Jean Piaget's Theories and Applications for First Grade Mathematics

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The theories of Jean Piaget have illuminated thoughts about learning and reasoning operations for children of all ages. His research has had great impact on teaching strategies for educators, especially those of elementary age students. Of particular interest is applying his theories to teaching first grade students in the subject of mathematics. By looking at Jean Piaget the man and his cognitive development theories, one can gain a better understanding for applying his thoughts to teaching mathematics at this level.

Jean Piaget born in Switzerland in 1886, had a strong interest in Biology and taught at a school as a young man. He eventually began to study the thought processes of young children looking for ways their thinking differs from adults. He used observatory research and a series of experiments created by himself to identify patterns and address learning concepts for children. His initial thoughts were very much influenced by his observations of his own children. In addition, he published many books and articles with his findings. His work has been revered and criticized by many. Most of his critics attack his informal research methods, but many see his research as a source for ideas and insight into a child's mind.

Piaget's findings addressed several aspects of learning. First, he postulated that humans seek an equilibrium of understanding to make sense of their environment (Copeland, 1974, p. 34). In order to organize the info individuals have, "schemas" or mental structure is formed (Alder, 1953, p. 4). When the equilibrium or balance is thrown off by some new factor, Piaget addresses a process that happens, called adaptation, when the schemas are altered in one of two ways (Alder, 1953, p. 4). These two processes are known as assimilation and accommodation (Havis & Yawkey, 1977, p. 136). The first

happens when the new information comes about as a result of previous experience, so the child can alter the schema to assimilate the new info. However, when this new data conflicts greatly with previous experience, accommodation occurs; a child creates a new schema in response to the new information. Piaget believed these processes were the basic for learning.

During his research, Piaget found there were levels of development at which these processes of adaption could occur and mature. These levels are known as his four stages of development. The first is the sensorimotor stage, which occurs between birth and 2 years (Alder, 1963, p. 6). During this stage, children develop object permanence, which is the concept of an object existing even out of sight. The next stage is the preoperational stage, occurring between 2 and 7 years of age (Alder, 1963, p. 6). This stage is characterized by the use of language for symbolic representations. According to Piaget, children in this stage have a vague sense of logic and their mental operations only move in one direction (Copeland, 1974, p. 26). This limitation does not allow children to reason through multistep problems including conservation problems, which I will discuss in more detail later. The next stage is the concrete operational stage, which occurs between the ages of 7 and 12 years (Copeland, 1974, p. 26). This stage is defined by the logical thought based in concrete experiences, hence the name of concrete operational stage. This stage also sees the development two-directional thinking, which allows for the concept of conservation to develop. The final stage is the formal operational stage developing around 12 years of age and represents the highest level of logical thinking (Copeland, 1974, p. 26). Hypothetical reasoning and symbolic thought highlight this stage. The ages

of all of these stages are flexible, but nevertheless provide valuable insight for educators into cognitive operations of children.

Relating these theories to first grade mathematics, Piaget's stages of development prove most helpful for educators. Looking at the age span of 6-7 years for first graders, it is clear that this level includes a transition between two stages; the preoperational stage and the concrete operational stage. Understanding both stages and the transition between them is critical for developing strong mathematical understanding. During the first grade, Texas Essential Knowledge and Skills (TEKS) outline the learning objectives for this level. This paper will focus on three of these objectives.

The first TEKS objective we will look at is "(1)Number, operation, and quantitative reasoning. The student uses whole numbers to describe and compare quantities" (TAC, 2006). This objective relies heavily on understanding of number sense. Piaget addresses this understanding by testing the concept of conservation in children. His hypothesis is that a child might be able to count but not have an understanding of true number sense, which is a one-to-one relationship of objects to numbers (Alder, 1953, p. 12). This is proven true through an experiment when a child is asked to count out a certain number of marbles and place them in a short wide jar. The child is then asked to count out the same number of marbles and put them in a tall narrow jar. When asked if the jars had equal number of marbles, children in the preoperational stage thought the jar that was "fuller" contained more. This type of experiment reveals preoperational thinking that lacks the ability to reverse actions in the minds eye and see that the same number had been previously counted out. Children at this stage also do not see that objects hold their number relationship when put in different situations. However, children in the concrete

operational stage can reverse the events and reason that the jars contain the same amount and they could prove it with a concrete representation. It is important for educators teaching this standard to help students move into the concrete operational stage by providing concrete experience for children to manipulate objects and experiment with different situations. Alder (1963) points out that Piaget's theory is addressed "if children are permitted active, manipulative experience with self-determined exploration in concrete situations" (p. 21). One such experience might be to have children created matching groups with different manipulatives, to enhance the one-to-one understanding and the concept of conservation. This is just one method for addressing this first TEKS objective.

The second TEKS objective to investigate is "(3) Number, operation, and quantitative reasoning. The student recognizes and solves problems in addition and subtraction situations" (TAC, 2006). This objective is one that many teachers spend much of first grade working on since this grade is the basis for formal mathematical operations skills. Piaget addresses the operational skill of addition and found that this skill requires not only an understanding of conservation but also an understanding of the part, part, whole concept, where a whole is made of some parts and a whole less some part is equal to the other part (Copeland, 1974, p. 118). Piaget did an experiment where students were shown two sets of candy, one with two pieces and one with three pieces, and then were shown a third set of the two parts being pushed together (Copeland, 1974, p. 117). When children were asked which set had more, students lacking the part, part, whole concept always chose the two separate piles. This is telling for educators. Bobby Ojose (2008) points out that teachers must provide multiple experiences for students to represent these

operations so they can see patterns and make the connections necessary (p. 28). For example, graphs, manipulatives, symbols, and words need to be used to represent addition and subtraction operations at this grade level. Even so, logical understanding of these operations can never be fully achieved until students complete the first objective and hold a concrete understanding of number sense. Even lacking this sense, teachers can begin instilling part, part, whole concepts with various activities. One specific activity to help build this understanding is two give a child some number of blocks and ask him to split them in two groups. After having the child write down the representation of the two blocks, have him push them all back together into one pile and check to see if the same number as before remains. Doing this again and again with different types of manipulatives and different amounts can build and solidify the part, part, whole relationship as well as offer an opportunity for students to see patterns and face families. It also helps solidify representing formal operations with written symbols.

The last TEKS objective to look at is "(7) Measurement. The student directly compares the attributes of length, area, weight/mass, capacity, and temperature…The student selects and uses nonstandard units to describe length" (TAC, 2006). Piaget outlines that measurement should begin in one dimension for children just entering the concrete operational stage, so for the purposes of this paper we will address the length aspects of this objective (Copeland, 1974, p. 247). As Copeland (1974) points out, the concept of conservation is "fundamental to the development of measurement concepts" (p. 248). This is apparent when asking children to use some unit of measure. They must believe this unit remains the same even if it is moved. This might seem obvious but consider using a piece of yarn as a unit. If you take two pieces of the same length and

show one straight and one bent at an angle, students without the concept of conservation will not understand why the bent length is not shorter. However, once this concept is established, students can begin by measuring through comparison of objects to one another to find smaller and larger attributes. Copeland (1974) summarizes Piaget's thoughts of teaching measurement by pointing out that according to Piaget's stages of development, students need to have an advanced understanding of spatial reasoning in order to formally measure something (p. 249). According to this idea, measuring length in first grade is purely an experimental activity where students are beginning to build the foundation for concepts of spatial relationships. There are however, some things educators can do to help this process along. The first is to encourage using different units to measure objects, such as a stick or cutout of a student's body to measure the length of the hallway. These activities will help strengthen student's number understanding and conservation concepts, despite lacking adequate measurement concept understanding. Students should also be encouraged to find equality in object lengths. This will also strengthen conservation concepts while building a foundation for spatial relationships.

For each of these TEKS objectives, Piaget's theories have considerable implications and applications. Educators can gain not only valuable insight on how their students learn, but concrete ideas for developing the concepts and understandings of mathematics in ways that compliment their learners; levels. While some of Piaget's thoughts have been found controversial, I feel his approach is an important one. Overall, Piaget aims to put the child's understanding first and build concepts on that understanding. Piaget understood the pitfalls of teaching students through rote memorization. He saw how much more important it was that student could reason, even if

their reasoning came later than their prescribed grade level. My hope as an educator is to not only employ some of these practices and ideas, but also keep an open mind about where my students are individually in their journey to formal operations.

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