# Developing Numerical Skills by Applying Piagets Theory of Cognitive Development

**Abstract**

Piaget's theory was the forerunner of today's "Cognitive revolution" with its emphasis on mental process. Piaget took an organismic perspective, viewing cognitive development as the product of children's efforts to understand and act on their world. Piaget's method combined observation with flexible questioning. To find out how children think. Piaget followed up their answer with more questions. This article articulated described and characterized, highlighting the stage appropriate numerical technique that help lay a solid foundation for future numerical learning. From the forgoing study as children develop, they progress through stages characterized by unique ways of understanding the world. During the sensorimotor stage infants learn senses and motor senses. Young children develop eye hand coordination schemes and object parlance. The preoperational stage includes advances in symbolic thought are accompanied by a growing understanding of space, causality, identities, categorization and number. During the concrete operational stage children can use mental operation to solve actual problems and think more logically than before because they can take multiple aspect of a situation in to account. In the final stage, formal operations students develop the capacity for abstract thought and metacognitively, as well as reason hypothetically.

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**Introduction**

Jean piaget's theory was the forerunner of today's "cognitive revolution" with its emphasis on mental process. Piaget took an organismic perspective, viewing cognitive development as the product of children's efforts to understand and act on their world. Piagets described cognitive development as occurring in four qualitatively different stages, which represent universal patterns of development. At each stage a child's mind develops a new way of operating. From infancy through adolescence, mental operations involve from learning based on simple sensory and motor activity to logical, abstract thought. Cognitive growth occurs through three interrelated processes: organization (Integration of knowledge into systems); adaptation (Adjustment to new information about the environment); and equilibration (the tendency to seek a stable balance among cognitive development). One contribution of piagetician theory concerns the developmental stages of children's cognition. His work on children's Quantities development as provided numerical analyst with crucial insights into how children learn numerical concepts and Ideas. This articles describes stages of cognitive development with an emphasis on their importance to numerical development and provide suggestion for planning numerical instruction.

The approach of this article will be to provide a brief discussion of Piaget's underlying assumptions regarding the stages of development. Each stage will be described and characterized, highlighthting the stage appropriate numerical techniques that help lay a solid foundation for future numerical learning.

One contribution of Piagetian theory concerns the developmental stages of children's cognition. His work on children's quantitative development has provided mathematics educators with crucial insights into how children learn mathematical concepts and ideas. This article describes stages of cognitive development with an emphasis on their importance to mathematical development and provides suggestions for planning mathematics instruction.

The approach of this article will be to provide a brief discussion of Piaget's underlying assumptions regarding the stages of development. Each stage will be described and characterized, highlighting the stageappropriate mathematics techniques that help lay a solid foundation for future mathematics learning. The conclusion will incorporate general implications of the knowledge of stages of development for mathematics instruction.

A developmental stage consists of a period of months or years when certain development takes place. Although students are usually grouped by chronological age, their development levels may differ significantly (Weinert & Helmke, 1998), as well as the rate at which individual children pass through each stage. This difference may depend on maturity, experience, culture, and the ability of the child (Papila & Olds, 1996). According to Berk (1997), Piaget believed that children develop steadily and gradually throughout the varying stages and that the experiences in one stage form the foundations for movement to the next. All people pass through each stage before starting the next one; no one skips any stage. This implies older children, and even adults, who have not passed through later stages process information in ways that are characteristic of young children at the same developmental stage (Eggen & Kauchak, 2000).

**Stages of Cognitive Development**

Piaget has identified four primary stages of development: sensorimotor, preoperational, concrete operational and formal operational.

**Sensorimotor Stage**

In Piaget's theory, the first stage in cognitive development during which infants learn through senses and motor activity. This stage is characterized by the progressive acquisition of object permanence in which the child becomes able to find objects after they have been displaced, even if the objects have been taken out of his field of vision. For example, Piaget's experiments at this stage include hiding an object under a pillow to see if the baby finds the object.

An additional characteristic of children at this stage is their ability to link numbers to objects (Piaget, 1977) (e.g., one dog, two cats, three pigs, four hippos). To develop the numerical capability of a child in this stage, the child's ability might be enhanced if he is allowed ample opportunity to act on the environment in unrestricted (but safe) ways in order to start building concepts (Martin, 2000). Evidence suggests that children at the sensorimotor stage have some understanding of the concepts of numbers and counting (Fuson, 1988). Educators of children in this stage of development should lay a solid numerical foundation by providing activities that incorporate counting and thus enhance children's conceptual development of number. For example, teachers and parents can help children count their fingers, toys, and candies. Questions such as "Who has more?" or "Are there enough?" could be a part of the daily lives of children as young as two or three years of age.

**Preoperational Stage**

Jean Piaget named early childhood, from approximately ages 2 to 7, The preoperational stage because children are not yet ready to engage in mental operations, or manipulations, that require logical thinking. The characteristics development in this second major stage of cognitive development is a great expansion in the use of symbolic thought or representational ability, which first emerges at the end of the sensorimotor stage.

In this second stage, children should engage with problem-solving tasks that incorporate available materials such as blocks, sand, and water. While the child is working with a problem, the teacher should elicit conversation from the child. The verbalization of the child, as well as his actions on the materials, gives a basis that permits the teacher to infer the mechanisms of the child's thought processes.

There is lack of logic associated with this stage of development; rational thought makes little appearance. The child links together unrelated events, sees objects as possessing life, does not understand point-of-view, and cannot reverse operations. For example, a child at this stage who understands that adding four to five yields nine cannot yet perform the reverse operation of taking four from nine.

Teaching students in this stage of development should employ effective questioning about characterizing objects. For example, when students investigate geometric shapes, a teacher could ask students to group the shapes according to similar characteristics. Questions following the investigation could include, "How did you decide where each object belonged? Are there other ways to group these together?" Engaging in discussion or interactions with the children may engender the children's discovery of the variety of ways to group objects, thus helping the children think about the quantities in novel ways (Thompson, 1990).

**Concrete Operations Stage**

At about age 7, according to piaget, children enter the stage of concrete operations, so named because children can now use mental operations to solve concrete problems. Children can think more logically than before because they can take multiple aspects of a situation into account. Children in the stage of concrete operations can perform many tasks at much higher level than they could in the preoperational stage. They have a better understanding of spatial concepts, of causality, of categorization, of inductive and deductive reasoning, and of conservation-

According to Burns & Silbey (2000), "hands-on experiences and multiple ways of representing a numerical solution can be ways of fostering the development of this cognitive stage" (p. 55). The importance of hands-on activities cannot be overemphasized at this stage. These activities provide students an avenue to make abstract ideas concrete, allowing them to get their hands on numerical ideas and concepts as useful tools for solving problems.

Because concrete experiences are needed, teachers might use manipulatives with their students to explore concepts such as place value and arithmetical operations. Existing manipulative materials include: pattern blocks, Cuisenaire rods, algebra tiles, algebra cubes, geoboards, tangrams, counters, dice, and spinners. However, teachers are not limited to commercial materials, they can also use convenient materials in activities such as paper folding and cutting. As students use the materials, they acquire experiences that help lay the foundation for more advanced numerical thinking. Furthermore, students' use of materials helps to build their numerical confidence by giving them a way to test and confirm their reasoning.

Providing various numerical representations acknowledges the uniqueness of students and provides multiple paths for making ideas meaningful.

Engendering opportunities for students to present numerical solutions in multiple ways (e.g., symbols, graphs, tables, and words) is one tool for cognitive development in this stage. Eggen & Kauchak (2000) noted that while a specific way of representing an idea is meaningful to some students, a different representation might be more meaningful to others.

**Formal Operations**

According to piaget, adolescent enter the highest level of cognitive development- formal operations- when they develop the capacity for abstract thought. This development usually around age 11, gives them a new, more flexible way to manipulate information. They can use symbols for symbols (For example, letting the letter stand for an unknown numeral) and thus can learn algebra and calculus.

The child at this stage is capable of forming hypotheses and deducing possible consequences, allowing the child to construct his own mathematics.

Furthermore, the child typically begins to develop abstract thought patterns where reasoning is executed using pure symbols without the necessity of perceptive data.

Reasoning skills within this stage refer to the mental process involved in the generalizing and evaluating of logical arguments (Anderson, 1990) and include clarification, inference, evaluation, and application.

**Clarification**

Clarification requires students to identify and analyze elements of a problem, allowing them to decipher the information needed in solving a problem. By encouraging students to extract relevant information from a problem statement, teachers can help students enhance their mathematical understanding.

**Inference**

Students at this stage are developmentally ready to make inductive and deductive inferences in mathematics. Deductive inferences involve reasoning from general concepts to specific instances. On the other hand, inductive inferences are based on extracting similarities and differences among specific objects and events and arriving at generalizations.

**Evaluation**

Evaluation involves using criteria to judge the adequacy of a problem solution. For example, the student can follow a predetermined rubric to judge the correctness of his solution to a problem.

Evaluation leads to formulating hypotheses about future events, assuming one's problem solving is correct thus far.

**Application**

Application involves students connecting mathematical concepts to real-life situations. For example, the student could apply his knowledge of rational equations to the following situation: "You can clean your house in 4 hours. Your sister can clean it in 6 hours. How long will it take you to clean the house, working together?"

**Conclusion**

Piaget explored children's cognitive development to study his primary interest in genetic epistemology. Upon completion of his doctorate, he became intrigued with the processes by which children achieved their answers; he used conversation as a means to probe children's thinking based on experimental procedures used in psychiatric questioning.

This article articulated described and characterized, highlighting the stage appropriate numerical technique that help lay a solid foundation for future numerical learning. From the forgoing study as children develop, they progress through stages characterized by unique ways of understanding the world. During the sensorimotor stage infants learn senses and motor senses. Young children develop eye hand coordination schemes and object parlance. The preoperational stage includes advances in symbolic thought are accompanied by a growing understanding of space, causality, identities, categorization and number. During the concrete operational stage children can use mental operation to solve actual problems and think more logically than before because they can take multiple aspect of a situation in to account. In the final stage, formal operations students develop the capacity for abstract thought and metacognitively, as well as reason hypothetically.

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