MODULE 6

COGNITIVE DEVELOPMENT

OUTLINE

LEARNING GOALS

Constructivist Theories of Cognitive Development

- Individual and Social Constructivism
- Piaget’s Theory
- Vygotsky’s Theory

1. Contrast individual and social constructivism.
2. Describe cognitive development through Piaget’s stages, and identify what causes changes in thinking.
3. Describe intersubjectivity, internalization, and scaffolding within the zone of proximal development.

Issues in Cognitive Development: Piaget and Vygotsky

- What Comes First: Development or Learning?
- Role of Language in Cognitive Development
- Role of Play in Cognitive Development

4. Compare and contrast the views of Piaget and Vygotsky on issues in cognitive development.

5. Discuss how teachers can use constructivist theories to develop effective instruction.

CONSTRUCTIVIST THEORIES OF COGNITIVE DEVELOPMENT

1. Contrast individual and social constructivism.

2. Describe cognitive development through Piaget’s stages, and identify what causes changes in thinking.

Constructivism is a paradigm in psychology that characterizes learning as a process of actively constructing knowledge. Individuals create meaning for themselves or make sense of new
information by selecting, organizing, and integrating information with other knowledge, often in the context of social interactions (Bruning, Schraw, Norby, & Ronning, 2004; Mayer, 2003). Constructivist ideas about intellectual development can be traced back to the early 1900s and two notable theorists: Jean Piaget, a Swiss scientist and philosopher, and Lev Vygotsky, a Russian educational psychologist. Their work has significantly influenced U.S. educational practices. Many constructivist approaches continue to be studied by psychologists and used by teachers in today’s classrooms.

During the 1940s and 1950s, schools typically used teacher-centered instructional approaches based on behavioral learning theories. Teachers were dispensers of information, and learning involved breaking down complex skills into subskills, learning those subskills in isolation, memorizing, and practicing. In the 1970s and 1980s, educational thinking began to shift toward teaching approaches that emphasized the teacher as facilitator and involved knowledge construction (rather than memorization) and peer interaction.

**Individual and Social Constructivism**

Constructivism is often defined as individual or social. In individual constructivism, a person constructs knowledge by using cognitive processes to gain knowledge from experience rather than by memorizing facts provided by others. In social constructivism, individuals construct knowledge through an interaction between the knowledge they bring to a situation and social/cultural exchanges within that context. For example, a child who is interested in how wheels and axles work may engage in individual construction of knowledge by tinkering with a bicycle, or she may socially construct knowledge by working alongside an adult who is fixing a bike.

While Piaget often is considered an individual constructivist and Vygotsky a social constructivist, the line between individual and social constructivism can easily become blurred:

- Even though Piaget was interested primarily in how meaning is individually constructed, he acknowledged social experiences as an important factor in cognitive development (Lourenço & Machado, 1996; Paris, Byrnes, & Paris, 2001).
- While Vygotsky was interested primarily in social and cultural interactions as triggers of cognitive change, his theory actually emphasizes knowledge construction as both socially mediated and individually constructed (Moshman, 1997; Palincsar, 1998; Windschitl, 2002).

Let’s further explore Piaget’s and Vygotsky’s views on knowledge construction.

**Piaget’s Theory**

**Basic Tenets**

Piaget's first intellectual interests were the study of nature and epistemology, a branch of philosophy that is concerned with the origins of knowledge. These interests shaped his views of cognitive development, leading him to propose a theory of genetic epistemology—the idea that knowledge develops from an interaction between nature and nurture. He proposed that all children’s thinking evolves as a result of four factors (Piaget, 1970):

1. Biological maturation (nature)
2. Active exploration of the physical environment (nurture)
3. Social experiences (nurture)
4. Equilibration (or self-regulation)
Biological maturation. Maturation implies a biological “readiness” to learn, opening the door for a person to profit intellectually from social experiences and active exploration. Our current level of cognitive functioning determines what knowledge we are able to construct from our experiences. On a trip to an aquarium, knowledge construction for a toddler or preschooler might be limited to acquisition of concepts (for example, dolphin, whale, turtle), whereas an older child might be able to classify aquatic life and an adolescent could engage in discussions about how aquatic life evolved.

Active exploration of the physical environment. Individuals construct new knowledge when they engage in active self-discovery, as they interact with objects in their environment. In infancy, the acquisition of schemes—organized patterns of physical action—is the basis of all further development. Infants’ schemes, such as grasping and sucking or filling and emptying containers, allow them to learn about the world. Schemes in preschoolers, older children, and adolescents are performed mentally and are called operations (Zigler & Gilman, 1998). For example, figuring out $2 + 2 = 4$ is an operation that involves mentally combining two objects and two more objects to get four.

Social experiences. Social interaction is necessary for the development of logic in older children and adolescents. Here the process (interactions) as well as the product (solution) is stored mentally (Piaget, 1976a). To be effective, the exchange of ideas and cooperation with others should occur between peers instead of between adults and children, because peers are more likely to cooperate as equals, can more easily see each other’s point of view, and can more easily challenge each other (Karpov, 2006; Piaget, 1976b). In discussing opposing points of view, students are able to see multiple perspectives and may change their existing way of thinking (Brown & Palinscar, 1989). However, social interactions alone are not sufficient for intellectual development (Lourenço & Machado, 1996; Piaget, 1950).

Equilibration. Because Piaget (1950, 1985) believed that nature and nurture were insufficient in themselves to explain changes in thinking, he proposed equilibration to regulate—or control—all the individual influences on development. Intellectual development involves continual adaptation whereby individuals construct new and more sophisticated cognitive structures (schemes or operations). Equilibration is a process of maintaining a cognitive balance between our existing knowledge and new experiences. When individuals are confronted with new experiences, they have a sense of disequilibrium, a discrepancy between their existing way of knowing and the new experiences. This motivates them to explore and to reach a conclusion that restores balance in their cognitive system (Piaget, 1985). For example, a student learning the commutative property of addition—that changing the order of addends does not change the sum—may be confused by the assertion that $4 + 3 = 3 + 4$, having learned these as separate and unrelated facts. This student’s disbelief may lead him to test the commutative property with several addends (such as $5 + 7$ and $7 + 5$, or $8 + 9$ and $9 + 8$) to achieve a cognitive balance—knowledge that the commutative property “works.”

Cognitive adaptation can be achieved through assimilation and accommodation, which work together to help the individual maintain equilibration (Piaget, 1970; Sternberg, 2003):

- **Assimilation** involves integrating new information or a new experience into an existing cognitive structure. For example, on a trip to the grocery store, a young girl might see a Granny Smith apple and call it “apple” because it looks like the McIntosh apple that she eats. Sometimes new experiences can be incorrectly assimilated, as when a preschooler learning the alphabet mistakes the letter R for the letter P, which he already knows and easily recognizes.

- **Accommodation** involves any modification of an existing scheme or formation of a new cognitive structure when it is not possible to fit information into an existing structure. For example, after many repeated experiences, the preschooler will develop the correct concept for the letter R.

Think of some ways you could promote disequilibrium in your future students.
STAGE MODEL

In his book *The Psychology of Intelligence* (1950), Piaget explained how knowledge evolves through four stages, shown in Figure 6.1. Stage theories often suggest distinct and abrupt changes from one stage to the next, with children shifting to a qualitatively different way of thinking than before. In contrast to this stage view, Piaget considered children’s progression from stage to stage as a continuous adaptation of cognitive structures, with each new capability growing out of the achievements of the previous stage. Each stage is defined by new cognitive abilities not evident in previous stages as well as cognitive limitations compared to later stages. While Piaget was not interested in the ages at which children acquire different levels of thinking, numerous studies indicate ages at which these cognitive abilities typically emerge. Let’s take a closer look at Piaget’s four stages:

- Sensorimotor
- Preoperational
- Concrete operational
- Formal operational

**Sensorimotor stage.** Acquiring a capacity for internalized thinking is the central goal of the sensorimotor stage. During much of infancy, intelligence is external and behavioral, with infants constructing knowledge from sensory perceptions and motor actions (Brainerd, 2003). Infants initially do not realize that they exist as separate entities apart from objects and people in their environment or that objects and people exist independent of their perceptions (Zigler & Gilman, 1998). Throughout the first year of life, infants gradually develop knowledge of themselves as separate entities, and by 8 to 12 months, they begin to acquire **object permanence**—an awareness that objects and people continue to exist even when they are not visible. Acquiring object permanence gives infants the capacity to represent objects, people, and events as entities that exist mentally, an important ability for the next stage. Children’s acquisition and use of language allow them to progress cognitively from sensorimotor capabilities in infancy to mental representations in the preoperational stage (Piaget, 1970).

**Preoperational stage.** In the preoperational stage, children develop **semiotic functions**. Semiotic (or symbolic) function is an ability to represent an object or action with signs and symbols, such as language, imagery, drawing, symbolic games, and deferred imitation (mentally storing an action and reproducing it later). The term *preoperational* indicates that children are unable to engage in operations that involve two-way thinking, a characteristic of the next stage. Instead, their operations are limited to one-way thinking (Piaget, 1970):

- Preoperational children are **egocentric**. They think about the world primarily from their own physical and cognitive perspective and are unable to think of future actions or events that they have not seen or engaged in (Zigler & Gilman, 1998). They may hold up a drawing so that they can see it rather than turning the picture around to show the viewer, or they may nod while talking on the phone to grandma, not realizing that she cannot see them. Preoperational children typically engage in *egocentric speech*, talking aloud about things that interest them without regard for the interests and conversational contributions of the listener.

- Preoperational children exhibit **centration**, an inability to focus on two dimensions simultaneously. For example, the child in Figure 6.1 sorting blocks may start sorting them by shape, failing to see that they can also be sorted by color. A preschool child visiting a farm may say that a horse is “bigger” than the cow standing next to it because it stands taller, but she fails to take into account that the cow weighs more.
### FIGURE 6.1 Piaget’s Stages of Cognitive Development.

<table>
<thead>
<tr>
<th>Sensorimotor (birth to 2 years)</th>
<th>Preoperational (2–7 years)</th>
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<td><img src="Igor_Emmerich/Image_Source/Getty_Images" alt="Image" /></td>
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<tr>
<td>Infants explore their world using sensory and motor actions. Object permanence is a major attainment necessary for the next stage. If you distract an infant and remove a toy from his view as shown here, he will not look for it—“out of sight, out of mind”—but an older infant will search for the toy.</td>
<td>One-way thinking is characteristic of this stage. Children at this stage typically show centration. This girl is selecting blocks by shape and ignoring color.</td>
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<th>Concrete operational (7–11 years)</th>
<th>Formal operational (11 years to adult)</th>
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<td>This student learning about weights and measures illustrates the ability of children in this stage to think logically using concrete materials.</td>
<td>This student, who is testing a hypothesis about evaluating which combination of solutions causes a chemical reaction, illustrates the abstract, logico-mathematical thinking of this stage.</td>
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</table>
• Preoperational children cannot engage in reversibility of operations. For example, they have not yet acquired conservation, the realization that quantity or amount remains the same (is conserved) despite changes in appearance. Consider Piaget's classic conservation tasks in Figure 6.2. A child who sees two rows of objects lined up as shown will acknowledge that each row has the same number of objects. When an adult spreads out one row of objects as the child observes and asks if the rows have the same number of objects, a preoperational child will say that the longer row has more, while a more cognitively advanced child will say that the rows have the same number because "you can put them back the way they were" (mentally reversing the operation). Similarly, a child whose mother cuts her sandwich in half and her brother's sandwich into fourths does not realize they are the same amount of sandwich.

In the classroom we see many signs of one-way thinking, as when children identify with a character in a story based on their own experiences or when they need to use manipulatives to solve an arithmetic problem.

Along with semiotic functions, identity constancy is an important milestone of the preoperational stage (Zigler & Gilman, 1998). Toward the end of this stage, children realize that an object remains qualitatively the same even if its appearance may have changed in some way (DeVries, 1969). For example, putting a ferocious dog mask on a cat does not change the cat into a dog. Identity constancy may be necessary for children to acquire conservation.

Concrete operational stage. In the concrete operational stage, children form mental representations that accurately reflect possible actions and events in the physical world (Zigler & Gilman, 1998). Unlike preoperational children, they are able to manipulate their operations—that is, to engage in two-way thinking. This in turn allows them to acquire reasoning skills (Brainerd, 2003). Concrete operational children who have acquired conservation will conclude that the two rows of objects, two pieces of clay, or two different-sized jars of liquid shown in Figure 6.2 have the same amount because they are able to mentally reverse the operation without having to test that hypothesis physically. While children's thinking becomes more logical and systematic, they are not yet able to manipulate abstract operations. In the classroom, we see signs of concrete operational thinking when students write a persuasive essay, solve a complex math problem, or test hypotheses in science using hands-on experiments. We also see difficulties related to concrete thinking, as when students have trouble making predictions in narratives or seeing the relevance of historical events to the present time.

Formal operational stage. While concrete operational thinkers are limited to concrete problems and tools, formal operational thinkers have achieved a characteristic way of thinking that allows them to solve many physical, logical, and mathematical problems:

• They exhibit abstract reasoning that is reflective and analytical (Brainerd, 2003), such as engaging in a debate, writing a critical analysis of a character in a novel, or considering future career plans.

• Formal operational thinkers can solve a problem without needing concrete representations like concrete operational thinkers. They may be able to find the area of various geometric forms using only an equation, whereas elementary school students may need the visual representation or manipulatives to aid their thinking.

• Students in the formal operational stage can consider implications and incompatibilities, think hypothetically, search for alternatives, and reject inappropriate solutions without physically needing to test them (Piaget, 1970; Zigler & Gilman, 1998). For example, they can evaluate how two different white powders are chemically different by systematically testing the color change of each powder when substances are added one by one and comparing the results for each powder, whereas children in the concrete operational stage might proceed in a haphazard manner or test some combinations and not others.
Piaget believed that cognitive development culminated in formal operational reasoning, the point at which we have developed all the cognitive processes necessary for thinking—from schemes and symbolic thinking to concrete and abstract operations (Inhelder & Piaget, 1955). However, does everyone reach formal operational thinking, and do individuals develop cognitively after this stage? Based on research indicating that in many cultures the development of formal operational reasoning depends on extensive schooling, Piaget acknowledged that differences in the acquisition of formal operational thinking can occur among individuals (Ashton, 1975; Goodnow, 1962; Laurendeau-Bendavid, 1977). An individual may acquire formal operational thinking in one domain but not another (Piaget, 1972a). Also, the rate at which individuals reach the formal operational stage, like any of the other stages, depends partly on cultural and educational factors (Piaget, 1970; Zigler & Gilman, 1998). While we may reach a final way of thinking about the world with formal operations, Piaget believed that we continue throughout adulthood to acquire new knowledge and accumulate more content in our cognitive systems (Piaget, 1970; Zigler & Gilman, 1998). Research suggests that the formal operational stage provides a solid foundation for understanding the development of wisdom, moral reasoning, and expertise in adulthood (Baltes, 1987; Kohlberg, 1984; Sternberg, 1990).

Moral reasoning: See Module 4
Piaget made scientific contributions to fields such as biology, philosophy, and sociology, as well as psychology, and his writings gave rise to a proliferation of developmental research for several decades. The vast amount of research based on Piaget’s theory has led to several criticisms, outlined in Table 6.1. It is important for teachers to be aware of all of the evidence—support for the criticisms and countercriticism—to fully understand students’ cognitive development. Also keep in mind that all theories are flawed. No single theory can perfectly explain or predict a psychological construct—in this case, cognitive development. Despite any criticisms, Piaget undoubtedly changed our understanding of the cognitive potential of children (Lourenço & Machado, 1996).

### TABLE 6.1 Criticism of Piaget's Theory: Support and Counterarguments

<table>
<thead>
<tr>
<th>CRITICISM OF PIAGET'S THEORY</th>
<th>SUPPORT FOR THE CRITICISM</th>
<th>COUNTERARGUMENTS</th>
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<tr>
<td>1. Underestimates children's cognitive abilities.</td>
<td>Infants achieve object permanence earlier than Piaget proposed. Preoperational children can pass concrete-operational tasks when they are modified to simplify instructions or reduce memory and language demands.</td>
<td>Research findings with younger infants may indicate only an awareness that the perceptual array has changed, rather than clear acquisition of object permanence. Children’s success on simplified concrete-operational tasks may be due to lower-level cognitive competencies (e.g., using a counting strategy on number conservation) rather than logico-mathematical reasoning (reversibility).</td>
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<td>2. Proposes that cognitive development cannot be meaningfully accelerated.</td>
<td>Preoperational children can learn conservation (not just memorize answers) through various methods, such as providing corrective feedback (right or wrong), directing their attention to the appropriate visual cues, modeling adult behavior, and working with peers who have mastered conservation.</td>
<td>Piaget was interested not in the rate of development, accelerations, and delays but in describing processes that account for developmental changes. The rate of progression through the stages will vary, depending on individuals’ previous experiences.</td>
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<td>3. Wrongly proposes that self-discovery is necessary for cognitive development.</td>
<td>There is little available evidence to support unguided, self-discovery as necessary for cognitive development.</td>
<td>Discovery can enhance thinking when students are given appropriate structure and guidance.</td>
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<td>4. May not be stagelike.</td>
<td>Children master different conservation tasks at different ages—number conservation around age 7; mass, somewhat later; and liquid conservation, toward the end of concrete operations—even though conservation is a concrete operational acquisition.</td>
<td>Piaget’s theory allowed for asynchrony in development, proposing continual transformations and integration of less advanced thinking into more complex forms of thinking. The stages give us a “big picture” of these transformations.</td>
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<td>5. Is limited to Western cultures.</td>
<td>Critics argue that Piaget’s theory is not universal as he originally proposed.</td>
<td>The sequence of development through the four stages has been found in cultures around the world, from Mexico and Australia to Thailand, Rwanda, Papua, Iraq, and Ghana. Research showing that the rate of development through stages varies across cultures supports Piaget’s assertion that intellectual development depends on specific cultural and educational environments.</td>
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Vygotsky’s Theory
Like Piaget, Vygotsky (1978, 1993) argued that cognitive development results from a complex interaction between heredity and environment—what he called the natural and the cultural lines of development, respectively. To understand how culture influences cognitive development, we need to know what cognitive structures the child already has developed and brings to the learning situation (Vygotsky, 1935/1994). Vygotsky considered the natural line to include genetic factors, but he did not discuss these as much as he did cultural factors (Tudge & Scrimsher, 2003). Rather, he emphasized the role of social interactions in the development of cognitive processes such as problem solving, self-regulation, and memory.

Zone of proximal development. To illustrate the social origins of individual cognitive functioning, Vygotsky (1978, 1935/1994) created a now-famous metaphor, the zone of proximal development (ZPD). The ZPD is the difference between

- children’s actual developmental level (what they already can accomplish independently), and
- their level of potential development (the highest level they can reach with guidance from more capable individuals).

This zone includes all possible skills that children are on the verge of developing and can perform only with help from someone more cognitively advanced (rather than peers at the same cognitive level, as Piaget argued). Interaction with adults or more capable children (older children or those with higher ability) on tasks that are slightly above children’s current level enables optimal learning to occur. With this type of interaction, children develop new skills and internalize more advanced ways of thinking, reaching a new level of potential development. When they reach this new level of thinking, this becomes their actual developmental level, and the cycle continues. For example, a first grader working alone may be able to write only a brief story with short sentences and simple vocabulary, but with help from a third-grade “buddy,” she is able to write a longer, more elaborate story. With repeated experiences working with her buddy, she will eventually be able to write longer, more complex stories on her own. Let’s examine the factors involved in cognitive growth within the ZPD.

Mechanisms of cognitive change. Within the ZPD, adults and learners engage in intersubjectivity, or co-construction of knowledge. Intersubjectivity is a process in which two individuals who begin a task with different knowledge and perspectives come to a shared understanding as each person adjusts to the perspective of the other (Newson & Newson, 1975; Vygotsky, 1978). Both the learner and the more skilled individual are active partners in coconstruction. In the first-grade example, even though the first grader and the third grader have different levels of writing skill and perhaps different ideas about what to include in the story, they must bridge the gap between them and together create the story.

How do the more experienced and less experienced partners bridge the gap? During a joint activity, adults, older children, and more capable peers use psychological and cultural tools (what Piaget called semiotic functions) to mediate the child’s thinking and shape the development of more complex thought (Rowe & Wertsch, 2002; Vygotsky, 1978). Broadly speaking, tools can be signs and symbols (primarily language), mnemonics, concepts, or any activities, interactions, or symbolic systems the culture provides (Das, 1995). To illustrate the adult’s role, Wood, Bruner, and Ross (1976) used the metaphor scaffolding, based on Vygotsky’s writings. Like the temporary platforms used in the construction of a building, scaffolding is a temporary social support to help children accomplish a task. It supports preschoolers as well as older students when they are learning new tasks (Barron et al., 1998; Brown & Kane, 1988).

As children master the use of psychological and cultural tools, a gradual internalization occurs, in which they slowly acquire more cognitive responsibility for the task, and scaffolding gradually is withdrawn (called fading; Vygotsky, 1962; Wood, 1989). Children shift from performing cognitive processes socially with an adult to performing them mentally by themselves.
The tools become part of children's repertoires, the children's new cognitive processes become part of their actual developmental level, and a new zone is created, with a new level of potential development (Karpov & Bransford, 1995; Vygotsky, 1978).

Teachers should keep in mind two points when applying the zone of proximal development to their classroom:

1. This zone in which optimal learning occurs will differ among students. Two same-age students can have the same actual developmental level but differ considerably in their learning potential in particular subjects or in their ability to benefit from external assistance (Sternberg, 2002; Vygotsky, 1978). Some students may have a narrower ZPD and may need more frequent and explicit assistance (Day & Cordon, 1993).

2. Scaffolding actually is driven by the learner rather than controlled by the more experienced person (Tudge & Scrimsher, 2003). To be effective, adults must match their communication and support to the learner's needs and current cognitive level (Dennen, 2004; Jacobs & Eccles, 2000). Vygotsky saw adults as both pushing and pulling development, yielding a co-constructive, bidirectional process within the ZPD rather than a one-way transmission from the adult to the learner (Tudge & Scrimsher, 2003).

It is difficult to critically evaluate Vygotsky's theory due to its smaller research base in comparison with Piaget's theory. Even though Vygotsky wrote extensively on the science of child development from 1928 until 1934, his career was cut short when he died at age 37 from tuberculosis. Also, in the Soviet Union, the study of child development and all references to it (including Vygotsky's theory) were denounced and banned from 1936 to the 1950s, and researchers and educators in the United States have only recently had access to translations of his writings (Tudge & Scrimsher, 2003). Researchers have begun to evaluate Vygotsky's theory and its impact on education by investigating the efficacy of various constructivist teaching methods based on his ideas about the co-construction of knowledge and intersubjectivity within the ZPD.

Can you think of ways in which Piaget's and Vygotsky's theories are similar, different, and complementary?

ISSUES IN COGNITIVE DEVELOPMENT: PIAGET AND VYGOTSKY

Piaget and Vygotsky simultaneously developed theories of cognitive development during the early 20th century. Vygotsky wrote critiques of Piaget's work, but Piaget did not read any of Vygotsky's writings until years after Vygotsky's death (Piaget, 1962). Even though they never met in person, their views provide us with a dialogue on important issues in cognitive development. Let's examine these issues next.

What Comes First: Development or Learning?

Development involves acquiring concepts spontaneously through natural experiences, and learning involves applying the newly developed cognitive structures to new situations (Lawton & Hooper, 1978; Piaget, 1970). According to Piaget, development precedes learning because an individual must be developmentally ready to learn (Wink & Putney, 2002). A child's stage of
development places constraints on what and how much he or she can learn from instruction (Brainerd, 1978; Inhelder, Sinclair, & Bovet, 1974). We must know a child’s current stage before we can know what it is possible to teach the child (Piaget, 1970).

Vygotsky used the ZPD to explain how theoretical learning, a form of learning that occurs in school, pulls development to higher levels (Karpov & Bransford, 1995). Before children enter school, they engage in empirical learning, a simple form of learning that results in spontaneous concepts. Spontaneous concepts are unsystematic, unconscious, and sometimes incorrect ideas generalized from children’s everyday concrete experiences (Davydov, 1972, 1988). Spontaneous concepts provide the conceptual framework—prior knowledge—for acquiring scientific concepts, or concepts acquired during theoretical learning (Karpov, 2006; Vygotsky, 1962).

During instruction, teachers should provide problem-solving activities that enable students to use scientific concepts in practical ways. This allows scientific concepts to meet students’ personal, concrete experiences so their spontaneous concepts become structured and conscious (Karpov, 2006; Vygotsky, 1987). For example, elementary school students may begin school with knowledge of how a flower grows from a seed (an everyday experience). In school, they will learn the definitions of concepts related to plants and engage in scientific observation and recording of factors that affect plant growth (amount of water, sunlight, etc.). Their spontaneous concept or everyday knowledge about plant growth is transformed and restructured into scientific concepts.

Vygotsky cautioned that learning leads to development only if instruction has been organized properly to focus on cognitive functions not yet completely mastered (Karpov & Bransford, 1995). Teachers should create a ZPD in which social interaction and collaboration lead the student to use and develop new cognitive processes and skills (Vygotsky, 1978).

**Role of Language in Cognitive Development**

Piaget and Vygotsky shared similar views on the role of language in thinking. They agreed that internalized (not spoken) language:

- is needed for conscious thoughts—that we think in words (Das, 1995; Moll, 2001; Vygotsky, 1987);
- serves a reflective function, allowing individuals to refer to the past, present, and future (Das, 1995); and
- serves a planning function, whereby individuals practice a dialogue with a hypothetical other person before actually engaging in it (Piaget, 1926).

They also agreed on the role of language in logical thinking, but they differed in the importance they placed on language. For Vygotsky, language and thought are intertwined: Thinking is a mental process that needs language as its base (Leontiev & Luria, 1972). For Piaget, language plays a necessary but not primary role in logical thinking. During the concrete and formal operational stages, children use language as a tool for developing logical thinking, to think through problems and express what they know and do not know (Das, 1995; Inhelder & Piaget, 1955). However, because logical thinking involves a continual coordination of actions—from organizing sensorimotor schemes to coordinating logical operations—thinking comes before language (Piaget, 1970).

Piaget and Vygotsky also disagreed on the role of externalized speech in cognitive development. In Vygotsky’s theory, social situations provide the initial context in which children develop planning and self-regulation strategies (Rowe & Wertsch, 2002). Adults and children use socialized speech (speech used to communicate with others) as a tool for coordinating their actions with those of others. Children gradually learn to regulate their thoughts and actions using private speech, a self-regulatory, internalized speech.
In Piaget’s theory, externalized speech takes the form of egocentric speech and is a cognitive limitation of preoperational thinking. Egocentric speech gradually diminishes as children progress through the preoperational stage and develop the two-way thinking characteristic of the concrete operational stage. Vygotsky, however, saw Piaget’s egocentric speech as a necessary transition between socialized speech and private speech (Rowe & Wertsch, 2002). Vygotsky conducted research on Piaget’s egocentric speech that showed substantial increases in egocentric speech during cognitively challenging activities (Kohlberg, Yaeger, & Hjertholm, 1968; Rowe & Wertsch, 2002). Recent research is consistent with Vygotsky’s notion of private speech (Winsler, 2009; Winsler & Naglieri, 2003). School-age children use private speech when solving many academic tasks, such as arithmetic problems, when engaged in difficult tasks, and when deciding how to proceed after setbacks (Berk, 1986, 1992). Even adolescents and adults use private speech during challenging tasks, such as when organizing an essay or planning a study session. However, they may not always experience improved performance from private speech like children do (Behrend, Rosengren, & Perlmutter, 1989; Berk & Spuhl, 1995; Duncan & Tarulli, 2009). Therefore, externalized speech is a useful tool for independently planning and regulating a variety of actions.

Can you think of other examples when children and adolescents may need to talk themselves through a problem out loud?

**Role of Play in Cognitive Development**

The importance of play in the intellectual development of preschool-age children is evident in both Piaget’s and Vygotsky’s theories. Piaget (1945/1962) regarded pretend play as evidence of the child’s ability to use and understand symbols, emerging at the end of the sensorimotor stage and developing throughout the preoperational stage (Smith, 2002). He also emphasized pretend play as an individual process, suggesting that the child alone invented and used symbols (Smolucha & Smolucha, 1998).

Vygotsky (1978) considered pretend play to be a more social phenomenon than did Piaget. Imaginative play creates a ZPD in which children behave beyond their current developmental level and advance to higher levels of cognitive functioning (Moll, 2001; Whiting & Floyd, 2009). In pretend play, children advance their thinking by:

- creating actions that originate from ideas (“Let’s pretend we’re dinosaurs”),
- detaching the meaning of objects from their typical appearance (a stick for a gun), and
- creating imaginary contexts for practicing roles, rules, and expectations they have experienced in their everyday life (playing a parent role and punishing a doll).

Sociodramatic play is a particular form of pretend play in which children jointly create and act out an imaginary context. In sociodramatic play, children learn to guide their behavior because they must think before acting (Vygotsky, 1978). They also use intersubjectivity by sharing a joint focus on the task, exchanging knowledge, and moving between pretend and reality to negotiate the play experience (e.g., stepping out of play to decide on roles; Goncu, 1993; Whiting & Floyd, 2009). This type of play advances cognitive development and prepares children for later symbol-based learning, such as reading and writing (Bodrova & Leong, 1997; Pellegrini & Galda, 1993). This type of symbolic learning may also lay the foundation for later hypothetical thinking that we see in the formal operational stage (Alexander, 1989; Harris, 2006).

Current research suggests that play experiences may continue to support children’s cognitive development through the later elementary school years:

- Peer play in elementary school is related to academic success and the development of social skills (Bjorklund & Pellegrini, 2000; Hirsh-Pasek, Golinkoff, Berk, & Singer, 2008).
Peer play and physical games during recess activities have positive benefits on executive functioning skills (such as attention, planning, organization, and monitoring) and achievement in school subjects (Best, 2012; Fedewa & Ahn, 2011). These activities reduce students’ attention and memory demands and allow them to more efficiently process information when they return from the break (Pellegrini, 2009; Pellegrini & Bohn, 2005). Even when recess is held indoors with less opportunity for physical activity, elementary school students experience more attention after recess than before (Pellegrini, Huberty, & Jones, 1995; Pellegrini & Smith, 1993).

Sociodramatic play with peers in middle childhood may contribute to the development of writing skills because it fosters the ability to imagine, to orally write and edit play “scripts,” and to develop a sense of audience (Fromberg, 2002; Singer & Singer, 2006).

**APPLICATIONS: CONSTRUCTIVIST PRINCIPLES FOR EFFECTIVE TEACHING**

Discuss how teachers can use constructivist theories to develop effective instruction.

The constructivist theories we've discussed in this module can provide teachers with several guidelines for effective teaching.

*Consider students’ developmental level when designing curricula and activities.* Both theorists recognized the importance of knowing a child's current level of thinking before planning instruction. Based on Piaget’s theory, teachers can use a student's stage of cognitive development to determine appropriate instructional materials and activities (Brainerd, 1978; Piaget, 1970). Likewise, Vygotsky recommended that teachers identify what the child brings to the situation and then arrange activities to foster the development of cognitive processes on the verge of emerging (Tudge & Scrimsher, 2003; Vygotsky, 1998). Teachers can use dynamic testing to determine what students are able to learn with assistance (their ZPD) rather than
rely on assessments that show only what a student already knows (Campione & Brown, 1990; Vygotsky, 1998). *Dynamic testing* is an interactive assessment in which teachers probe students’ thinking and provide guidance and feedback during the testing. This points to students’ learning potential by identifying how much they can achieve above their current level with appropriate support (Brown & Ferrara, 1985; Grigorenko & Sternberg, 1998).

Whether we consider stages or ZPD, students profit from experiences that are within their reach cognitively. When teachers design tasks that are moderately challenging, students will be operating in their ZPD—or, in Piagetian terms, they will experience disequilibrium.

**Encourage students to be active learners.** Encouraging students to be active learners does not mean that we must always use social interactions and group work (a common misapplication of Vygotsky’s theory) or that all learning must be discovery based (an assumption based on Piaget’s theory). Social interactions are beneficial only if they occur appropriately within students’ ZPDs and if students are given the proper scaffolding. Also, unguided self-discovery is less effective than other teaching methods for learning and transfer of knowledge to new situations, because learning may not occur if students are given too much freedom in the discovery process (Mayer, 2004; van Joolingen, de Jong, Lazonder, Savelbergh, & Manlove, 2005). Rather, **active learning** can be defined more broadly as any type of meaningful learning in which students construct a rich knowledge base (rather than memorizing facts) of interconnected concepts, prior knowledge, and real-life experiences (Bransford & Schwartz, 1999; Murphy & Woods, 1996; Renkl, Mandl, & Gruber, 1996).

**Link new concepts to students’ prior knowledge.** Teachers can encourage meaningful learning (as well as the transfer of learning to new settings) by capitalizing on what students already know. According to Piaget, individuals first assimilate a new experience into their existing cognitive framework (thinking that a brick would fall faster than a feather in a lesson on gravity) and later may reorganize their cognitive structure to accommodate the new experience (realizing that they fall at the same rate after learning about air resistance; Piaget, 1970; Zigler & Gilman, 1998). Vygotsky likewise believed that children’s spontaneous concepts from their everyday experiences form the basis for the development of more sophisticated concepts in school (Karpov & Bransford, 1995).

**Use teaching methods based on constructivist principles.** To encourage active, meaningful learning, teachers can use a variety of approaches based on constructivist principles:

- To teach reading comprehension, teachers can use methods such as **reciprocal teaching and instructional conversations**—methods based on Vygotsky’s ZPD. Both methods contain elements of cognitive apprenticeships such as modeling and scaffolding. Reciprocal questioning, another method that relies on coconstruction of knowledge, can be used from elementary through high school to help students understand new concepts or skills through structured conversations.

- **Cognitive apprenticeships** involve opportunities to develop cognitive skills within the context of authentic activities. Students participate at a level commensurate with their abilities and move gradually toward full participation. Within cognitive apprenticeships, teachers use techniques such as modeling, scaffolding, and fading. Cognitive apprenticeships with teachers or other adults as mentors can be used at all levels of development, such as an elementary student learning about math and money while working at a school store, a middle school student refining writing skills while working at a school newspaper, or high school and college students completing internships within the community.

- Methods such as **inquiry learning**, in which students solve problems by following research steps, and **cooperative learning**, in which students work together to achieve a shared goal, can be used for any subject and with students from elementary through high school.
Provide multiple exposures to content. Returning to content at different times, in different contexts, for different purposes, and from different perspectives will enhance students' knowledge acquisition (Haskell, 2001; Spiro, Feltovich, Jacobson, & Coulson, 1992). Examining content from differing perspectives, such as in-class debates and discussions, may lead students to restructure or modify their existing knowledge. Revisiting content over time and in different contexts also encourages transfer of knowledge by preventing learned information from being tied to specific situations or contexts (Salomon & Perkins, 1989).

Recognize cultural context in learning situations. Consistent with Vygotsky’s theory, teachers need to consider how the setting of particular instructional activities and the larger cultural context may affect learning (Griffin & Cole, 1999; Tharp & Gallimore, 1988). In arranging instructional activities that involve social interaction, such as collaborative projects or class discussions, teachers need to consider how styles of interaction may differ among students from different cultural backgrounds. For example, Native Hawaiian children, who tend to engage in negative wait time (children talking at the same time), and Navajo children, who wait a long time to be sure a speaker has finished talking, may have different needs during social interactions in the classroom (Tharp, 1989).

Think about the grade level of students you expect to teach. How can you use the guidelines presented here in your classroom?

SUMMARY

1. **Contrast individual and social constructivism.** In individual constructivism, a person constructs knowledge independently by using cognitive processes to abstract information from experiences. In social constructivism, individuals construct knowledge within a social/cultural context—the social interactions and what they bring to the learning situation are interconnected.

2. **Describe cognitive development through Piaget’s stages, and identify what causes changes in thinking.** In the sensorimotor stage, infants construct knowledge from sensory and motor experiences, preparing them for later symbolic thinking. While preoperational children are able to form mental representations, their thinking is one way. Operations develop further in the concrete operational stage, in which children can think logically and mentally reverse their thinking, albeit concretely. Formal operational thinkers can mentally manipulate abstract concepts. Maturational changes, active exploration, social interactions, and equilibration together cause thinking to evolve through the four stages.

3. **Describe intersubjectivity, internalization, and scaffolding within the zone of proximal development.** In the ZPD, a child and an older individual engage in intersubjectivity, an active coconstruction of knowledge. As the adult provides scaffolding, the child gradually gains more skill and takes on more responsibility for the task. Cognitive processes that initially were shared between the adult and the child and were scaffolded by the adult gradually become internalized by the child, and the adult slowly removes the scaffolding.

4. **Compare and contrast the views of Piaget and Vygotsky on issues in cognitive development.** Piaget argued that development precedes learning, while Vygotsky proposed that formal learning in school pulls development to a new level. Both theorists emphasized the importance of play in young children’s cognitive development. However, Piaget considered pretend play to be an individual process, while Vygotsky considered it to be social as well as individual. The theorists also agreed on the role of language in logical thinking and shared similar ideas about the role of internalized language in thinking. They differed in their view of the role of externalized speech in planning actions and regulating thoughts—Piaget considered it a cognitive weakness of preoperational children, while Vygotsky viewed it as a tool for planning and regulating actions.

5. **Discuss how teachers can use constructivist theories to develop effective instruction.** Teachers can begin by considering students’ level of thinking when designing curricula and activities because students will benefit from experiences that are within their reach cognitively. During instruction, teachers should encourage students to be active learners and to link new concepts to their prior knowledge. Both Piaget and Vygotsky believed that children continually modify their existing thinking through active construction of knowledge. To encourage
meaningful learning, teachers can choose among a variety of constructivist methods based on Piaget’s and Vygotsky’s theories. Examining content from different perspectives can also help students restructure or modify their existing knowledge, and revisiting content in different contexts will promote transfer. Finally, teachers should consider how the social settings within the classroom, as well as the larger cultural context, may affect students’ learning.

**KEY CONCEPTS**

- accommodation, 114
- active learning, 125
- assimilation, 114
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- egocentric, 115
- egocentric speech, 115
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- semiotic functions, 115
- social constructivism, 113
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- zone of proximal development (ZPD), 120

**CASE STUDIES: REFLECT AND EVALUATE**

### EARLY CHILDHOOD: FIRE SAFETY

These questions refer to the case study on page 84.

1. Using the concept of egocentrism, explain why Michala wanted to sit on the letter M on the carpet.
2. Use the case situation in which Brianna and Michala are coloring their flash cards to contrast Piaget’s and Vygotsky’s views on externalized speech.
3. According to Piaget’s theory, why would demonstrations be an effective way to teach preschoolers about fire safety? Would demonstrations be effective for elementary school students, according to his theory?
4. Identify Miss Angela’s use of scaffolding in the case, and explain how scaffolding helps children in the zone of proximal development.
5. Think of one original fire safety activity (not already mentioned in the case) that would be consistent with Piaget’s theory of cognitive development. Think of another original fire safety activity that would be consistent with Vygotsky’s theory of cognitive development. Describe how each activity is supported by the theory. What factors, consistent with these theories, do teachers need to consider when planning instruction at the early childhood level?

### ELEMENTARY SCHOOL: PROJECT NIGHT

These questions refer to the case study on page 86.

1. Explain in your own words why the project-based unit would be considered a constructivist approach to learning.
2. Based on the students’ current stage of cognitive development, why was it necessary for Mr. Morales to break down the project into smaller, more manageable steps?
3. Based on Piaget’s stage theory of cognitive development, would you have expected students’ self-evaluations to be so superficial? Why or why not?
4. How does the “research team” format exemplify Vygotsky’s social construction of knowledge within the zone of proximal development?
5. Explain how the “research team” activity might stimulate disequilibrium in students. Explain how assimilation and accommodation would be involved in this activity.
MIDDLE SCHOOL: FROGS

These questions refer to the case study on page 88.

1. According to Piaget’s theory of cognitive development, what factors should Ms. Thesdale consider in planning biology lessons?

2. Explain how Ms. Thesdale could stimulate disequilibrium in her students before the frog dissection and why disequilibrium is important for cognitive change.

3. Ms. Thesdale assumed that the social interaction of working together in groups on dissection would foster cognitive growth. Based on the processes that stimulate cognitive change within the zone of proximal development, evaluate the effectiveness of the group dissection activity.

4. Based on Vygotsky’s zone of proximal development, was it appropriate for Ms. Thesdale to place Tyler with Jay and Vincent? Why or why not? What types of support would Tyler need from other students and from Ms. Thesdale in order to benefit from instruction involving social interaction?

5. How can Ms. Thesdale encourage active learning in her students? Provide specific suggestions, and explain whether each is supported by Piaget’s or Vygotsky’s theory.

HIGH SCHOOL: THE SUBSTITUTE

These questions refer to the case study on page 90.

1. Is it valid for a teacher to assume that high school students should be at the formal operational stage of development? Use Piaget’s theory to support your answer.

2. Based on Piaget’s theory of cognitive development, is a skit an effective method for helping Mr. Matthews’s high school students understand A Tale of Two Cities? Why or why not?

3. From your reading of the case, what mistakes did Mr. Reddy make in teaching his British literature class, based on the four factors necessary for developmental change in Piaget’s theory?

4. Explain how the group discussions at the end of the case exemplify intersubjectivity and internalization.

5. Assume that you are teaching a junior-level British literature course in high school. What would be your expectations of the students, and how would you approach teaching this subject? Explain how your response fits with either Piaget’s or Vygotsky’s theories, or both.

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