

Examples:


b. Asking children what they think of a picture.

c. Writing down words requested by children.

d. Complimenting children's attempts at writing, reading, or communicating.

e. Showing the left-to-right, top-to-bottom orientation of text.

If a book related to mathematical concepts (e.g., measurement, numeration, patterns) is read, it is coded as mathematics integrated.

4. Activities related to other developmental areas is coded when the activity is related to science, social studies, art, music, movement, woodworking, drama, dance, health, safety, etc.

Examples:

a. Rhyming, singing, and moving activities.
b. Discussing science-related concepts from a book.
c. Interacting with children as a customer in the dramatic center.
d. Helping children to obtain self-help skills.
e. Discussing self-concepts with children.
f. Having a snack.

5. **Others** is coded when the teacher is not involved in a teaching-related activity, e.g., giving directions for transitional activities, attending to classroom routines or classroom management, talking to other staff or parents, and other undetermined behaviors, etc.

Examples:

a. Assigning children to groups or to work.
b. Correcting children’s inappropriate behavior.
c. Getting ready for the activities.
d. Interacting with people other than children of the class for things other than teaching activities.

C. **Teaching Behavior**

Teaching behaviors are classified in five categories: (1) low-level cognitive distancing, (2) medium-level cognitive distancing, (3) high-level cognitive distancing, (4) monitoring children’s participation, and (5) others. Cognitive distancing strategy is determined by the level of teachers’ interactions promoting children’s thinking from here and now to more abstract and representational thinking. Very often, teachers use cognitive distancing strategies by asking open-ended questions to stimulate children’s high-level thinking. However, not all open-ended questions are high-level distancing. Many of them, such as "What is your brother's name?" and "What day is today?" can be answered by recall and are therefore defined as low-level distancing.

The definitions and examples of categories of the following cognitive distancing levels are adapted and modified from Flaugher and Sigel’s (1980) Parent-child Interaction Instrument.

Three cognitive distancing levels are used, based upon the level of the distancing demand upon the child:

**Low-Level Cognitive Distancing**

- label
- produce information
- describe, define
- describe - interpret
- demonstrate
observe

**Medium-Level Cognitive Distancing**
sequence
reproduce*
describe/infer similarities
describe/infer differences
classify
estimate
enumerate
synthesize within classifying

**High-Level Cognitive Distancing**
evaluate consequence
evaluate competence
evaluate effect
evaluate effort and/or performance
evaluate necessary and/or sufficient
infer cause-effect
infer effect
generalize
transform
plan
confirm a plan
conclude
propose alternatives
resolve conflict

* reproduce - Behaviors of this category are grouped according to what is demanded of the children by the teacher. Example: reproduce/label = low distancing; reproduce/plan = high distancing.

**DEFINITIONS AND EXAMPLES OF TEACHER'S COGNITIVE DISTANCING BEHAVIORS**

1. Low-Level cognitive distancing is coded when the teacher is giving a statement or request demanding the child to:
Observe
Definition:
Getting the child to attend using any senses: hearing, seeing, smelling; asking the child to examine.
Examples:
"Watch what I am doing."
"Do you see how the marble is going down?"

Label
Definition:
Naming a singular object or event or action; locating a place.
Examples:
"What is this?"
"Where is the book?"
"Who made this?"
"Whose name tag is this?"

Identify
Definition:
Pointing to a singular object or event or action from others.
Examples:
"Which one is a triangle?"
"Is this a tadpole?"
"Is this your bag?"

Define/describe
Definition:
Providing elaborated information of a single instance. The statement may be definitional.
Examples:
"What is make-believe?"
"What is a square?"
"What is the man doing?"

Demonstrate
Definition:
Showing primarily through actions or gestures how something is to be done; the how process.
Examples:
"Show me how to do it."
"How do you play with this?"

Produce Information
Definition:
Producing, processing, confirming or rejecting information about labeling, location, materials, events; linking information. Requires a yes - no answer from child.
Examples:
"Is this a boat?"
"Did you make this?"

Interpret
Definition:
To attribute or to explain meaning; more personal than a definition.
Examples:
"What does it mean to make believe?"
"What do you mean?"

Teacher's low-level cognitive distancing strategies are often presented in the whole class to a group, or with the individual child while the teacher is
a. giving explanation, information, and directions,
b. giving verbal or physical commands to call children's attention to or to invite children to participate in activities,
c. demonstrating procedures of activities or showing objects or materials to children,
d. participating in an activity,
e. pointing something out to children,
f. reading to children,
g. attempting to draw children's attention to an activity or inviting children to participate in an activity.

2. Medium-level cognitive distancing is coded when the teacher requires children to

Sequence
Definition:
Temporal ordering of events, as in a story or carrying out a task; steps discussed. Typical key words of sequencing are last, next, afterwards, start, and begin.
Examples:
"First, do this, then this."
"Tell me how you made it."
"Where did you go next?"

Reproduce
Definition:
Reconstructing previous experiences; dynamic interaction of events, interdependence, functional; child's organization of previous experience.

Examples:
"Can you make one like this?"
"What did you do when you flew on a plane?"

Compare
Definition:
Describing or inferring characteristics or properties across classes; noting the existence of a similarity or difference.

Examples:
"Do they look the same?"
"How do you think they should go together?"
"How are they different?"
"Which one does not belong to this group?"

Describe/Infer Similarities
Definition:
Noting or identifying common characteristics. Perceptual or conceptual analysis, sensory comparison, analogies, part-whole relations.

Examples:
"In what ways is your boat like mine?"
"Do you see the same colors in Zach's and Tim's shirts?"
"What does it look like to you?"
"Draw yours the same way."

Describe/Infer Differences
Definition:
Noting or identifying differences among instances, including perceptual or conceptual analysis.

Examples:
"In what ways is Zach's truck different from Tim's?"
"Which truck looks different from #6, yours or mine?"
"Does your truck look different from a real truck?"
"How does this rabbit differ from the other one?"

Classify

a. Symmetrical
Definition:
Identifying the commonalities of a class of equivalent instances or labeling the class;
stating why instances are alike, not how.
Examples:
equivalence
  "Why is yours like mine?"
  "Why is this like a tower?"
class label
  "What do you call red, yellow, blue, and green?"
  "What do you sail on the lake in, or canoe in?"

b. Asymmetrical
Definition:
Organizing instances within the same class in some sequential ordering: logical
hierarchy; viewing the relation as a continuum; seriation of any kind; comparison in
which each instance is related to the previous one and the subsequent one; relative
(bigger than, smaller than, more or less).
Examples:
  "Does your rocket fly better than mine?"
  "Which spaceship looks most like the one on the picture?"

c. Synthesize
Definition:
Organizing components into a unified whole; explicit pulling together; creating new
forms; sum of a number of discrete things.
Examples:
  "When you add "rain" to "bow," what word does that make?"
  "If I add these two marbles into your pile, how many marbles will you have?"
  "How many things do you know that can fly?"

Estimating
Definition:
Estimating quantity.
Examples:

"How often do you go to the library?"
"How often do you see rainbows?"
"How many cups of water will fill the bottle?"
"How many steps does it take you to go from the table to the door?"

Enumerating

Definition:
Seriation, enumeration of number of things; ordinal counting (1, 2, 3, 4, 5).

Examples:

"Count the steps on the board."
"Count the cookies we are going to have."
"Count the people wearing red in the group today."

Medium- and high-level distancing strategies often are accompanied by teaching behaviors in the whole-class, in the small group, and with individuals. The teacher presents situations or problems to stimulate children’s thinking. Such situations or problems require children to generate solutions and alternatives. The teacher may try to link children’s past experience with present situations. The teacher usually presents cognitive distancing according to children’s cognitive developmental levels, background experiences, and learning styles. The teacher may also encourage children to be involved in discussion so that they can express and communicate their ideas.

3. **High-level cognitive distancing** is coded when the teacher is encouraging children to Evaluate

Definition:
Assessing the quality of any givens.

a. **Consequence**

Definition:
Assessing the quality of a product, or outcome, or feasibility, or the aesthetic quality of personal liking. Criteria needed for evaluation, e.g., good - bad, right - wrong, fun - not fun, silly - not silly. Evaluation of other’s interpretation of what the child means.

Examples:

"Do you think this will work?"
"Can we build a castle with sand?"
"If rainbows are real, can you play with them?"
"Could we paint a rock and use it for a paperweight?"
"Is this a good boat?"
"Do you like this book?"
"Is this hard to make?"

Comments:
Conditional competencies or qualified "can you" questions are included under this category.

b. Own Competence
Definition:
Assessing own competence or ability.
Examples:
"Do you know how to make a tow-truck?"
"Can you count?"

c. Affect
Definition:
Assessing the quality of a feeling state.
Examples:
"Is it fun to feel happy?"
"How do you feel about being sad?"

d. Effort and/or Performance
Definition:
Assessing the quality of the performance and/or the effort expended on a task.
Examples:
"Did you work hard at that?"
"You did that well."
"Are you working hard or are you playing?"

e. Necessary and/or Sufficient
Definition:
Assessing information that is necessary or sufficient for something to happen; reality confirmation; recognition of absurdities.
Examples:
"Can the girl really catch the moon?"
"Can you have a rainbow when there is no sun?"
"Do you have to have a rock to hold the paper?"
Infer
Definition:
Focusing on non-apparent, unseen properties or relations.

a. Cause-Effect
Definition:
Predicting outcome on the basis of causal relations of instances or statement thereof; explanation or reason for some event, direct or indirect.
Examples:
"How (cause) could you make it fit in that hole (effect)."
"Can we make a truck (effect) by using these legos (cause)?"
"How (cause) can you keep the logs (effect) together without falling apart?"
"Will the truck fly (effect) when you let it go (cause)?"
"If we put the legos like that (cause), what will we make (effect)?"
How (cause) come it becomes red (effect)?

b. Affect/Feelings
Definition:
Predicting or assessing how a person feels, believes, or intends.
Examples:
"Was the boy feeling sad?"
"Did Amy mean to tear up the box?"

c. Effects
Definition:
Predicting what will happen without articulating causality; effect of a cause; prediction of someone else's competence, or feasibility, or locations.
Examples:
"Did she find it?"
"Where will the marble go?"
"Will Amy tear up this box?"
"Will the string work all those things?"

Generalize
Definition:
Application or transfer of knowledge to other settings or objects; a new situation going beyond the immediate task or context.
Examples:

"Have you seen anything like this before?"
"This is my spaceship, and that is your spaceship, and that is Alexa’s spaceship."
"Now that we know how rainbows and rain water go together, do you think the fish bowl water can make a rainbow?"

Transform
Definition:
Changing the nature, function, appearance of instances; focusing on the process of change of state of materials, persons, or events. Inferring is a part of this - the prediction of what will happen relating to a change of state.

Examples:

"What do you need to do to a rock to change it into sand?"
"What will the rock turn into if you smash it?"
"What will Catarina become when she lives in the castle?"
"What will the play dough become if you press it with a cookie cutter?"

Plan
Definition:
Arranging of conditions to carry out a set of actions in an orderly way; acting out a rule of the task or actually carrying out the task. The child is involved in the decision.

Examples:

"What would you like to do with these rocks?"
"How can everyone have a turn?"
"Do you want to read to me?"
"If you want to make a square by using the rubber band and geoboard, what should you do?"

Comment:
If cause-effect is indicated, materials must be present. Most often appears in the form of questions, but indirect questions and imperatives seeking information also may appear.

Confirm a Plan
Definition:
Checking whether the plan was carried out.

Examples:

"Do you think this will work?"
"Does it look the way you expected it to?"
"Did it turn out the way you wanted?"

**Conclude**

**Definition:**
Relating actions, objects or events in an additive and/or integrative way; summarizing, reviewing. This category is used for the last statement or question in a series of questions leading up to a conclusion. Key words are so, therefore.

**Examples:**
"Are you finished?"
"Looks like it’s wet, so it must have rained, right?"
"Who’s winning the game?"
"If the rock becomes sand, could it be used as a paperweight?"

**Comment:**
The child has to go through more than one cognitive step to arrive at an answer.

**Propose Alternatives**

**Definition:**
Offering different ideas or suggestions other than the one already being presented.

**Examples:**
"Is there any other way we can do this?"
"Does anyone have different ideas?"
"Does everyone agree with Andy?"

**Resolve Conflict**

**Definition:**
Giving ideas or suggestions to solve problems in situations causing disagreement or difficulty.

**Examples:**
"Beth needs two more longer logs to build the roof; how can she make it?"
"How can both Cali and Matthew play the game?"

If the teacher is showing more than one teaching behavior in one interval, higher level cognitive distancing behavior is coded. In other words, medium-level distancing is coded when low- and medium-level distancing are present; high-level distancing is coded when medium- and high-level distancing are present. For example, when the teacher tells children, "Look at what I have here. Tell me what we can do with it," it is coded as high-level distancing because the teacher is asking children to plan an activity.
4. **Monitoring children's participation** is coded when the teacher is watching and listening to children to ensure that children are participating appropriately. The teacher also is assuring children's safety and learning while questioning children or responding to their questions and requests. He/she may add new or more materials to facilitate learning or to stop inappropriate behaviors. He/She may have eye contact with students or smile at them to encourage participation and let children know that he/she is available when they need him/her.

Examples:
- b. Responding to children's initiatives by offering help or suggestions.
- c. Helping children solve conflicts.
- d. Inviting off-task children to participate in activities.
- e. Waiting for children to respond or to refocus attention on activity.
- f. Correcting inappropriate or undesirable behaviors.

5. **Others** is coded when the teacher behavior does not fit in these categories, e.g., dealing with an unexpected event, or visitors. The teacher is not doing cognitive distancing or monitoring children's participation. Usually, this category is coded when the teacher is not with any child or is talking with other staff or parents. Other non-teaching behaviors or undetermined behaviors are coded as others.

Examples:
- a. Going to another room to take materials.
- b. Interacting with people other than children in the class.
- c. Reading alone.
- d. Writing alone.
- e. Getting ready for activities.

**D. Interaction**

Teacher interactions with children are categorized as (1) positive, (2) neutral, (3) negative or (4) others.

1. **Positive** interaction is defined as verbal and nonverbal emotional support regarding conduct or behavior of the child, such as praise, approval, and encouragement.

Examples:
- a. Smiling.
- b. Giving eye contact to approve of children's behavior.
- c. Patting the child.
- d. Nodding head to agree with ideas or behaviors.
e. Saying "Great." "Good job. "You are right." "I am impressed by what you have done." "That sounds interesting." "You have made this geoboard very interesting to me."
f. Offering help and comfort to children.

**Neutral** is coded as the teacher is giving statements and asking or answering questions to encourage children's appropriate and active participation, which usually is not accompanied by praise, approval, or encouragement in specific language or physical signs. This behavior can be observed when the teacher is, for example:

a. Reading a book,
b. Writing or drawing,
c. Monitoring children's participation,
d. Demonstrating (e.g., "This is a yellow circle."), or
e. Giving information, direction, or explanation.

Examples:

"I took a bus to school yesterday."
"Does everyone agree with Amy's answer?"
"What can we do with these acorns?"
"That is a neat baby snail."

3. **Negative** is coded when the teacher is criticizing or correcting children's behaviors, statements, or answers verbally or physically. Other teacher behaviors including threats, warning, scolding, and physical punishment are coded as negative interaction.

Examples:

a. Saying to the child: "Kate, you need to go back to sit at your spot."
b. Saying to the child: "Your answer is wrong."
c. Saying to the child: "John, you should not take Jesse's book without asking him."
d. Saying to the child: "Andrea, you should not say that."
e. Sending the child to another room or area.
f. Physically hitting the child.

4. **Others** is coded when the teacher is not looking at the children as a whole class or as an individual. There is no interaction between the teacher and the children in the class.

**E. Activity Source**

Activity source is categorized according to 11 categories: (1) manipulatives, (2) foods,
(3) media/audiovisual materials, (4) people, (5) books, (6) computers, (7) calculators, (8) games, (9) writing/drawing materials, (10) workbooks, and (11) others.

1. **Manipulatives** is coded when concrete objects or models are used to promote teaching and learning.

   Examples:
   
   a. Sand box.
   
   b. Water table.
   
   c. Legos.
   
   d. Blocks.
   
   e. Play dough.
   
   f. Art materials.
   
   g. Puzzles.
   
   h. Dramatic play materials.
   
   i. Beans.
   
   j. Buttons.
   
   k. Marbles.
   
   l. Pegboards.

2. **Foods** is coded when the source of the activity is for the participants to eat during the snack time or after the activity. Food used for art materials or for measurement at rice table, however, such as rice, macaroni, or spaghetti, is coded as manipulatives. Cookies counted for snack are coded foods.

3. **Media/Audiovisual materials** is coded when posters, pictures, chalkboards, bulletin boards, tape players, record players, overhead projectors, movies or filmstrips are used to promote children’s interest and participation.

4. **People** is coded when a special speaker or visitor comes to present interesting activities or concepts in the class. A child doing show-and-tell also is coded as people for the activity source.

   Examples:
   
   a. A parent bringing his/her newborn baby to the class.
   
   b. A firefighter is talking about his job.
   
   c. A child in the class talking about his/her visit to grandparents in another town.
   
   d. A child in the class used as a model to demonstrate the procedure of the activity.

5. **Books** is coded when the teacher is reading to children, listening to the child reading, and discussing the book with children.
6. **Computers** is coded when the teacher is demonstrating something on the computer, or is interacting with children while they are working on it.

7. **Calculators** is coded when the teacher is using a calculator to demonstrate, to discuss ideas, or to solve problems.

8. **Games** is coded when speed or score is involved to promote learning.

Examples:
   a. Lotus.
   b. Bingo.
   c. Cardboard games.
   d. Memory card games.

9. **Writing/drawing materials** is coded when the materials are provided on which children can write or draw. This is different from workbooks because children are free to make their own designs with these writing/drawing materials.

10. **Workbooks/worksheets** is coded as pre-designed materials used by the children to write, trace, copy, color, or to draw. These can be either teacher made or commercial materials.

11. **Others** is coded as the source when other items than the above are used, such as pets, plants, or special materials. Others also is coded when nothing is used by the teacher or children during the teacher-children interactions.

**CHILD OBSERVATIONS**

The system for coding child behavior includes 30 categories. These are divided into four groups: (A) child orientation; (B) activity type; (C) classroom behavior; and (D) activity source.

**A. Child Orientation**

The observer will check one of five categories to indicate with whom the child interacts: (1) whole class, (2) group, (3) teacher, (4) peer, (5) no one.

1. If the child is attending the activity with the majority of the class and the teacher, then (1) interacts with the whole class is coded. The majority of the class is defined as more than one half the children in the class doing the same activity. If the teacher is not involved in the activity with the target child in a large group, although the child is with more than one half the whole class, only (2) group is coded.

2. If the child is attending an activity with more than one but fewer than one half the children in the class, then (2) group is coded. It is not necessary to have the teacher involved when group is coded.
3. Teacher is coded when the child is interacting with the teacher or with other adults in the classroom. These adults can be teacher's aides, volunteers, parents, resource people, visitors, etc. If the child is working alone while watching or smiling at the teacher, or if the child is having eye contact with the teacher from a distance, teacher still is coded.

4. Peer is coded when the child is interacting with another individual child. If the child is having eye contact with or speaks aloud to another child from a distance, peer is coded. If the child is interacting with more than one child, then it is coded group.

5. Alone is coded when the child is not interacting with others. This can include when the child is working alone, watching others from a distance, or wandering around in the classroom.

B. Activity Type

One of these categories of behaviors will be coded to indicate the type of activities that the child is engaging in: (1) mathematics activity, (2) mathematics integrated with other learning-related activities, (3) literacy and literacy integrated with other learning-related activities, (4) activity related to other developmental areas, and (5) others.

1. Mathematics activities is coded when the child is involved in activities related to concepts of quantity, number, counting, time, money, geometry, spatial sense, measurement, matches, comparison, classification, estimation, prediction, statistics, chance (probability), graphs, fractions, decimals, patterns, and relations. This category is coded when a mathematical concept is presented alone, without involving other developmental areas.

   Examples:
   a. Counting days on the calendar.
   b. Measuring length.
   c. Matching numerical symbols with objects or pictures.
   d. Making patterns with a geoboard.
   e. Copying or making shapes.
   f. Inferring similarities and differences.

2. Mathematics integrated with other learning-related activities is coded when a mathematical concept is introduced as problem solving in many situations presented or created by children themselves. Mathematics integrated activities are based upon children's daily experiences and extended to other learning activities.

   Examples:
   a. Engaging in a finger-play or music activity related to mathematical concepts.
   b. Cooking while measurement is involved.
c. Counting, addition, subtraction, and other mathematical concepts involved in games.

d. Sorting objects during clean-up.

e. Teacher's dispersing a certain of crackers to a group of children.

f. Teacher's using pictorial signs to indicate quantity in picture or writing.

g. Saying or writing number names.

Mathematics Integrated is coded when measurable or countable constructive materials are the source of the activity. For example, the child is playing with a pegboard, geoboard, legos, rods, logs, puzzles, or unit blocks. Activities involving cooking, play dough, water table, and sandbox are also coded as mathematics integrated.

3. Literacy and literacy integrated with other learning-related activities is coded when reading, writing, and language art are involved. Activities such as alphabet recognition, word naming, auditory/visual discrimination, writing, rhyming, listening, defining, relations between sounds and spellings are coded as this category. Other activities related to showing usefulness of reading ability, relations between spoken and written words explaining language of instruction also are coded as literacy-related. When a book related to science or social studies is read to the child, literacy is coded.

4. Activities related to other developmental areas is coded when the activity is related to science, social studies, art, music, movement, woodworking, drama, dance, health and safety, etc.

Examples:

a. Planting seeds.

b. Discussing concepts related to science from a book.

c. Role-playing in a dramatic center.

d. Playing a musical instrument.

e. Throwing a beanbag.

f. Using art materials to make something.

g. Cutting with scissors.

5. Others is coded when the child is not involved in either mathematics-related activity or other learning-related activities. This includes transitional activities, self care, self stimulating, and out of sight.

Examples:

a. The child is helping with transitional activities, such as cleaning up or putting materials back on the shelves.
b. The child is cleaning his/her nose, washing hands, going to the bathroom.
c. The child is pulling his/her own hair, or rocking himself/herself on a chair.
d. The child is out of the classroom.

C. Classroom Behavior

This group of child behaviors is categorized in nine classes to indicate participation: (1) initiating learning-related conversations, problems, and questions to others, (2) responding to teacher’s low-level cognitive distancing, (3) responding to teacher’s medium-level cognitive distancing, (4) responding to teacher’s high-level cognitive distancing, (5) responding to peers, (6) working alone appropriately, (7) other appropriate participating behaviors, (8) others.

1. **Initiating conversations, problems, and questions to others** is coded when the child is addressing his/her own ideas, discoveries, experiences, and feelings to the teacher, other adults, or peers for sharing approval or recognition. The child may bring up his/her problems or questions to ask for help or permission. If it is ambiguous who initiates the conversation, then the content of the conversation is used to determine whether the child initiates. Procedural questions related to the activity also are coded in this category.

Examples:

   a. "Look what I made."
   b. "Mrs. King, may I have two more cups to sort the buttons?"
   c. "Can you help me write an '8'?"
   d. "Elaine, you have cut more squares than I have."
   e. "Madison, can you help me hold this tube?"
   f. "How did you do it?"
   g. "What should I do first?"
   h. "I need the scissors."
   i. "I like your picture."
   j. Telling story, reciting, or doing show-and-tell.

2. **Responding to teacher’s low-level cognitive distancing** is coded when the child is reacting to the teacher after the teacher’s statement or request by observing, demonstrating, labeling, identifying, and giving definitions. The child may answer teacher’s questions individually or in unison with others.

Examples:

   a. Watching what the teacher is demonstrating.
b. Singing songs with others.
c. Showing an object to others.
d. Defining a word.
e. Telling the name of an object.

3. **Responding to teacher’s medium-level cognitive distancing** is coded when the child is reacting to the teacher’s request or statement by sequencing, classifying, telling similarities or differences, estimating, enumerating, synthesizing, imitating or copying what the teacher did. Children’s medium- or high-level cognitive responses to teacher statement or request more often are observed during the interactions between the teacher and the individual child or in a small group because children have more opportunities to express their own ideas than when they are with the whole class.

   Examples:
   a. Putting objects in order.
   b. Sorting the objects.
   c. Telling similar or different attributes of objects, situations, or events.
   d. Copying an alphabet or a number name.

4. **Responding to teacher’s high-level cognitive distancing** is coded when the child is reacting to the teacher’s request by becoming involved in an activity plan, confirming a plan, evaluating consequences, evaluating competence, evaluating affect, evaluating effort and/or performance, evaluating necessary and/or sufficient, giving reasons or relations of cause and effect, inferring affect, inferring effect, generalizing, transforming, giving a conclusion, proposing alternatives, and resolving conflict.

   Examples:
   a. "I am going to make a necklace with these beans."
   b. "The truck I made runs faster than that one."
   c. "We need one more chair because we have six people here and we only have five chairs."
   d. "I have one truck like this, but it is a little different from this one. Mine is red. This one is green."

5. **Responding to peers** is coded when the child is reacting appropriately to peers’ statements, questions or requests, such as by offering suggestions and ideas. If the interacting is inappropriate or task-irrelevant, such as grabbing objects back after a peer takes them away without permission, it is coded as **others**.
Examples:

a. "O.K. Let's put more water in it."

b. "Sure, you can try to fly my airplane."

c. "O.K. Allen, you can use this one."

d. "No. This one is taller."

e. "Mrs. Nelson said that we need to wait until it becomes cool."

f. "The buds will come out in a couple of days if we water the seed every day."

g. "No. I got it first."

6. **Working alone appropriately** is coded when the child is working independently without interacting with people. A child's wandering around or interacting with materials inappropriately is coded as **others**.

Examples:

a. Writing, drawing, or painting.

b. Working on puzzles.

c. Playing at a sand box or a water table.

d. Reading.

e. Examining objects or materials

f. Playing with concrete objects and audiovisual materials

g. Working on the computer

h. Working with a calculator

i. Working on a workbook/sheet.

j. Listening to tape/record player.

k. Watching film on VCR

7. **Other appropriate participating behaviors** is coded when the child is not involved in the above behaviors but the behavior is acceptable in the class, e.g., watching or listening to the teacher or other participants from a distance; engaging in problem solving with others, such as comparing or counting sets of objects, people, and events.

Examples:

a. Offering help or comfort to others.

b. Helping the teacher.

c. Waiting for the teacher or peers.

d. Hiding in a quiet place.

e. Looking at own drawing or writing or examining own products.

f. Pretending to rest at the dramatic center.
g. Choosing a new activity upon completion of an activity the teacher has selected and guided.

h. Cleaning up, putting materials back on the shelves.

i. Asking or answering non-learning related questions, e.g., Would you like to have some crackers?

j. Raising hand for the opportunity to answer a learning-related question.

k. Engaging in problem solving with others, e.g., comparing or counting sets of objects, people, and events with others.

l. Playing games with others.

8. Others is coded when the behavior does not fit in any of the above seven categories. The child is involved in inappropriate or task-irrelevant behaviors, such as being involved in disruptive behavior during whole-class or group time, interacting with people or materials inappropriately during free choice time, or self-help behaviors or out of the classroom.

Examples:

a. Making noise in group time.
b. Poking another child.
c. Taking objects or materials from others without permission.
d. Fighting.
e. Abusing objects.
f. Wandering around the classroom without showing interest in activities.
g. Crying.
h. Washing hands.
i. Going to the bathroom.
j. Sitting in a quiet place without showing interest in participating.

D. Activity Source

The activity sources in child observations are categorized in the same 11 classes as used in teacher observations. The focus is the activities in which the behavior occurs. The source is used by either the teacher or the child when the teacher-child or child-child interaction takes place. If the child is working alone or is involved in other appropriate task-relevant activities without interacting with others, then the source is focused on what the child works with.