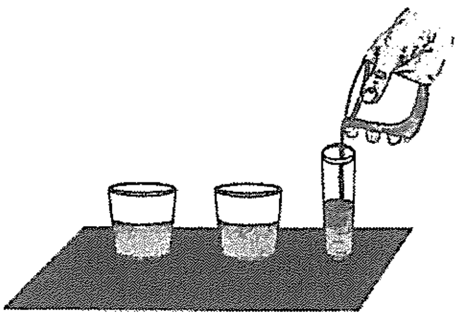
Piaget's Theory of Cognitive Development



As an introduction to Piaget's theory of cognitive development, consider the following problem:

> You have two identical glasses of water. You then pour the contents of one into a third glass as shown here. Now, are the amounts of water in the first and third glasses the same or different?

The question may seem silly; the amounts are obviously the same. However, when Jean Piaget used a problem such as this to examine children's thinking, he found that 4 and 5 year olds thought that the taller glass had more water. These differences in children's thinking proved fascinating to Piaget and resulted in one of the most widely studied theories of cognitive development (Inhelder & Piaget, 1958; Piaget, 1952, 1959, 1980). We examine his theory in this section.

Ed Psych and You

Are you bothered when something doesn't make sense? Do you want the world to be predictable? Are you more comfortable in classes where the instructor specifies the requirements and outlines the grading practices? For most people, the answer to these questions is "Yes." Why do you think this is the case?

The Drive for Equilibrium

People want their experiences to make sense. They have an intrinsic need for understanding, order, and certainty, and it helps us understand why the answer to the questions we ask here in "Ed Psych and You" is yes. "We inquire about the past, present, and future. We investigate every conceivable subject. Human beings want and need to make sense of things that happen—or don't happen—in the short run as well as over the long haul" (Marinoff, 2003, p. 3).

Piaget (1952, 1959, 1980) described this need for understanding as the drive for **equilibrium,** a cognitive state in which new experiences make sense to us because we're able to explain them using our existing understanding (Berk, 2010). As long as we're able to make sense of new experiences, we remain at equilibrium; when we can't, our equilibrium is disrupted, and we're motivated to reestablish it. Development occurs when our understanding advances as a result of regaining equilibrium.

Equilibrium. A cognitive state in which we're able to explain new experiences by using existing understanding.

The drive for equilibrium can be a double-edged sword. Karen's students, for example, were at equilibrium when they thought that *mass* and *density* were the same. This helps us understand why people retain misconceptions and why critical thinking is so difficult for many (Willingham, 2009).

The Development of Schemes

To make sense of our experiences and reach equilibrium, people construct **schemes,** mental operations that represent our understanding of the world. They are the building blocks of thinking. For instance, when you learned to drive a car, you had a series of experiences with attempting to start the engine, maneuver in traffic, and make routine driving decisions. As you (cognitively) organized these experiences, they became your "driving" scheme.

Schemes. Mental operations that represent our constructed understanding of the world.

As suggested by our example with the containers of water, the schemes we construct vary with age. Infants develop psychomotor schemes, such as grasping objects; school-age children develop more abstract schemes like classification and proportional reasoning. Piaget used the idea of schemes to refer to a narrow range of operations, such as children's conservation-of-volume scheme (the idea that the amount of liquid doesn't change when poured into a different-shaped container, as you saw in our example) (Piaget, 1952). However, teachers and some researchers (e.g. Wadsworth, 2004) find it useful to extend Piaget's idea to include content-related schemes, such as *adding-fractions-with-unlike-denominators, creating-a-persuasive-essay,* or *reptile* schemes. As with our driving scheme, each represents our understanding, and they are commonly described as *schemas* rather than schemes. We use this expanded view in our description of Piaget's work.

Responding to Experiences: Assimilation and Accommodation

Experience is a huge factor in development, and when we have new experiences, we either interpret them with our existing schemes or change our schemes. For instance, suppose you first learned to drive a Honda Civic with an automatic transmission, and later you bought a Toyota Camry, also with an automatic. You were easily able to drive the Camry, because your thinking about driving didn't have to change. You *assimilated* the experience with the Camry into your original driving scheme. **Assimilation** is the process of using existing schemes to interpret new experiences (Berk, 2010).

Assimilation. The process of using existing schemes to interpret new experiences.

Now, suppose you buy a Ford Mustang, and it has a stick shift. You must change your thinking about driving, or, in other words you must *accommodate* your driving scheme. **Accommodation** is the process of creating new schemes or adjusting old ones when they can no longer explain new experiences. You modified your original driving scheme, so you can now drive cars with either an automatic or a stick shift.

Accommodation. The process of creating new schemes or adjusting old ones when they can no longer explain new experiences.

The same processes apply in schools. For instance, if young children are given the problem

$$\begin{array}{r} 47 \\ -\ 23 \\ \hline \end{array}$$

and they get 24 as an answer, their *subtracting-whole-numbers* scheme suggests that they subtract smaller numbers from larger ones. However, if they are then given this problem,

$$\begin{array}{r} 43 \\ -\ 27 \\ \hline \end{array}$$

and they also get 24 as an answer, they have—mistakenly—assimilated the new experience into their existing scheme. Their thinking didn't change and they still subtracted the smaller numbers from the larger ones, ignoring the positioning of the numbers. With modeling, explanation, and practice, children change their thinking and accommodate their scheme, and development advances.

Factors Influencing Development

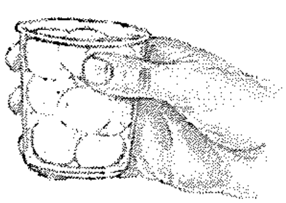
Experience is essential for development, because new experiences that require accommodation—changes in thinking—advance development. Two forms of experience are important: (1) experience with the physical world and (2) interactions with other people. Let's look at them.

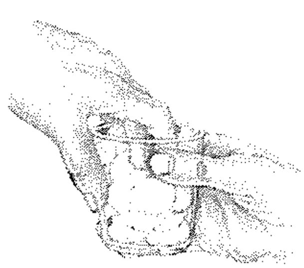
Experience with the Physical World

To see how experience with the physical world influences development, think again about your driving. Because of your experience with stick shifts, you had to accommodate your driving scheme, and your ability to drive developed. For young children, maturation is also important, but for both young and older learners, experience is the primary factor influencing healthy cognitive development (Piaget, 1980).

The essential role experience plays in cognitive development helps us answer our first question at the beginning of the chapter: "Why did Karen's students struggle with a concept as basic as *density*?" Lack of the direct, concrete experiences they needed to understand the concept is the answer. For example, many of us have used the formula Density = Mass/Volume ($d = m/v$), inserted numbers, and got answers that meant little to us.

To see how Karen responds to this problem, let's sit in on another conversation the Tuesday following their Friday discussion.





"What's that for?" Ken asks, seeing Karen walking into the teachers' lounge with a plastic cup filled with cotton balls.

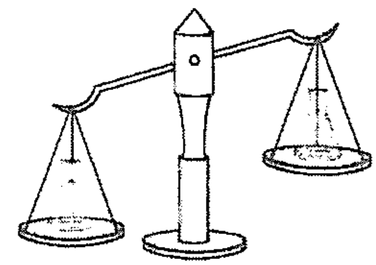
"I just had the greatest class," Karen replies. "You remember how frustrated I was on Friday when the kids didn't understand basic concepts like *mass* and *density*. . . . I thought about it over the weekend, and decided to try something different, even if it seemed sort of elementary.

"See," she goes on, compressing the cotton in the cup. "Now the cotton is more dense. And now it's less dense," she points out, releasing the cotton.

"Then, I made some different-sized blocks out of the same type of wood. Some of the kids first thought the density of the big block was greater. But then we weighed the blocks, measured their volumes, and computed their densities, and the kids saw they were the same. They gradually began to get it.

"This morning," she continues, "I had them put equal volumes of water and vegetable oil on our balances, and when the balance tipped down on the water side, they saw that the mass of the water was greater, so water is more dense. I had asked them to predict which was more dense before we did the activity, and most of them said oil. We talked about that and they concluded the reason they predicted oil is the fact that it's thicker.

"Now, here's the good part. . . . Calvin, he hates science, remembered that oil floats on water, so it made sense to him that oil is less dense. He actually got excited about what we were doing and came up with the idea that less dense materials float on more dense materials. . . . You could almost see the wheels turning. We even got into population density and compared a door screen with the wires close together to one with the wires farther apart, and how that related to what we were studying. The kids were really into it. A day like that now and then keeps you going."



This helps us answer the second question we asked at the beginning of the chapter: "What, specifically, can Karen do in response to her students' struggles?" She responded by providing the specific, concrete experiences they needed to understand the concept. Now, her students are better equipped to explain why people float more easily in the ocean than in lakes, why hot-air balloons rise, and many others. Their thinking is more fully developed because of the experiences she provided.

Social Experience

Piaget also emphasized the role of **social experience**, the process of interacting with other people, on development (Wadsworth, 2004). Social experience allows learners to test their schemes against those of others. When schemes match, we remain at equilibrium; when they don't, our equilibrium is disrupted, we are motivated to accommodate them, and development occurs.

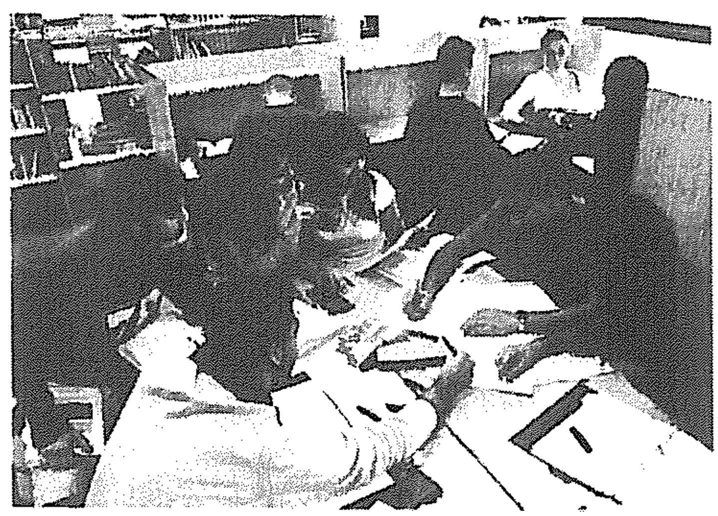
Social experience. The process of interacting with others.

You can provide social experiences for your students in two ways. First, you can guide their developing understanding with your questioning, and second, you can form groups in which students interact. Karen used the former, and many teachers include group work as an integral part of their instruction.

Piaget's Influence on Early Childhood Education

Piaget's emphasis on experience has strongly influenced preschool and kindergarten programs (Berk, 2010). For instance, in many early childhood classrooms, you'll see water and sand tables, building blocks, and other concrete materials that provide young children with concrete experiences.

Maria Montessori, an Italian educator who stressed the importance of exploration and discovery, developed what is probably the best known early childhood program (Dillard, 2007). In her work with children of poverty, Montessori concluded that learning environments in which children simultaneously "worked" on both academic and social activities were needed for development. It wasn't really work, however, because children could freely explore learning centers that provided hands-on activities and opportunities for social interaction with other students. Make-believe was encouraged with dress-up costumes and other accessories like play telephones.



Social experience promotes development by having learners compare their schemes to those of others.

Today, however, early childhood education emphasizes accountability and early reading skills—such as knowing the letters of the alphabet and understanding basic concepts such as *left* and *right*—or math skills—counting, number recognition, and even adding to and taking away, for instance. As a result, child-centered programs have decreased in favor of those more academically oriented. "Despite evidence that formal academic training in early childhood undermines motivation and emotional well-being, preschool and kindergarten teachers have felt increased pressure to take this approach" (Berk, 2010, p. 245). Despite the popularity of Piaget's emphasis on experience with the physical and social worlds, academically oriented early childhood programs are likely to grow.

Stages of Development

Stages of development. General patterns of thinking for children at different ages or with different amounts of experience.

Stages of development—general patterns of thinking for children at different ages or with different amounts of experience—are among the most widely known elements of Piaget's theory. As you examine the stages, keep the following ideas in mind:

- Movement from one stage to another represents a qualitative change in thinking—a difference in the *way* children think, not the *amount* they know. As an analogy, a qualitative change occurs when caterpillar metamorphoses into a butterfly, and a quantitative change occurs as the butterfly grows larger.
- Children's development is steady and gradual, and experiences in one stage form the foundation for movement to the next (P. Miller, 2002).
- All people pass through each stage in the same order but at different rates. Students at the same age may be at different stages, and the thinking of older children and even adults may be similar to that of younger children if they lack experience in that area (Keating, 2004).

The stages are summarized in Table 2.1 and described in the sections that follow.

Table 2.1 Piaget's stages and characteristics

Stage	Characteristics	Example
Sensorimotor (0–2)	Goal-directed behavior	Makes jack-in-the-box pop up
	Object permanence (represents objects in memory)	Searches for object behind parent's back
Preoperational (2–7)	Rapid increase in language ability with overgeneralized language	"We goed to the store."
	Symbolic thought	Points out car window and says, "Truck!"
	Dominated by perception	Concludes that all the water in a sink came out of the faucet (the cartoon in Chapter 1)
Concrete Operational (7–11)	Operates logically with concrete materials	Concludes that two objects on a "balanced" balance have the same mass even though one is larger than the other
	Classifies and serial orders	Orders containers according to decreasing volume
Formal Operational (11–Adult)	Solves abstract and hypothetical problems	Considers outcome of WWII if the Battle of Britain had been lost
	Thinks combinatorially	Systematically determines how many different sandwiches can be made from three different kinds of meat, cheese, and bread

The Sensorimotor Stage (0 to 2 Years)

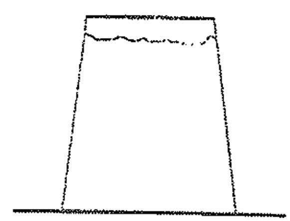
In the sensorimotor stage, children use their motor capacities, such as grasping objects, to understand the world, and they don't initially represent the objects in memory; the objects are literally "out of sight, out of mind," early in this stage. Later, they acquire **object permanence**, the understanding that objects exist even when out of sight. Children at this stage also develop the ability to imitate, which allows them to learn by observing others.

Object permanence. The understanding that objects exist even when out of sight.

The Preoperational Stage (2 to 7 Years)

The term *preoperational* derives from the idea of "operation," or mental activity. A child who identifies different animals as dogs, cats, and bears, for example, is performing a mental operation.

Perception dominates children's thinking in this stage. For instance, look at the drawing here, which represents an inverted glass filled with water, and a card on the bottom. (Go ahead and try this.) Since they can see the glass, water, and card, preoperational thinkers conclude that the water is holding the card on the glass (atmospheric pressure is what actually holds the card next to the glass).



Many cognitive changes occur in children as they pass through this stage. For example, they make enormous progress in language development, reflecting their growth in the ability to use symbols, and they also learn huge numbers of concepts. For example, a child on a car trip will point excitedly and say, "Truck," "Horse," and "Tree," delighting in exercising these newly formed schemes. These concepts are concrete, however, and children in this stage have limited notions of abstract ideas such as *fairness*, *democracy*, and *energy*.

The influence of perceptual dominance is also seen in another prominent idea from Piaget's theory: preoperational thinkers' inability to conserve.

Conservation. **Conservation** refers to the idea that the "amount" of some substance stays the same regardless of its shape or the number of pieces into which it is divided. A number of conservation tasks exist. The example with the glasses of water that we used to introduce our discussion of Piaget's work is one, and two others are outlined in Figure 2.3.

Conservation. The idea that the "amount" of some substance stays the same regardless of its shape or the number of pieces into which it is divided.

In Figure 2.3 we see that preoperational children don't "conserve;" that is, it makes sense to them that the amount of water, the number of coins, or the amount of clay can somehow change without adding or subtracting anything from them. Let's see how this occurs using the example with the water. (You will be asked to explain how this occurs with the coins and clay in "Check Your Understanding," question 2.2.)

First, they tend to *center* on the height of the water in the glass. **Centration** (or centering) is the tendency to focus on the most perceptually obvious aspect of an object or event and ignore other features. The height is most perceptually obvious, so preoperational children conclude that the tall, narrow glass has more water. Second, young children lack **transformation,** the ability to mentally record the process of moving from one state to another, such as pouring the water from the first to the third glass. To them it's a new and different container of liquid. Third, they also lack **reversibility,** the ability to mentally trace the process of moving from an existing state back to a previous state, such as being able to mentally reverse the process of pouring the water from one glass to another. When lack of transformation and reversibility are combined with their tendency to center, we can see why they conclude that the tall, narrow glass has more water in it, even though none was added or removed.

Centration (centering). The tendency to focus on the most perceptually obvious aspect of an object or event, neglecting other important aspects.

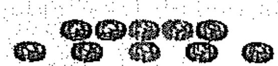
Transformation. The ability to mentally record the process of moving from one state to another.

Reversibility. The ability to mentally trace the process of moving from an existing state back to a previous state.

Egocentrism. Preoperational thinkers also demonstrate **egocentrism,** the inability to see objects and events from others' perspectives. In a famous experiment, Piaget and Inhelder

Egocentrism. The inability to see objects and events from others' perspectives.

Figure 2.3 Conservation tasks for number and mass

Conservation Task	Initial Presentation by Observer	Change in Presentation by Observer	Typical Answer From Preoperational Thinker
Number	The observer shows the child two identical rows of objects. The child agrees that the number in each row is the same. 	The observer spreads the bottom row apart while the child watches. The observer then asks the child if the two rows have the same number of objects or if there are more in one row. 	The preoperational child typically responds that the row that has been spread apart has more objects. The child centers on the length, ignoring the number.
Mass	The observer shows the child two balls of clay. The child agrees that the amount of clay is the same in each. (If the child doesn't agree that they have the same amount, the observer then asks the child to move some clay from one to the other until the amount is the same.) 	The observer flattens and lengthens one of the balls while the child watches. The observer then asks the child if the two have the same amount of clay or if one has more. 	The preoperational child typically responds that the longer, flattened piece has more clay. The child centers on the length.

A nonconserver is influenced by appearances, believing that the flat pieces of clay have different amounts than the balls of clay even though they were initially the same.

(1956) showed young children a model of three mountains and asked them to describe how the mountains would look to a doll seated on the opposite side. Preoperational children described the doll's view as identical to their own.

The Concrete Operational Stage (7 to 11 Years)

The concrete operational stage, which is characterized by the ability to think logically when using concrete materials, marks another advance in children's thinking (Flavell, Miller, & Miller, 2002). For instance, when facing the conservation-of-number task, learners in this stage simply say, "You just made the row longer" or "You just spread the coins apart" (so, the number must remain the same).

Concrete operational learners also overcome some of the egocentrism of preoperational thinkers. They are able to understand the perspectives of storybook characters and better understand the views of others, which makes them better able to work effectively in groups.

Classification and Seriation. **Classification,** the process of grouping objects on the basis of common characteristics, and **seriation,** the ability to order objects according to increasing or decreasing length, weight, or volume, are two logical operations that develop during this stage, and both are essential for understanding number concepts (Piaget, 1977). For example, before age 5, children can form simple groups, such as separating black and white circles into two sets. When a black square is added, however, they typically include it with the black circles, instead of forming subclasses of black circles and black squares. By age 7, they can form subclasses, but they still have problems with more complex classification systems.

Classification. The process of grouping objects on the basis of common characteristics.

Seriation. The ability to order objects according to increasing or decreasing length, weight, or volume.

Transitivity. The ability to infer a relationship between two objects based on knowledge of their relationship with a third object.

When children are able to order objects according to some dimension, such as length (seriation), they can master **transitivity,** the ability to infer a relationship between two objects based on their relationship with a third. For example, suppose we have three sticks, you're shown sticks 1 and 2, and you see that 1 is longer than 2. Now, stick 1 is removed, you're shown 2 and 3, and you see that 2 is longer than 3. You demonstrate transitivity when you conclude that 1 is longer than 3, reasoning that since 1 is longer than 2, and 2 is longer than 3, 1 must be longer than 3.

Concrete operational learners can think logically, but they need tangible materials to do so effectively.

Though concrete operational thinkers have made dramatic progress, their thinking is still limited. For instance, they interpret sayings such as "Make hay while the sun shines" literally, such as concluding, "You should gather your crop before it gets dark."

Let's see how this compares to formal thinkers.

The Formal Operational Stage (Age 11 to Adult)

Although concrete operational learners are capable of logical thought, their thinking is tied to the real and tangible. Formal thinkers, in contrast, can think *abstractly, systematically,* and *hypothetically* (P. Miller, 2002). For example, formal thinkers would suggest that "Make hay while the sun shines" means something abstract, such as "Seize an opportunity when it exists." Their ability to think in the abstract allows the study of courses, such as algebra and physics, to be meaningful.

Formal thinkers also reason systematically and recognize the need to control variables in forming conclusions. For example, if given the following problem,

> You're making sandwiches for a picnic. You have rye and whole wheat bread, turkey, ham, and beef for meat, and Swiss and cheddar cheese. How many different kinds of sandwiches can you make?

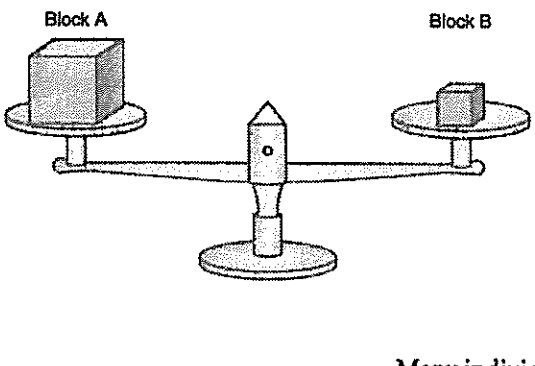
formal thinkers attack the problem systematically such as rye, turkey, and Swiss; rye, turkey, and cheddar; rye, ham, and Swiss, and so on. A concrete thinker attacks the problem haphazardly, such as rye, turkey, and Swiss; whole wheat, beef, and cheddar, etc.

Formal operational learners can also think hypothetically. For instance, considering what our country might be like today if the British had won the Revolutionary War requires hypothetical thinking for American history students, as does considering the influence of dominant and recessive genes for biology students.

When students can't think abstractly, systematically, or hypothetically, they revert to memorizing what they can, or, in frustration, give up altogether.

Ed Psych and You

Look at the figure below. The blocks on the balance are solid cubes that aren't compressible. Which of the following statements is true of the relationships between block A and block B? 1. A is bigger than B. 2. The mass of A is greater than the mass of B. 3. A is more dense than B. 4. A is made out of a different material than B. What stage of development is required to respond correctly to each question?



Piaget's Stages and Research on Student Thinking

Let's see how you did answering the "Ed Psych and You" question: Statement 1 is true, and, because we *can see* that A is bigger (greater volume), it is a preoperational task. A first grader, for example, would be able to respond successfully.

Responding correctly to statement 2 requires logical thought. The beam is balanced; therefore, the masses of the two objects are the same, so the statement is false. It requires logical thought with concrete materials, so it is a concrete operational task.

Statement 3 is also false. A is larger than B, but the masses are the same, so the density of A is less than B, not greater. Finally, statement 4 is true; if the blocks are solids and have different densities, they must be made of different materials. Statements 3 and 4 require abstract thinking, so they are formal operational tasks.

Don't feel bad if you struggled with one or more of these items. Here's why. Even as adults, *virtually all of us are formal operational thinkers only in areas where we have considerable experience* (Berk, 2010). Research indicates that the thinking of nearly half of all college students isn't formal operational in areas outside their majors (Wigfield, Eccles, & Pintrich, 1996). Many individuals, including adults, never reach the stage of formal operations in a number of content domains.

This creates a dilemma, particularly for those of you who are planning to teach in middle, junior high, and high schools, because understanding numerous topics—and particularly those in high schools—requires formal operational thinking. It was clear that Karen's students' thinking was not formal operational with respect to *density*. Further, while *centering* is viewed as characteristic of young children's thinking, we see it in older students and even adults. Karen's students were eighth graders, but they centered on the "thickness" of cooking oil and concluded that it's more dense than water, and many adults do the same.

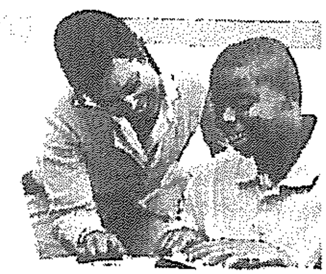
These findings have important implications for those of us in middle schools, junior highs, high schools, and even universities. Many of our students come to these settings without the concrete experiences needed to think at the level of abstraction often required. Knowing this, we provide concrete experiences for them, as Karen did with her eighth graders. The many examples that we include in discussions of the topics presented in this book are our efforts to provide you with the concrete experiences needed to understand educational psychology.

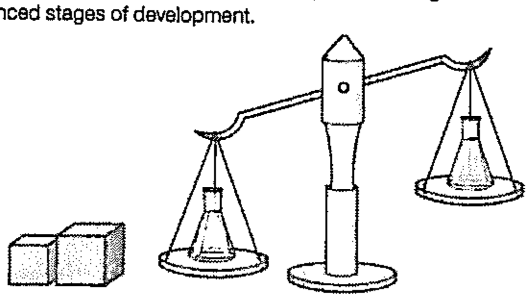
Ed Psych and teaching

Applying Piaget's Theory with Your Students

Piaget's theory suggests that you keep the developmental needs of your students in mind as you design and implement instruction. The following guidelines can help you in your efforts to apply this understanding with your students.

1. Provide concrete experiences that represent abstract concepts and principles.
2. Help students link the concrete representations to the abstract idea.
3. Use social interaction to help students verbalize and refine their developing understanding.
4. Design learning experiences as developmental bridges to more advanced stages of development.





Let's review Karen's work to see how she applied these guidelines in her teaching. She applied the first two with her demonstrations of the concept *density*. For instance, she showed students the cotton balls in the cup, the blocks, and the balance with the water and oil, and they discussed screens and population density.

Karen didn't simply demonstrate the concept and then explain it, however. She combined the examples and demonstrations with detailed discussion. Without it, Calvin, for example, probably wouldn't have been able to conclude that less dense materials float on materials that are more dense. "You could almost see the wheels turning," as Karen described it. In leading this discussion, Karen applied the third guideline.

Her discussion and the students' increased understanding then prepared them to understand additional concepts such as population density, buoyancy, and flotation. Armed with this increased understanding, they are better prepared to explain advanced ideas such as hot air balloons and massive oil tankers. These bridges applied the fourth guideline.

Evaluating Piaget's Theory

As with all theories, Piaget's work has both critics and supporters. Let's look at them, beginning with some of the criticisms.

- Piaget underestimated the abilities of young children. Abstract directions and requirements cause children to fail at tasks they can do under simpler, more realistic conditions (Siegler, 2006).
- Piaget overestimated the abilities of older learners. As you saw in our discussion of student thinking, many middle and high school students are not formal operational thinkers (Flavell et al., 2002).
- Children's logical abilities depend more strongly on prior knowledge and experience in a specific area than Piaget suggested (Alexander, 2006).
- Piaget's descriptions of stages don't adequately describe the changes for all types of tasks (Fischer & Bidell, 2006; Siegler, 2006). For example, the development of concrete operations typically begins with conservation of mass, proceeds through a range of other tasks, and ends with conservation of volume. Instead of discrete stages, many development psychologists now think that general developmental trends best describe the patterns of cognitive development (Halford & Andrews, 2006; Rogoff, 2003).

- Piaget's work was essentially context free and failed to adequately consider the influence of culture on development (M. Cole, Cole, & Lightfoot, 2005; Rogoff, 2003). (We examine the role of culture in development in our discussion of Lev Vygotsky's work in the next section.)

Despite these shortcomings, Piaget's work has been enormously influential. For instance, educators now see learning as an active process in which learners construct their own knowledge, and Piaget strongly contributed to this view.

Piaget's work has also influenced the curriculum (Tanner & Tanner, 2007). Lessons are now organized with concrete experiences presented first, followed by more abstract and detailed ideas. His influence is also evident in the emphasis on "hands-on" experiences in science, in children writing about their own experiences in language arts, and in students beginning social studies topics by studying their own neighborhoods, cities, states, country, and finally those of other nations.

Although some of the specifics of Piaget's theory are now criticized, his emphasis on experience and his idea that learners construct their own knowledge remain unquestioned. He continues to have an enormous influence on curriculum and instruction in this country.

Current Views of Cognitive Development

Neo-Piagetian theory. A theory of cognitive development that accepts Piaget's stages but uses the acquisition of specific processing strategies to explain movement from one stage to the next.

Piaget did his work many years ago, and more recent research has built on and refined his theory. For instance, **neo-Piagetian theory** uses the acquisition of specific information-processing strategies to explain movement from one stage to the next as an alternative to Piaget's global stages (Siegler, 2006). To illustrate this perspective, look at the following list for 15 seconds, cover it up, and see how many items you can remember.

apple	bear	cat	grape
hammer	pear	orange	cow
chair	sofa	chisel	lamp
saw	table	elephant	pliers

Most adults organize the list into categories such as furniture, fruit, tools, and animals, and use the categories to remember specific items (Pressley & Hilden, 2006). Young children tend to use less efficient strategies such as repeating items verbatim. Their ability to gradually begin using more efficient strategies marks an advance in development.

Neo-Piagetian theory also emphasizes the important role that *working memory*, the part of our memory system that holds small amounts of information while we process and attempt to make sense of it, plays in development. As children develop, their working memory capacity increases, which allows them to think about more items of information simultaneously (Case, 1992, 1998).

check your understanding

2.1 The hands-on activities that we see in today's classrooms are applications of Piaget's theory. Explain specifically how hands-on activities apply his theory.

2.2 Use the concepts *centration, transformation,* and *reversibility* to explain why preoperational children don't "conserve" number and mass in the coins and clay tasks.

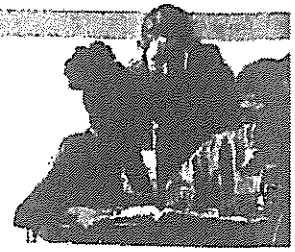
2.3 Read the following vignette, and explain how it illustrates the concepts *accommodation, assimilation development, equilibrium, experience, organization,* and *scheme.*

You work with the Windows operating system, and you're comfortable performing a variety of operations.

Then, you buy a mini laptop that uses a Linux operating system. Initially, you struggle to use the system, but with some study and practice, you are now able to use the Linux system quite acceptably, and you're even finding that you can learn new operations on it quickly.

To receive feedback for these questions, go to Appendix A.

Classroom connections



Promoting Cognitive Development in Classrooms Using Piaget's Theory

1. Concrete experiences are essential to cognitive development. Provide concrete examples, particularly when abstract concepts are first introduced.
   - **Elementary:** A first-grade teacher begins her unit on animals by taking her students to the zoo, and she uses craft sticks with beans glued on them to represent groups of 10 in math.
   - **Middle School:** A geography teacher draws lines on a beach ball to represent latitude and longitude. He initially uses the ball so his students aren't distracted by the detail on a globe.
   - **High School:** An American government teacher involves his students in a simulated trial to provide a concrete example of the American court system.
2. Social interaction contributes to cognitive development. Use interaction to assess students' development and expose them to more advanced thinking.
   - **Elementary:** After completing a demonstration on light refraction, a fifth-grade science teacher asks students to describe their understanding of what they see. He encourages the students to ask questions of each other.
   - **Middle School:** An English teacher has her students discuss different perspectives about a character's motives in a novel they've read.
   - **High School:** A geometry teacher asks students to explain their reasoning as they demonstrate proofs at the chalkboard. She requires the students to clarify their explanations when their classmates are confused.
3. Development is advanced when learning tasks stretch the developmental capabilities of learners. Provide your students with developmentally appropriate practice in reasoning.
   - **Elementary:** A kindergarten teacher gives children in pairs a variety of geometric shapes, asks the students to group the shapes, and then has the pairs explain their grouping while he represents them on a flannel board.
   - **Middle School:** An algebra teacher has her students factor this polynomial expression: $m^2 + 2m + 1$. She then asks, "If no 2 appeared in the middle term, would the polynomial still be factorable?"
   - **High School:** A history class concludes that people often emigrate for economic reasons. Their teacher asks, "Consider an upper-class family in Mexico. Would they be likely to immigrate to the United States?" The class uses this and other hypothetical cases to examine the generalizations they've formed.