# Cognitive Development and Language

**Teachers’ Casebook: What Would You Do?** 19

**Module 2: Development: Some General Principles** 20

- The Brain and Cognitive Development 21
- The Development of Language 24
- Diversity in Language: Dual Language Development 26
- Language Development in the School Years 26

**Module 3: Piaget’s Theory of Cognitive Development** 31

- Influences on Development 31
- Basic Tendencies in Thinking 32
- Four Stages of Cognitive Development 33

**Module 4: Vygotsky’s Sociocultural Perspective** 43

- The Social Sources of Individual Thinking 44
- Cultural Tools and Cognitive Development 45
- The Role of Language and Private Speech 45
- The Role of Learning and Development 48
- The Role of Adults and Peers 48

**Module 5: Implications of Piaget and Vygotsky for Teachers** 51

- Understanding and Building on Students’ Thinking 51
- Activity and Constructing Knowledge 52
- The Value of Play 52
- Some Limitations of Piaget’s Theory 53
- Assisted Learning 55
- The Zone of Proximal Development 55

**Teachers’ Casebook: What Would They Do?** 59
What is going on with Trevor? In the following four modules, you will find out. We begin with a discussion of the general principles of human development and take a brief look at the human brain. We also explore language development and discuss the role of the school in developing and enriching language skills (Module 2). Then we will examine the ideas of two of the most influential cognitive developmental theorists, Jean Piaget (Module 3) and Lev Vygotsky (Module 4). Piaget’s ideas have implications about what students can learn and when they are ready to learn it. The work of Lev Vygotsky, a Russian psychologist, is becoming more and more influential. His theory highlights the important role teachers and parents play in the cognitive development of the child. Finally, we will look at the implications of these theories for classroom teachers (Module 5).

The district curriculum guide calls for a unit on poetry, including lessons on symbolism in poems. You are concerned that many of your 5th-grade students may not be ready to understand this abstract concept. To test the waters, you ask a few students what a symbol is.

“It’s sorta like a big metal thing that you bang together.” Tracy waves her hands like a drum major. “Yeah,” Sean adds, “My sister plays one in the high school band.”

You realize they are on the wrong track here, so you try again. “I was thinking of a different kind of symbol, like a ring as a symbol of marriage or a heart as a symbol of love, or . . . .”

You are met with blank stares.

Trevor ventures, “You mean like the Olympic torch?”

“And what does that symbolize, Trevor?” you ask.

“Like I said, a torch.” Trevor wonders how you could be so dense.

Development:
Some General Principles

The term development in its most general psychological sense refers to certain changes that occur in human beings (or animals) between conception and death. The term is not applied to all changes, but rather to those that appear in orderly ways and remain for a reasonably long period of time. A temporary change caused by a brief illness, for example, is not considered a part of development. Psychologists also make a value judgment in determining which changes qualify as development. The changes—at least those that occur early in life—are generally assumed to be for the better and to result in behavior that is more adaptive, more organized, more effective, and more complex (Mussen, Conger, & Kagan, 1984).

Human development can be divided into a number of different aspects. Physical development, as you might guess, deals with changes in the body. Personal development is the term generally used for changes in an individual’s personality. Social development refers to changes in the way an individual relates to others. And cognitive development refers to changes in thinking.

Many changes during development are simply matters of growth and maturation. Maturation refers to changes that occur naturally and spontaneously and that are, to a large extent, genetically programmed. Such changes emerge over time and are relatively unaffected by environment, except in cases of malnutrition or severe illness. Much of a person’s physical development falls into this category. Other changes are brought about through learning, as individuals interact with their environment. Such changes make up a large part of a person’s social development. But what about the development of thinking and personality? Most psychologists agree that in these areas, both maturation and interaction with the environment (or nature and nurture, as they are sometimes called) are important, but they disagree about the amount of emphasis to place on each.

Although there is disagreement about both what is involved in development and the way it takes place, there are a few general principles almost all theorists would support.

1. **People develop at different rates.** In your own classroom, you will have a whole range of examples of different developmental rates. Some students will be larger, better coordinated, or more mature in their thinking and social relationships. Others will be much slower to mature in these areas. Except in rare cases of very rapid or very slow development, such differences are normal and should be expected in any large group of students.

2. **Development is relatively orderly.** People develop abilities in a logical order. In infancy, they sit before they walk, babble before they talk, and see the world through their own eyes before they can begin to imagine how others see it. In school, they will master addition before algebra, Bambi before Shakespeare, and so on. Theorists may disagree on exactly what comes before what, but they all seem to find a relatively logical progression.

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**Development**
- Orderly, adaptive changes we go through from conception to death.
- Physical development: Changes in body structure and function over time.
- Personal development: Changes in personality that take place as one grows.
- Social development: Changes over time in the ways we relate to others.
- Cognitive development: Gradual orderly changes by which mental processes become more complex and sophisticated.
- Maturation: Genetically programmed, naturally occurring changes over time.
3. Development takes place gradually. Very rarely do changes appear overnight. A student who cannot manipulate a pencil or answer a hypothetical question may well develop this ability, but the change is likely to take time.

The Brain and Cognitive Development

What Would You Say? You are interviewing for a job in a great district—it is known for innovation. After a few minutes, the principal asks, “Do you know anything about this brain-based education? I’ve read a lot about that lately.” How would you answer?

If you have taken an introductory psychology class, you have read about the brain and nervous system. You probably remember, for example, that there are several different areas of the brain and that certain areas are involved in particular functions. For example, the feathery looking cerebellum coordinates and orchestrates balance and smooth, skilled movements—from the graceful gestures of the dancer to the everyday action of eating without stabbing yourself in the nose with a fork. The cerebellum may also play a role in higher cognitive functions such as learning. The hippocampus is critical in recalling new information and recent experiences, while the amygdala directs emotions. The thalamus is involved in our ability to learn new information, particularly if it is verbal. The reticular formation plays a role in attention and arousal, blocking some messages and sending others on to higher brain centers for processing, and the corpus callosum moves information from one side of the brain to the other (Wood & Wood, 1999; Meece 2002).

The outer 1/8-inch-thick covering of the cerebrum is the wrinkled-looking cerebral cortex—the largest area of the brain. The cerebral cortex accounts for about 85% of the brain’s weight in adulthood and contains the greatest number of neurons—the tiny structures that store and transmit information. The cerebral cortex allows the greatest human accomplishments, such as complex problem solving and language. This crumpled sheet of neurons serves three major functions: receiving signals from sense organs (such as visual or auditory signals), controlling voluntary movement, and forming associations. In humans, this area of the brain is much larger than it is in lower animals. The cortex is the last part of the brain to develop, so it is believed to be more susceptible to environmental influences than other areas of the brain. (Berk, 2002; Meece, 2002). Let’s see how this part of the brain develops.

The Developing Brain: Cerebral Cortex. The cortex develops more slowly than other parts of the brain, and parts of the cortex mature at different rates. The part of the cortex that controls physical motor movement matures first, then the areas that control complex senses such as vision and hearing, and last, the frontal lobe that controls higher-order thinking processes. The temporal lobes of the cortex that play major roles in emotions and language do not develop fully until the high school years and maybe later.

Neuroscientists are just beginning to understand how brain development is related to aspects of adolescence such as risk-taking, decision making, and managing impulsive behaviors. Getting angry or wanting revenge when we are insulted are common human emotions. It is the job of the prefrontal cortex to control these impulses through reason, planning, or delay of gratification. But the impulse inhibiting capacities of the brain are not present at birth (as all new parents quickly discover). Research now indicates that it takes at least two decades for the biological processes of brain development to produce a fully functional prefrontal cortex (Weinberger, 2001). Thus middle and high school students still lack the brain development to balance impulse with reason and planning. Weinberger suggests that parents have to “loan” their children a prefrontal cortex, by helping them set rules and limits and

Connect & Extend

TO THE RESEARCH
In the next decade we should see increasing research on the brain, development, learning, and teaching. For example, in 1998, there was a special issue of Educational Psychology Review on cognitive neuroscience and education. The authors of this volume emphasized that the brain is a complex collection of systems working together to construct understanding, detect patterns, create rules, and make sense of experience. These systems change over the lifetime as the individual matures and develops.
make plans, until the child’s own prefrontal cortex can take over. Schools and teachers also can play major roles in cognitive and emotional development if they provide appropriate environments for developing, but sometimes impulsive, brains (Meece, 2002).

**Specialization and Integration.** Different areas of the cortex seem to have different functions, as shown in Figure 2.1. Even though different functions are found in different areas of the brain, these specialized functions are quite specific and elementary. To accomplish more complex functions such as speaking or reading, the various areas of the cortex must work together (Byrnes & Fox, 1998). For example, many areas of the cortex are necessary in processing language. To answer a question, you must first hear it. This involves the primary auditory cortex. Movements controlled by the motor cortex are required to speak your response. Broca’s area (near the area that controls the lips, jaw, and tongue) has a role in setting up a grammatically correct way of expressing an idea, and Wernicke’s area (near the auditory cortex) is necessary for connecting meaning with particular words. A person with a functioning Broca’s area but a damaged Wernicke’s area will say meaningless things in a grammatically correct structure. Damage limited to Broca’s area, on the other hand, is associated with short, ungrammatical sentences, but the words are appropriate (Anderson, 1995a).

Another aspect of brain functioning that has implications for cognitive development is **lateralization**, or the specialization of the two hemispheres of the brain. We know that each half of the brain controls the opposite side of the body. Damage to the right side of the brain will affect movement of the left side of the body and vice versa. In addition, certain areas of the brain affect particular behaviors. For most of us, the left hemisphere of the brain is a major factor in language processing, and the right hemisphere handles much of the spatial-visual information and emotions (nonverbal information). For some left-handed people, the relationship may be reversed, but for most left-handers there is less hemispheric specialization altogether (Berk, 2002). In addition, females on average seem to show less hemispheric specialization than males (O’Boyle & Gill, 1998). Before lateralization, damage to one part of the cortex often can be overcome as other parts of the cortex take over the function of the damaged area. But after lateralization, the brain is less able to compensate.

These differences in performance by the brain’s hemispheres, however, are more relative than absolute; one hemisphere is just more efficient than the other in performing certain functions. Nearly any task, particularly the complex skills and abilities that concern teachers, requires participation of many different areas of the brain in constant communication with each other. For example, the right side of the brain is better at figuring out the meaning of a story, but the left side is where grammar and syntax are understood, so both sides of the brain have to work together in reading. “The primary implication of these findings is that the practice of teaching to ‘different sides of the brain’ is not supported by the neuroscientific research” (Byrnes & Fox, 1998, p. 310). Thus, beware of educational approaches based on simplistic views of brain functioning—what Keith Stanovich (1998) has called “the left-brain–right-brain nonsense that has inundated education through workshops, inservices, and the trade publications” (p. 420). Remember, no mental activity is exclusively the work of single part of the brain—so there is no such thing as a “right-brained student” unless that individual has had the left hemisphere removed, a rare and radical treatment for some forms of epilepsy.

**The Developing Brain: Neurons.** About one month after conception, brain development starts. In the tiny tube that is the very beginning of the human brain,
Each neuron (nerve cell) includes dendrites that bring in messages and an axon that sends out messages. This is a single neuron, but each neuron is in a network with many others.

In the synapse, or intersection between axon and dendrite, neurotransmitters carry information from one neuron to another.


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**Figure 2.2 A Single Neuron**

Neuron cells (nerve cells that store and transfer information) emerge at the amazing rate of 50,000 to 100,000 per second for the next three months or so (McDevitt & Ormrod, 2002). These cells send out axons and dendrites—long arm- and branch-like fibers—to connect with other neuron cells and share information. Look at Figure 2.2; the dendrites on the left of the figure bring information in and the axon in the middle transmits information out through the axon terminals on the right of the figure. The neurons send messages to each other by releasing chemicals that jump across the tiny spaces, called **synapses**, between the dendrites of one neuron and the axons of other neurons.

By the time we are born, we have all the neurons we will ever have, about 100 to 200 billion, and each neuron has about 2,500 synapses. However, the fibers that reach out from the neurons and the synapses between the fiber ends increase during the first years of life, perhaps into adolescence. By age two to three, each neuron has around 15,000 synapses; children this age have many more synapses than they will have as adults (McDevitt & Ormrod, 2002). In fact, they are oversupplied with the neurons and synapses that they will need to adapt to their environments. However, only those that are used will survive, and unused neurons will be “pruned” (Diamond & Hobson, 1998).

Two kinds of overproduction and pruning processes take place. One is called **experience-expectant** because synapses are overproduced in certain parts of the brain during certain developmental periods, awaiting (expecting) stimulation. For example, during the first months of life, the brain expects visual and auditory stimulation. If a normal range of sights and sounds occurs, then the visual and auditory areas of the brain develop. But children who are born completely deaf receive no auditory stimulation and, as a result, the auditory processing area of their brains becomes devoted to processing visual information. Similarly, the visual processing area of the
brain for children blind from birth becomes devoted to auditory processing (Siegler, 1998). Experience-expectant overproduction and pruning processes are responsible for general development in large areas of the brain.

The second kind of synaptic overproduction and pruning is called **experience-dependent**. Here synaptic connections are formed based on the individual’s experiences. New synapses are formed in response to neural activity in very localized areas of the brain when the individual is not successful in processing information. Again, more synapses are produced than will be kept after “pruning.” Experience-dependent processes are involved in individual learning.

So stimulation is important in both development (experience-expectant processes) and learning (experience-dependent processes). In fact, animal studies have shown that rats raised in stimulating environments (with toys, tasks for learning, and human handling) develop 25% more synapses than rats who are raised with little stimulation (Greenough, Black, & Wallace, 1987). Early stimulation is important for humans as well. It is clear that extreme deprivation of stimulation can have negative effects on brain development, but extra stimulation will not necessarily improve development for young children who are getting adequate or typical amounts of stimulation (Byrnes & Fox, 1998; Kolb & Whishaw, 1998). So spending money on expensive toys or baby education programs probably provides more stimulation than is necessary.

Even though the brain is developing rapidly during early childhood, learning continues over a lifetime. Early severe stimulus deprivation can have lasting effects, but because of brain plasticity or adaptability, some compensation can overcome deprivation or damage. Of course, many factors besides stimulus deprivation, such as the mother’s intake of drugs (including alcohol and caffeine) during pregnancy, toxins in the infant’s environment such as lead paint, or poor nutrition, can have direct and dramatic negative effects on brain development.

Another factor that influences thinking and learning is **myelination**, or the coating of neuron fibers with an insulating fatty covering. This process is something like coating bare electrical wires with rubber or plastic. Look at Figure 2.2 and notice the gray coating on the axon. This myelin coating makes message transmission faster and more efficient. Myelination happens quickly in the early years, but continues gradually into adolescence and is the reason the child’s brain grows rapidly in size in the first few years of life.

**Implications for Teachers.** Much has been written lately about brain-based education. Many of these publications for parents and teachers have useful ideas, but beware of suggestions that oversimplify the complexities of the brain. As you can see in the Point/Counterpoint, the jury still is out on many of these programs.

**The Development of Language**

All children in every culture master the complicated system of their native language, unless severe deprivation or physical problems interfere. This knowledge is remarkable. At the least, sounds, meanings, words and sequences of words, volume, voice tone, inflection, and turn-taking rules must all be coordinated before a child can communicate effectively in conversations.

It is likely that many factors—biological and experiential—play a role in language development. We saw earlier that culture plays a major role by determining what language tools are necessary in the life of the people. The important point is that children develop language as they develop other cognitive abilities by actively trying to make sense of what they hear and by looking for patterns and making up rules to put together the jigsaw puzzle of language. In this process, humans may have built-in biases, rules, and constraints about language that restrict the number of possibiliti-
ties considered. For example, young children seem to have a constraint specifying that a new label refers to a whole object, not just a part. Another built-in bias leads children to assume that the label refers to a class of similar objects. So the child learning about the rabbit is equipped naturally to assume that *rabbit* refers to the whole animal (not just its ears) and that other similar-looking animals are also rabbits (Markman, 1992). Reward and correction play a role in helping children learn correct language use, but the child’s thinking in putting together the parts of this complicated system is very important (Rosser, 1994).
Diversity in Language: Dual Language Development

In 2000, about six million school-aged children in the United States spoke a language other than English at home. The number grows each year. For example, by 2035, about 50% of the kindergarten children in California will speak languages other than English at home (Winsler, Dias, Espinosa, & Rodríguez, 1999).

Luckily, learning a second language does not interfere with understanding in the first language. In fact, the more proficient the speaker is in the first language, the more quickly she or he will master a second language (Cummins, 1984, 1994). For most children who learn two languages simultaneously as toddlers, there is a period between ages 2 and 3 when they progress more slowly because they have not yet figured out that they are learning two different languages. They may mix up the grammar of the two. But researchers believe that by age 4, if they have enough exposure to both languages, they get things straight and speak as well as native monolinguals, people who speak only one language (Baker, 1993; Reich, 1986). Also, bilingual children may mix vocabularies of the two languages when they speak, but this is not a sign that they are confused because their bilingual parents often intentionally mix vocabularies as well. It takes from three to five years to become truly competent in the second language (Baker, 1993; Bhatia & Richie, 1999).

It appears that there is a critical period for learning accurate language pronunciation. The earlier people learn a second language, the more their pronunciation is near-native. After adolescence it is difficult to learn a new language without speaking with an accent (Anderson & Graham, 1994). However, it is a misconception that young children learn a second language faster than adolescents or adults. In fact, older students go through the stages of language learning faster than young children. Adults have more learning strategies and greater knowledge of language in general to bring to bear in mastering a second language (Diaz-Rico & Weed, 2002). Age is a factor in learning language, but “not because of any critical period that limits the possibility of language learning by adults” (Marinova-Todd, Marshall, & Snow, 2000, p. 28). Kathleen Berger (2003) concludes that the best time to teach a second language is during early or middle childhood, but the best time to learn on your own through exposure (and to learn native pronunciation) is early childhood.

There is no cognitive penalty for students who learn and speak two languages. In fact, there are benefits. Higher degrees of bilingualism are correlated with increased cognitive abilities in such areas as concept formation, creativity, and cognitive flexibility. In addition, these students have more advanced metalinguistic awareness; for example, they are more likely to notice grammar errors. These findings seem to hold as long as there is no stigma attached to being bilingual and as long as students are not expected to abandon their first language to learn English (Berk, 2002; Bialystok, 1999; Galambos & Goldin-Meadow, 1990; Garcia, 1992; Ricciardelli, 1992). Even though the advantages of bilingualism seem clear, as we will see in Module 14, there are strong debates about what these findings should mean for education.

Language Development in the School Years

By about age 5 or 6, most children have mastered the basics of their native language. What remains for the school-age child to accomplish?

Pronunciation. The majority of 1st graders have mastered most of the sounds of their native language, but a few may remain unconquered. The $j$, $v$, $th$, and $zh$ sounds are the last to develop. About 10% of 8-year-olds still have some trouble with $s$, $z$, $v$,
Young children may understand and be able to use many words, but prefer to use the words they can pronounce easily.

**Syntax.** Children master the basics of word order, or syntax, in their native language early. But the more complicated forms, such as the passive voice (“The car was hit by the truck”), take longer to master. By early elementary school, many children can understand the meaning of passive sentences, yet they do not use such constructions in their normal conversations. Other accomplishments during elementary school include first understanding and then using complex grammatical structures such as extra clauses, qualifiers, and conjunctions.

**Vocabulary and Meaning.** The average 6-year-old has a vocabulary of 8,000 to 14,000 words, growing to about 40,000 by age 11. In fact, some researchers estimate that students in the early grades learn up to 20 words a day (Berger, 2003). School-age children enjoy language games and jokes that play on words. In the early elementary years, some children may have trouble with abstract words such as justice or economy. They also may not understand the subjunctive case (“If I were a butterfly . . .”) because they lack the cognitive ability to reason about things that are not true (“But you aren’t a butterfly . . .”). They may take statements literally and thus misunderstand sarcasm or metaphor. Fairy tales are understood concretely simply as stories instead of as moral lessons, for example. Many children are in their preadolescent years before they are able to distinguish being kidded from being taunted or before they know that a sarcastic remark is not meant to be taken literally (Berger, 2003; Gardner, 1982b).

**Pragmatics.** Pragmatics involves the appropriate use of language to communicate. For instance, children must learn the rules of turn-taking in conversation. Young children may appear to take turns in conversations, but if you listen in, you realize that they are not exchanging information, only talk time. In later elementary school, children’s conversations start to sound like conversations. Contributions are usually on the same topic. Also, by middle childhood, students understand that an observation can be a command, as in “I see too many children at the pencil sharpener.” By adolescence, individuals are very adept at varying their language style to fit the situation. So they can talk to their peers in slang that makes little sense to adults, but marks the adolescent as a member of the group. Yet these same students can speak politely to adults (especially when making requests) and write persuasively about a topic in history (Berk, 2002).

**Metalinguistic Awareness.** Around the age of 5, students begin to develop metalinguistic awareness. This means their understanding about language and how it works becomes explicit. They have knowledge about language itself. They are ready to study and extend the rules that have been implicit—understood but not consciously expressed. This process continues throughout life, as we all become better able to manipulate and comprehend language. One goal of schooling is the development of language and literacy.

**Partnerships with Families.** Especially in the early years, the students’ home experiences are central in the development of language and literacy (Roskos & Neuman, 1993; Snow, 1993; Whitehurst et al., 1994). In homes that promote literacy, parents and other adults value reading as a source of pleasure, and there are books th, and zh (Rathus, 1988). The more proficient speakers are in their first language, the faster they will learn a second language.

Syntax  The order of words in phrases or sentences.

Pragmatics  The rules for when and how to use language to be an effective communicator in a particular culture.

Metalinguistic awareness  Understanding about one’s own use of language.
and other printed materials everywhere. Parents read to their children, take them to bookstores and libraries, limit the amount of television everyone watches, and encourage literacy-related play such as setting up a pretend school or writing “letters” (Pressley, 1996; Roskos & Neuman, 1998; Sulzby & Teale, 1991). Of course, not all homes provide this literacy-rich environment, but teachers can help, as you can see in the Family and Community Partnerships Guidelines.

**Family and Community Partnerships**

**Promoting Literacy**

Communicate with families about the goals and activities of your program.

**Examples**
1. At the beginning of school, send home a description of the goals to be achieved in your class—make sure it is in a clear and readable format.
2. As you start each unit, send home a newsletter describing what students will be studying—give suggestions for home activities that support the learning.

Involve families in decisions about curriculum.

**Examples**
1. Have planning workshops at times family members can attend—provide child care for younger siblings, but let children and families work together on projects.
2. Invite parents to come to class to read to students, take dictation of stories, tell stories, record or bind books, and demonstrate skills.

Provide home activities to be shared with family members.

**Examples**
1. Encourage family members to work with children to read and follow simple recipes, play language games, keep diaries or journals for the family, and visit the library. Get feedback from families or students about the activities.
2. Give families feedback sheets and ask them to help evaluate the child’s school work.
3. Provide lists of good children’s literature available locally—work with libraries, clubs, and churches to identify sources.

SOURCE: From *Literacy Development in the Early Years: Helping Children Read and Write* (3rd ed.) (pp. 68–70), by L. Morrow. Published by Allyn & Bacon, Boston, MA. Copyright © 1997 by Pearson Education. Reprinted by permission of the publisher.
**SUMMARY**

**What are the different kinds of development?** Human development can be divided into physical development (changes in the body), personal development (changes in an individual's personality), social development (changes in the way an individual relates to others), and cognitive development (changes in thinking).

**What are three principles of development?** Theorists generally agree that people develop at different rates, that development is an orderly process, and that development takes place gradually.

**What is lateralization and why is it important?** Lateralization is the specialization of the two sides, or hemispheres, of the brain. The brain begins to lateralize soon after birth. For most people, the left hemisphere is the major factor in language, and the right hemisphere is prominent in spatial and visual processing. Even though certain functions are associated with certain parts of the brain, the various parts and systems of the brain work together to learn and perform complex activities such as reading and to construct understanding.

**What part of the brain is associated with higher mental functions?** The cortex is a crumpled sheet of neurons that serves three major functions: receiving signals from sense organs (such as visual or auditory signals), controlling voluntary movement, and forming associations. The part of the cortex that controls physical motor movement develops or matures first, then the areas that control complex senses such as vision and hearing, and last the frontal lobe, which controls higher-order thinking processes.

**How are humans predisposed to develop language?** **What role does learning play?** Children develop language as they develop other cognitive abilities by actively trying to make sense of what they hear, looking for patterns, and making up rules. In this process, built-in biases and rules may limit the search and guide the pattern recognition. Reward and correction play a role in helping children learn correct language use, but the child's thought processes are very important.

**What are pragmatics and metalinguistic awareness?** Pragmatics is knowledge about how to use language—when, where, how, and to whom to speak. Metalinguistic awareness begins around age 5 or 6 and grows throughout life.

**Key Terms**

<table>
<thead>
<tr>
<th>Cognitive Development</th>
<th>20</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development</td>
<td>20</td>
</tr>
<tr>
<td>Lateralization</td>
<td>22</td>
</tr>
<tr>
<td>Maturation</td>
<td>20</td>
</tr>
<tr>
<td>Metalinguistic Awareness</td>
<td>27</td>
</tr>
<tr>
<td>Myelination</td>
<td>24</td>
</tr>
<tr>
<td>Personal Development</td>
<td>20</td>
</tr>
<tr>
<td>Physical Development</td>
<td>20</td>
</tr>
<tr>
<td>Pragmatics</td>
<td>27</td>
</tr>
<tr>
<td>Social Development</td>
<td>20</td>
</tr>
<tr>
<td>Synapses</td>
<td>23</td>
</tr>
<tr>
<td>Syntax</td>
<td>27</td>
</tr>
</tbody>
</table>
4. Gradual orderly changes by which mental processes become more complex and sophisticated
5. Orderly, adaptive changes we go through from conception to death
6. Part of the brain some researchers say parents have to “loan” their children, helping them set rules and limits
7. Part of the brain that allows the greatest human accomplishments, such as complex problem solving
8. Part of the brain which is critical in recalling new information and recent experiences
9. Understanding about one’s own use of language
10. Genetically programmed, naturally occurring changes over time
11. The time space between neurons, across which chemical messages are sent
12. The order of words in phrases or sentence
13. Changes in personality that take place as one grows
14. Part of the brain that coordinates balance and movements as well as playing a role in higher cognitive functions
15. Part of the brain involved in our ability to learn new material, particularly verbal information
16. Rules for when and how to use language to be an effective communicator in a particular culture
17. Changes in body structure and function over time
18. The specialization of the two sides of the brain
Piaget’s Theory of Cognitive Development

Can you be in Pittsburgh, Pennsylvania, and the United States all at the same time? Is this a difficult question for you? How long did it take you to answer?

During the past half-century, Swiss psychologist Jean Piaget devised a model describing how humans go about making sense of their world by gathering and organizing information (Piaget, 1954, 1963, 1970a, b). We will examine Piaget’s ideas closely, because they provide an explanation of the development of thinking from infancy to adulthood.

According to Piaget (1954), certain ways of thinking that are quite simple for an adult, such as the question above, are not so simple for a child. For example, Piaget asked a 9-year-old:

What is your nationality?—I am Swiss.—How come?—Because I live in Switzerland.—Are you also a Genevan?—No, that’s not possible . . . I’m already Swiss, I can’t also be Genevan. (Piaget, 1965/1995, p. 252)

Sometimes all you need to do to teach a new concept is to give students a few basic facts as background. At other times, however, all the facts in the world are useless. The students simply are not ready to learn the concept. Like the nine-year-old above, they may have trouble with classifying one concept (Geneva) as a subset of another (Switzerland). Or their concepts of time may be different from your own. They may think, for example, that they will some day catch up to a sibling in age, or they may confuse the past and the future. Let’s examine why.

Influences on Development

As you can see, cognitive development is much more than the addition of new facts and ideas to an existing store of information. According to Piaget, our thinking processes change radically, though slowly, from birth to maturity because we constantly strive to make sense of the world. How do we do this? Piaget identified four factors—biological maturation, activity, social experiences, and equilibration—that interact to influence changes in thinking (Piaget, 1970a). Let’s briefly examine the first three factors. We’ll return to a discussion of equilibration in the next section.

One of the most important influences on the way we make sense of the world is maturation, the unfolding of the biological changes that are genetically programmed. Parents and teachers have little impact on this aspect of cognitive development, except to be sure that children get the nourishment and care they need to be healthy.
Activity is another influence. With physical maturation comes the increasing ability to act on the environment and learn from it. When a young child’s coordination is reasonably developed, for example, the child may discover principles about balance by experimenting with a seesaw. Thus, as we act on the environment—as we explore, test, observe, and eventually organize information—we are likely to alter our thinking processes at the same time.

As we develop, we are also interacting with the people around us. According to Piaget, our cognitive development is influenced by social transmission, or learning from others. Without social transmission, we would need to reinvent all the knowledge already offered by our culture. The amount people can learn from social transmission varies according to their stage of cognitive development.

Maturation, activity, and social transmission all work together to influence cognitive development. How do we respond to these influences?

Basic Tendencies in Thinking

As a result of his early research in biology, Piaget concluded that all species inherit two basic tendencies, or “invariant functions.” The first of these tendencies is toward organization—the combining, arranging, recombining, and rearranging of behaviors and thoughts into coherent systems. The second tendency is toward adaptation, or adjusting to the environment.

Organization. People are born with a tendency to organize their thinking processes into psychological structures. These psychological structures are our systems for understanding and interacting with the world. Simple structures are continually combined and coordinated to become more sophisticated and thus more effective. Very young infants, for example, can either look at an object or grasp it when it comes in contact with their hands. They cannot coordinate looking and grasping at the same time. As they develop, however, infants organize these two separate behavioral structures into a coordinated higher-level structure of looking at, reaching for, and grasping the object. They can, of course, still use each structure separately (Ginsburg & Opper, 1988; Miller, 2002).

Piaget gave a special name to these structures: schemes. In his theory, schemes are the basic building blocks of thinking. They are organized systems of actions or thought that allow us to mentally represent or “think about” the objects and events in our world. Schemes may be very small and specific, for example, the sucking-through-a-straw scheme or the recognizing-a-rose scheme. Or they may be larger and more general—the drinking scheme or the categorizing-plants scheme. As a person’s thinking processes become more organized and new schemes develop, behavior also becomes more sophisticated and better suited to the environment.

Adaptation. In addition to the tendency to organize their psychological structures, people also inherit the tendency to adapt to their environment. Two basic processes are involved in adaptation: assimilation and accommodation.

Assimilation takes place when people use their existing schemes to make sense of events in their world. Assimilation involves trying to understand something new by fitting it into what we already know. At times, we may have to distort the new information to make it fit. For example, the first time many children see a skunk, they call it a “kitty.” They try to match the new experience with an existing scheme for identifying animals.

Accommodation occurs when a person must change existing schemes to respond to a new situation. If data cannot be made to fit any existing schemes, then more appropriate structures must be developed. We adjust our thinking to fit the new information, instead of adjusting the information to fit our thinking. Children demonstrate accommodation when they add the scheme for recognizing skunks to their other systems for identifying animals.
People adapt to their increasingly complex environments by using existing schemes whenever these schemes work (assimilation) and by modifying and adding to their schemes when something new is needed (accommodation). In fact, both processes are required most of the time. Even using an established pattern such as sucking through a straw may require some accommodation if the straw is of a different size or length than the type you are used to. If you have tried drinking juice from box packages, you know that you have to add a new skill to your sucking scheme—don’t squeeze the box or you will shoot juice through the straw, straight up into the air and into your lap. Whenever new experiences are assimilated into an existing scheme, the scheme is enlarged and changed somewhat, so assimilation involves some accommodation.

There are also times when neither assimilation nor accommodation is used. If people encounter something that is too unfamiliar, they may ignore it. Experience is filtered to fit the kind of thinking a person is doing at a given time. For example, if you overhear a conversation in a foreign language, you probably will not try to make sense of the exchange unless you have some knowledge of the language.

**Equilibration.** According to Piaget, organizing, assimilating, and accommodating can be viewed as a kind of complex balancing act. In his theory, the actual changes in thinking take place through the process of **equilibration**—the act of searching for a balance. Piaget assumed that people continually test the adequacy of their thinking processes in order to achieve that balance.

Briefly, the process of equilibration works like this: If we apply a particular scheme to an event or situation and the scheme works, then equilibrium exists. If the scheme does not produce a satisfying result, then **disequilibrium** exists, and we become uncomfortable. This motivates us to keep searching for a solution through assimilation and accommodation, and thus our thinking changes and moves ahead.

**Four Stages of Cognitive Development**

**What Would You Say?** Your interview with the principal seems to be going fairly well. Her next question is, “We have openings at several grade levels, so I need to know about your understanding of students across grades. Are students in the 2nd and the 7th grade that different in the way they think—I mean in any ways that would affect your teaching?”

Now we turn to the actual differences that Piaget hypothesized for children as they grow. Piaget’s four stages of cognitive development are called sensorimotor, preoperational, concrete operational, and formal operational. Piaget believed that all people pass through the same four stages in exactly the same order. These stages are generally associated with specific ages, as shown in Table 3.1, but these are only general guidelines, not labels for all children of a certain age. Often, people can use one level of thinking to solve one kind of problem and a different level to solve another. Piaget noted that individuals may go through long periods of transition between stages and that a person may show characteristics of one stage in one situation, but characteristics of a higher or lower stage in other situations. Therefore, knowing a student’s age is never a guarantee that you know how the child will think (Ginsburg & Opper, 1988; Orlando & Machado, 1996).

**Infancy: The Sensorimotor Stage.** The earliest period is called the **sensorimotor stage**, because the child’s thinking involves seeing, hearing, moving, touching, tasting, and so on. During this period, the infant develops **object permanence**, the understanding that objects exist in the environment whether the baby perceives them or not. As most parents discover, before infants develop object permanence, it is relatively easy to take something away from them. The trick is to distract them and remove the object while they are not looking—“out of sight, out of mind.” The older...
infant who searches for the ball that has rolled out of sight is indicating an understanding that objects still exist even when they are not in view. Recent research, however, suggests that infants as young as 3 to 4 months may know that the object still exists, but they do not have the memory skills to "hold on" to the location of the object or the motor skills to coordinate a search (Baillargeon & DeVos, 1991; Meece, 2002).

A second major accomplishment in the sensorimotor period is the beginning of logical, goal-directed actions. Think of the familiar container toy for babies. It is usually plastic, has a lid, and contains several colorful items that can be dumped out and replaced. A 6-month-old baby is likely to become frustrated trying to get to the toys inside. An older child who has mastered the basics of the sensorimotor stage will probably be able to deal with the toy in an orderly fashion by building a "container toy" scheme: (1) get the lid off, (2) turn the container upside down, (3) shake if the items jam, (4) watch the items fall. Separate lower-level schemes have been organized into a higher-level scheme to achieve a goal.

A second major accomplishment in the sensorimotor period is the beginning of logical, goal-directed actions. Think of the familiar container toy for babies. It is usually plastic, has a lid, and contains several colorful items that can be dumped out and replaced. A 6-month-old baby is likely to become frustrated trying to get to the toys inside. An older child who has mastered the basics of the sensorimotor stage will probably be able to deal with the toy in an orderly fashion by building a "container toy" scheme: (1) get the lid off, (2) turn the container upside down, (3) shake if the items jam, (4) watch the items fall. Separate lower-level schemes have been organized into a higher-level scheme to achieve a goal.

The child is soon able to reverse this action by refilling the container. Learning to reverse actions is a basic accomplishment of the sensorimotor stage. As we will soon see, however, learning to reverse thinking—that is, learning to imagine the reverse of a sequence of actions—takes much longer.

### Early Childhood to the Early Elementary Years: The Preoperational Stage

By the end of the sensorimotor stage, the child can use many action schemes. As long as these schemes remain tied to physical actions, however, they are of no use in recalling the past, keeping track of information, or planning. For this, children need what
Piaget called operations, or actions that are carried out and reversed mentally rather than physically. The stage after sensorimotor is called preoperational, because the child has not yet mastered these mental operations but is moving toward mastery.

According to Piaget, the first type of thinking that is separate from action involves making action schemes symbolic. The ability to form and use symbols—words, gestures, signs, images, and so on—is thus a major accomplishment of the preoperational period and moves children closer to mastering the mental operations of the next stage. This ability to work with symbols, such as using the word “bicycle” or a picture of a bicycle to represent a real bicycle that is not actually present, is called the semiotic function.

The child’s earliest use of symbols is in pretending or miming. Children who are not yet able to talk will often use action symbols—pretending to drink from an empty cup or touching a comb to their hair, showing that they know what each object is for. This behavior also shows that their schemes are becoming more general and less tied to specific actions. The eating scheme, for example, may be used in playing house. During the preoperational stage, we also see the rapid development of that very important symbol system, language. Between the ages of 2 and 4, most children enlarge their vocabulary from about 200 to 2,000 words.

As the child moves through the preoperational stage, the developing ability to think about objects in symbolic form remains somewhat limited to thinking in one direction only, or using one-way logic. It is very difficult for the child to “think backwards,” or imagine how to reverse the steps in a task. Reversible thinking is involved in many tasks that are difficult for the preoperational child, such as the conservation of matter.

Conservation is the principle that the amount or number of something remains the same even if the arrangement or appearance is changed, as long as nothing is added and nothing is taken away. You know that if you tear a piece of paper into several pieces, you will still have the same amount of paper. To prove this, you know that you can reverse the process by taping the pieces back together.

A classic example of difficulty with conservation is found in the preoperational child’s response to the following Piagetian task. Leah, a 5-year-old, is shown two identical glasses, both short and wide in shape. Both have exactly the same amount of colored water in them.

**Interviewer:** Does one glass have more water, or are they the same?

**Leah:** Same

The experimenter then pours the water from one of the glasses into a taller, narrower glass.

**Interviewer:** Now, does one glass have more water, or are they the same?

**Leah:** The tall one has more.

**Interviewer:** How do you know?

**Leah:** It goes up more here (points to higher level on taller glass).

Notice, by the way, that Leah shows a basic understanding of identity (it’s the same water) but not an understanding that the amounts are identical (Ginsburg & Opper, 1988).

Piaget’s explanation for Leah’s answer is that she is focusing, or centering, attention on the dimension of height. She has difficulty considering more than one aspect of the situation at a time, or decentering. The preoperational child cannot understand that increased diameter compensates for decreased height, because this would require taking into account two dimensions at once. Thus, children at the preoperational stage have trouble freeing themselves from their own perceptions of how the world appears.

This brings us to another important characteristic of the preoperational stage. Preoperational children, according to Piaget, are egocentric; they tend to see the

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**Definitions:**

- **Operations**: Actions a person carries out by thinking them through instead of literally performing the actions.
- **Preoperational**: The stage before a child masters logical mental operations.
- **Semiotic function**: The ability to use symbols—language, pictures, signs, or gestures—to represent actions or objects mentally.
- **Reversible thinking**: Thinking backward, from the end to the beginning.
- **Conservation**: Principle that some characteristics of an object remain the same despite changes in appearance.
- **Decentering**: Focusing on more than one aspect at a time.
- **Egocentric**: Assuming that others experience the world the way you do.
world and the experiences of others from their own viewpoint. Ego-centric, as Piaget intended it, does not mean selfish; it simply means children often assume that everyone else shares their feelings, reactions, and perspectives. For example, if a little boy at this stage is afraid of dogs, he may assume that all children share this fear. Very young children center on their own perceptions and on the way the situation appears to them. This is one reason it is difficult for these children to understand that your right hand is not on the same side as theirs when you are facing them.

Egocentrism is also evident in the child’s language. You may have seen young children happily talking about what they are doing even though no one is listening. This can happen when the child is alone or, even more often, in a group of children—each child talks enthusiastically, without any real interaction or conversation. Piaget called this the collective monologue.

Research has shown that young children are not totally egocentric in every situation, however. Children as young as age 4 change the way they talk to 2-year-olds by speaking in simpler sentences, and even before age 2, children show toys to adults by turning the front of the toy to face the other person. So young children do seem quite able to take the needs and different perspectives of others into account, at least in certain situations (Gelman, 1979; Gelman & Ebeling, 1989). The Guidelines give ideas for working with preoperational thinkers.

Later Elementary to the Middle School Years: The Concrete-Operational Stage. Piaget coined the term concrete operations to describe this stage of “hands-on” thinking. The basic characteristics of the stage are the recognition of the logical stability of the physical world, the realization that elements can be changed or transformed and still conserve many of their original characteristics, and the understanding that these changes can be reversed.

Look at Figure 3.1 on page 38, which shows examples of the different tasks given to children to assess conservation and the approximate age ranges when most children can solve these problems. According to Piaget, a student’s ability to solve conservation problems depends on an understanding of three basic aspects of reasoning: identity, compensation, and reversibility. With a complete mastery of identity, the student knows that if nothing is added or taken away, the material remains the same. With an understanding of compensation, the student knows that an apparent change in one direction can be compensated for by a change in another direction. That is, if the liquid rises higher in the glass, the glass must be narrower. And with an understanding of reversibility, the student can mentally cancel out the change that has been made.

Another important operation mastered at this stage is classification. Classification depends on a student’s abilities to focus on a single characteristic of objects in a set and group the objects according to that characteristic. Given 12 objects of assorted colors and shapes, the concrete-operational student can invariably pick out the ones that are round.

Classification is also related to reversibility. The ability to reverse a process mentally now allows the concrete-operational student to see that there is more than one way to classify a group of objects. The student understands, for example, that buttons can be classified by color, then reclassified by size or by the number of holes.
Seriation is the process of making an orderly arrangement from large to small or vice versa. This understanding of sequential relationships permits a student to construct a logical series in which $A < B < C$ (A is less than B is less than C) and so on. Unlike the preoperational child, the concrete-operational child can grasp the notion that $B$ can be larger than $A$ but smaller than $C$.

With the abilities to handle operations such as conservation, classification, and seriation, the student at the concrete-operational stage has finally developed a complete and very logical system of thinking. This system of thinking, however, is still tied to physical reality. The logic is based on concrete situations that can be organized, classified, or manipulated. Thus, children at this stage can imagine several different arrangements for the furniture in their rooms before they act. They do not have to solve the problem strictly through trial and error by actually making the arrangements. However, the concrete-operational child is not yet able to reason about hypothetical, abstract problems that involve the coordination of many factors at once. This kind of coordination is part of Piaget’s next and final stage of cognitive development.

In any grade you teach, a knowledge of concrete-operational thinking will be helpful. In the early grades, the students are moving toward this logical system of thought. In the middle grades, it is in full flower, ready to be applied and extended by your teaching. In the high school years, it is often used by students whose thinking may not have fully developed to the next stage—the stage of formal operations. The

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**Guidelines: Teaching the Preoperational Child**

Use concrete props and visual aids whenever possible.

**Examples**
1. When you discuss concepts such as “part,” “whole,” or “one-half,” use shapes on a felt board or cardboard “pizzas” to demonstrate.
2. Let children add and subtract with sticks, rocks, or colored chips.

Make instructions relatively short, using actions as well as words.

**Examples**
1. When giving instructions about how to enter the room after recess and prepare for social studies, ask a student to demonstrate the procedure for the rest of the class by walking in quietly, going straight to his or her seat, and placing the text, paper, and a pencil on his or her desk.
2. Explain a game by acting out one of the parts.
3. Show students what their finished papers should look like. Use an overhead projector or display examples where students can see them easily.

Don’t expect the students to be consistent in their ability to see the world from someone else’s point of view.

**Examples**
1. Avoid social studies lessons about worlds too far removed from the child’s experience.
2. Avoid long lectures on sharing. Be clear about rules for sharing or use of materials, but avoid long explanations of the rationales for the rules.

Be sensitive to the possibility that students may have different meanings for the same word or different words for the same meaning. Students may also expect everyone to understand words they have invented.

**Examples**
1. If a student protests, “I won’t take a nap. I’ll just rest!” be aware that a nap may mean something such as “changing into pajamas and being in my bed at home.”
2. Ask children to explain the meanings of their invented words.

Give children a great deal of hands-on practice with the skills that serve as building blocks for more complex skills such as reading comprehension.

**Examples**
1. Provide cut-out letters to build words.
2. Supplement paper-and-pencil tasks in arithmetic with activities that require measuring and simple calculations—cooking, building a display area for class work, dividing a batch of popcorn equally.

Provide a wide range of experiences in order to build a foundation for concept learning and language.

**Examples**
1. Take field trips to zoos, gardens, theaters, and concerts; invite storytellers to the class.
2. Give students words to describe what they are doing, hearing, seeing, touching, tasting, and smelling.

Seriation is the process of making an orderly arrangement from large to small or vice versa. This understanding of sequential relationships permits a student to construct a logical series in which $A < B < C$ ($A$ is less than $B$ is less than $C$) and so on.
In addition to the tasks shown here, other tasks involve the conservation of number, length, weight, and volume. These tasks are all achieved over the concrete-optional period.

<table>
<thead>
<tr>
<th>6–7 years</th>
<th>8–10 years</th>
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<tbody>
<tr>
<td><strong>Is there the same amount of water in each glass?</strong></td>
<td><strong>Does each of these two cows have the same amount of grass to eat?</strong></td>
</tr>
<tr>
<td><strong>Now is there the same amount of water in each glass, or does one have more?</strong></td>
<td><strong>Now does each cow have the same amount of grass to eat, or does one cow have more?</strong></td>
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<tr>
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<th>8–10 years</th>
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<tbody>
<tr>
<td><strong>Is there the same amount of clay in each ball?</strong></td>
<td><strong>Does each piece have the same amount of clay, or does one have more?</strong></td>
</tr>
<tr>
<td><strong>Now does each piece have the same amount of clay, or does one have more?</strong></td>
<td><strong>Does each cow have the same amount of grass to eat, or does one cow have more?</strong></td>
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*Figure 3.1 Some Piagetian Conservation Tasks*

*Guidelines* on the next page should give you ideas for teaching children who can apply concrete operations.

**Junior and Senior High: Formal Operations.** Some students remain at the concrete-operational stage throughout their school years, even throughout life. However, new experiences, usually those that take place in school, eventually present most students with problems that they cannot solve using concrete operations. What
happens when a number of variables interact, as in a laboratory experiment? Then a mental system for controlling sets of variables and working through a set of possibilities is needed. These are the abilities Piaget called formal operations.

You are packing for long trip, but want to pack light. How many different three-piece outfits (slacks, shirt, jacket) will you have if you include three shirts, three slacks, and three jackets (assuming of course that they all go together in fashion perfection)? Time yourself to see how long it takes to arrive at the answer.

At the level of formal operations, all the earlier operations and abilities continue in force; that is, formal thinking is reversible, internal, and organized in a system of interdependent elements. The focus of thinking shifts, however, from what is to what might be. Situations do not have to be experienced to be imagined. Ask a young child how life would be different if people did not sleep, and the child might say, “People do sleep!” In contrast, the adolescent who has mastered formal operations can consider contrary-to-fact questions. In answering, the adolescent demonstrates the hallmark of formal operations—hypothetico-deductive reasoning. The formal thinker can consider a hypothetical situation (people do not sleep) and reason deductively (from the general assumption to specific implications, such as longer workdays, more money spent on energy and lighting, or new entertainment industries). Formal operations also include inductive reasoning, or using specific observations to identify general principles. For example, the economist observes many specific changes in the stock market and attempts to identify general principles about economic cycles. Formal-operations problem-solving strategy in which an individual begins by identifying all the factors that might affect a problem and then deduces and systematically evaluates specific solutions.

Formal operations Mental tasks involving abstract thinking and coordination of a number of variables.

Hypothetico-deductive reasoning
operational thinkers can form hypotheses, set up mental experiments to test them, and isolate or control variables in order to complete a valid test of the hypotheses. This kind of reasoning is expected in the later grades (Bjorklund, 1989).

After elementary school, the ability to consider abstract possibilities is critical for much of mathematics and science. Most math is concerned with hypothetical situations, assumptions, and givens: “Let \( x = 10 \),” or “Assume \( x^2 + y^2 = z^2 \),” or “Given two sides and an adjacent angle. . ." Work in social studies and literature requires abstract thinking, too: “What did Wilson mean when he called World War I the ‘war to end all wars’?” “What are some metaphors for hope and despair in Shakespeare’s sonnets?” “What symbols of old age does T. S. Eliot use in The Waste Land?” “How do animals symbolize human character traits in Aesop’s fables?”

The organized, scientific thinking of formal operations requires that students systematically generate different possibilities for a given situation. For example, if a child capable of formal operations is asked, “How many different shirt/slacks/jacket outfits can you make using three of each kind of clothing?” the child can systematically identify the 27 possible combinations (did you get it right?). A concrete thinker might name just a few combinations, using each piece of clothing only once. The underlying system of combinations is not yet available.

The ability to think hypothetically, consider alternatives, identify all possible combinations, and analyze one’s own thinking has some interesting consequences for adolescents. Since they can think about worlds that do not exist, they often become interested in science fiction. Because they can reason from general principles to specific actions, they often are critical of people whose actions seem to contradict their principles. Adolescents can deduce the set of “best” possibilities and imagine ideal worlds (or ideal parents and teachers, for that matter). This explains why many students at this age develop interests in utopias, political causes, and social issues. They want to design better worlds, and their thinking allows them to do so. Adolescents can also imagine many possible futures for themselves and may try to decide which is best. Feelings about any of these ideals may be strong.

Another characteristic of this stage is adolescent egocentrism. Unlike egocentric young children, adolescents do not deny that other people may have different perceptions and beliefs; the adolescents just become very focused on their own ideas. They analyze their own beliefs and attitudes. This can lead to what Elkind (1981) calls the sense of an imaginary audience—the feeling that everyone is watching. Thus, adolescents believe that others are analyzing them: “Everyone noticed that I wore this shirt twice this week.” “The whole class thought my answer was dumb!” “Everybody is going to love my new CD.” You can see that social blunders or imperfections in appearance can be devastating if “everybody is watching.” Luckily, this feeling of being “on stage” seems to peak in early adolescence by age 14 or 15.

Do We All Reach the Fourth Stage? As we have just seen, most psychologists agree that there is a level of thinking more sophisticated than concrete operations. But the question of how universal formal-operational thinking actually is, even among adults, is a matter of debate. According to Neimark (1975), the first three stages of Piaget’s theory are forced on most people by physical realities. Objects really are permanent. The amount of water doesn’t change when it is poured into another glass. Formal operations, however, are not so closely tied to the physical environment. They may be the product of experience and of practice in solving hypothetical problems and using formal scientific reasoning. These abilities tend to be valued and taught in literate cultures, particularly in colleges and universities.

Piaget himself (1974) suggested that most adults may be able to use formal-operational thought in only a few areas where they have the greatest experience or interest. So do not expect every student in your junior high or high school class to be able to think hypothetically about all the problems you present. Students who have not learned to go beyond the information given to them are likely to fall by the wayside. Sometimes students find shortcuts for dealing with problems that are beyond their grasp; they may memorize formulas or lists of steps. These systems may be help-
ful for passing tests, but real understanding will take place only if students are able to go beyond this superficial use of memorization—only, in other words, if they learn to use formal-operational thinking. The Guidelines may help you support the development of formal operations with your students.

**SUMMARY**

**What are the main influences on cognitive development?** Piaget's theory of cognitive development is based on the assumption that people try to make sense of the world and actively create knowledge through direct experience with objects, people, and ideas. Maturation, activity, social transmission, and the need for equilibrium all influence the way thinking processes and knowledge develop. In response to these influences, thinking processes and knowledge develop through changes in the organization of thought (the development of schemes) and through adaptation—including the complementary processes of assimilation (incorporating into existing schemes) and accommodation (changing existing schemes).

**What is a scheme?** Schemes are the basic building blocks of thinking. They are organized systems of actions or thought that allow us to mentally represent or "think about" the objects and events in our world. Schemes may be very small and specific (grasping, recognizing a square), or they may be larger and more general (using a map in a new city). People adapt to their environment as they increase and organize their schemes.

**As children move from sensorimotor to formal-operational thinking, what are the major changes?** Piaget believed that young people pass through four stages as they develop: sensorimotor, preoperational, concrete-operational, and formal-operational. In the sensorimotor stage, infants explore the world through their senses and motor activity, and work toward mastering object permanence and performing goal-directed activities. In the preoperational stage, symbolic thinking and logical operations begin. Children in the stage of concrete operations can think logically about tangible situations and can demonstrate conservation, reversibility, classification, and seriation. The ability to perform hypothetico-deductive reasoning, coordinate a set of variables, and imagine other worlds marks the stage of formal operations.

**Key Terms**

<table>
<thead>
<tr>
<th>Accommodation, 32</th>
<th>Goal-directed Actions, 34</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adaptation, 32</td>
<td>Hypothetico-deductive Reasoning, 39</td>
</tr>
<tr>
<td>Adolescent Egocentrism, 40</td>
<td>Identity, 36</td>
</tr>
<tr>
<td>Assimilation, 32</td>
<td>Object Permanence, 33</td>
</tr>
<tr>
<td>Classification, 36</td>
<td>Operations, 35</td>
</tr>
<tr>
<td>Collective Monologue, 36</td>
<td>Organization, 32</td>
</tr>
<tr>
<td>Compensation, 36</td>
<td>Preoperational, 35</td>
</tr>
<tr>
<td>Concrete Operations, 36</td>
<td>Reversibility, 36</td>
</tr>
<tr>
<td>Conservation, 35</td>
<td>Reversible Thinking, 35</td>
</tr>
<tr>
<td>Decentering, 35</td>
<td>Schemes, 32</td>
</tr>
<tr>
<td>Disequilibrium, 33</td>
<td>Semiotic Function, 35</td>
</tr>
<tr>
<td>Egocentric, 35</td>
<td>Sensorimotor, 33</td>
</tr>
<tr>
<td>Equilibration, 33</td>
<td>Seriation, 37</td>
</tr>
<tr>
<td>Formal Operations, 39</td>
<td></td>
</tr>
</tbody>
</table>

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**GUIDELINES**

**HELPING STUDENTS TO USE FORMAL OPERATIONS**

**Continue to use concrete-operational teaching strategies and materials.**

**Examples**

1. Use visual aids such as charts and illustrations as well as somewhat more sophisticated graphs and diagrams.
2. Compare the experiences of characters in stories to students' experiences.

**Give students the opportunity to explore many hypothetical questions.**

**Examples**

1. Have students write position papers, then exchange these papers with the opposing side and debate topical social issues—the environment, the economy, national health insurance.
2. Ask students to write about their personal vision of a utopia; write a description of a universe that has no sex differences; write a description of Earth after humans are extinct.

**Give students opportunities to solve problems and reason scientifically.**

**Examples**

1. Set up group discussions in which students design experiments to answer questions.
2. Ask students to justify two different positions on animal rights, with logical arguments for each position.

**Whenever possible, teach broad concepts, not just facts, using materials and ideas relevant to the students’ lives.**

**Examples**

1. When discussing the Civil War, consider other issues that have divided the United States since then.
2. Use lyrics from popular songs to teach poetic devices, to reflect on social problems, and to stimulate discussion on the place of popular music in our culture.
Write the letter of the correct definition beside the word.

1. _______ Adaptation
2. _______ Assimilation
3. _______ Accommodation
4. _______ Equilibration
5. _______ Conservation

   a. Principle stating that some characteristics of an object remain the same despite changes in appearance
   b. Searching for balance between information from cognitive schemes and the environment
   c. Using new information to create new schemas or alter existing schemas
   d. Adjusting to the environment
   e. Fitting new information into the existing schemas

6. Joan knows the answer to the question posed by her high school teacher, but she is worried that the other students will laugh at her response. Joan's behavior is typical of:

   a. parent conservation
   b. adolescent egocentrism
   c. adolescent classification
   d. reversible thinking

7. Number the following in the order in which they appear in Piaget's stages of cognitive development:

   _______ Understands laws of conservation and is able to classify and seriate
   _______ Begins to make use of imitation, memory, and thought
   _______ Has difficulty seeing another person's point of view
   _______ Develops concerns about social issues

8. If we apply a particular scheme to an event or situation and the scheme does not produce a satisfying result, we are motivated to keep searching for a solution through assimilation and accommodation. The source of this motivation is:

   a. Adaptation
   b. Goal directed behaviors
   c. Reversible thinking
   d. Disequilibrium

9. True or false: _______ The main difference between concrete-operational children and formal operations children is the movement from reliance on physical realities to experiences tied to formal reasoning practices.

10. True or false: _______ A student's age tells you his or her stage of cognitive development.

REFLECT
A group of vocal parents wants you to introduce workbooks to teach basic arithmetic in your class for 4- and 5-year-olds. They seem to think that "play" with blocks, water, sand, clay, and so on is "wasted time." How would you respond?
Psychologists today recognize that the child’s culture shapes cognitive development by determining what and how the child will learn about the world. For example, young Zinacanteco Indian girls of southern Mexico learn complicated ways of weaving cloth through informal teachings of adults in their communities. In Brazil, without going to school, children who sell candy on the streets learn sophisticated mathematics in order to buy from wholesalers, sell, barter, and make a profit. Cultures that prize cooperation and sharing teach these abilities early, whereas cultures that encourage competition nurture competitive skills in their children (Bakerman et al., 1990; Ceci & Roazzi, 1994). The stages observed by Piaget are not necessarily “natural” for all children because to some extent they reflect the expectations and activities of Western cultures (Rogoff & Chavajay, 1995).

A major spokesperson for this sociocultural theory (also called sociohistoric) was a Russian psychologist who died more than 50 years ago. Lev Semenovich Vygotsky was only 38 when he died of tuberculosis, but during that time he produced over 100 books and articles. Some of the translations now available are Vygotsky (1978, 1986, 1987, 1993, 1997). Vygotsky’s work began when he was studying learning and development to improve his own teaching (Wink & Putney, 2002). Over his brief lifetime, he wrote about language and thought, the psychology of art, learning and development, and educating students with special needs. His work was banned in Russia for many years because he referenced Western psychologists. But in the past 25 years, with the rediscovery of his work, Vygotsky’s ideas about language, culture, and cognitive development have become major influences in psychology and education and have provided alternatives to many of Piaget’s theories (John-Steiner & Mahn, 1996; McCaslin & Hickey, 2001; Wink & Putney, 2002).

Vygotsky believed that human activities take place in cultural settings and cannot be understood apart from these settings. One of his key ideas was that our specific mental structures and processes can be traced to our interactions with others. These social interactions are more than simple influences on cognitive development—they actually create our cognitive structures and thinking processes (Palincsar, 1998). In fact, “Vygotsky conceptualized development as the transformation of socially shared activities into internalized processes” (John-Steiner & Mahn, 1996, p. 192). We will examine two themes in Vygotsky’s writings that explain how social processes form learning and thinking: the social sources of individual thinking and the role of tools in learning and development, especially the tool of language (Wertsch, 1991; Wertsch & Tulviste, 1992).

By the time you have completed this module, you should be able to answer these questions:

- How does interpsychological development become intrapsychological development?
- What are the similarities and differences between Piaget’s and Vygotsky’s ideas about cognitive development?

Sociocultural theory Emphasizes role in development of cooperative dialogues between children and more knowledgeable members of society. Children learn the culture of their community (ways of thinking and behaving) through these interactions.
The Social Sources of Individual Thinking

Vygotsky assumed that “every function in a child’s cultural development appears twice: first, on the social level and later on the individual level; first between people (interpsychological) and then inside the child (intrapsychological)” (1978, p. 57). In other words, higher mental processes appear first between people as they are co-constructed during shared activities. Then the processes are internalized by the child and become part of that child’s cognitive development. For example, children first use language in activities with others, to regulate the behavior of the others (“No nap!” or “I wanna cookie.”). Later, however, the child can regulate her own behavior using private speech (“don’t spill”), as you will see in a later section. So, for Vygotsky, social interaction was more than influence, it was the origin of higher mental processes such as problem solving. Consider this example:

A six-year-old has lost a toy and asks her father for help. The father asks her where she last saw the toy; the child says “I can’t remember.” He asks a series of questions—did you have it in your room? Outside? Next door? To each question, the child answers, “no.” When he says “in the car?” she says “I think so” and goes to retrieve the toy. (Tharp & Gallimore, 1988, p. 14)

Who remembered? The answer is really neither the father nor the daughter, but the two together. The remembering and problem solving was co-constructed—between people—in the interaction. But the child may have internalized strategies to use next time something is lost. At some point, the child will be able to function independently to solve this kind of problem. So, like the strategy for finding the toy, higher functions appear first between a child and a “teacher” before they exist within the individual child (Kozulin, 1990).

Here is another example of the social sources of individual thinking. This time the social source is other students and the type of thinking involved is reasoning. Richard Anderson and his colleagues (2001) studied how 4th graders in small-group classroom discussions appropriate (take for themselves and use) argument strategems that occur in the discussions. An argument strategem is a particular form such as “I think [POSITION] because [REASON],” where the student fills in the position and the reason. For example, a student might say, “I think that the wolves should be left alone because they are not hurting anyone.” Another strategy form is “If [ACTION] then [BAD CONSEQUENCE],” as in “If they don’t trap the wolves, then the wolves will eat the cows.” Other forms manage participation, for example, “What do you think [NAME]?” or “Let [NAME] talk.”

Anderson’s research identified 13 forms of talk and argument that helped to manage the discussion, get everyone to participate, present and defend positions, and handle confusion. The researchers found that the use of these different forms of talking and thinking snowballed—once a useful argument was employed by one student, it spread to other students and the argument strategem form appeared more and more in the discussions. Open discussions—students asking and answering each other’s questions—were better than teacher-dominated discussion for the development of these argument forms. Over time, these ways of presenting, attacking, and defending positions could be internalized as mental reasoning and decision making for the individual students.

Both Piaget and Vygotsky emphasized the importance of social interactions in cognitive development, but Piaget saw a different role for interaction. He believed that interaction encouraged development by creating disequilibrium—cognitive conflict—that motivated change. Thus, Piaget believed that the most helpful interactions were those between peers because peers are on an equal basis and can challenge each other’s thinking. Vygotsky (1978, 1986, 1987, 1993), on the other hand, suggested that children’s cognitive development is fostered by interactions with people who are more capable or advanced in their thinking—people such as parents and teachers (Moshman, 1997; Palinscar, 1998). Of course, as we have seen above, students can learn from both adults and peers.
Cultural Tools and Cognitive Development

Vygotsky believed that cultural tools, including real tools (such as printing presses, rulers, abacus—today, we would add PDAs, computers, the Internet) and symbolic tools (such as numbers and mathematical systems, Braille and sign language, maps, works of art, signs and codes, and language) play very important roles in cognitive development. For example, as long as the culture provides only Roman numerals for representing quantity, certain ways of thinking mathematically—from long division to calculus—are difficult or impossible. But if a number system has a zero, fractions, positive and negative values, and an infinite number of numbers, then much more is possible. The number system is a cultural tool that supports thinking, learning, and cognitive development. This symbol system is passed from adult to child through formal and informal interactions and teachings.

Vygotsky emphasized the tools that the culture provides to support thinking. He believed that all higher-order mental processes, such as reasoning and problem solving, are mediated by (accomplished through and with the help of) psychological tools, such as language, signs, and symbols. Adults teach these tools to children during day-to-day activities and the children internalize them. Then the psychological tools can help students advance their own development (Karpov & Haywood, 1998). The process is something like this: As children engage in activities with adults or more capable peers, they exchange ideas and ways of thinking about or representing concepts—drawing maps, for example, as a way to represent spaces and places. These co-created ideas are internalized by children. Thus, children’s knowledge, ideas, attitudes, and values develop through appropriating or “taking for themselves” the ways of acting and thinking provided by their culture and by the more capable members of their group (Kozulin & Presseisen, 1995).

In this exchange of signs and symbols and explanations, children begin to develop a “cultural tool kit” to make sense of and learn about their world (Wertsch, 1991). The kit is filled with physical tools such as pencils or paint brushes directed toward the external world and psychological tools such as problem-solving or memory strategies for acting mentally. Children do not just receive the tools, however. They transform the tools as they construct their own representations, symbols, patterns, and understandings. As we learned from Piaget, children’s constructions of meaning are not the same as those of adults. In the exchange of signs and symbols such as number systems, children create their own understandings. These understandings are gradually changed as the children continue to engage in social activities and try to make sense of their world (John-Steiner & Mahn, 1996; Wertsch, 1991).

In Vygotsky’s theory, language is the most important symbol system in the tool kit, and it is the one that helps to fill the kit with other tools.

The Role of Language and Private Speech

Language is critical for cognitive development. It provides a means for expressing ideas and asking questions, the categories and concepts for thinking, and the links between the past and the future (Das, 1995). When we consider a problem, we generally think in words and partial sentences. Vygotsky thought that

the specifically human capacity for language enables children to provide for auxiliary tools in the solution of difficult tasks, to overcome
impulsive action, to plan a solution to a problem prior to its execution, and to master their own behavior. (Vygotsky, 1978, p. 28)

If we study language across cultures, we see that different cultures need and develop different language tools.

**Language and Cultural Diversity.** In general, cultures develop words for the concepts that are important to them.

How many different shades of green can you name? If you have access to a purse, check out the different shades of lipstick inside.

In my purse I now have lipsticks called “sheer berry” and “529A” (well, the 99-cent lipsticks have given up on color names). English speaking countries have over 3,000 words for colors. Such words are important in our lives for fashion and home design, artistic expression, films and television, and lipstick and eye shadow choices—to name only a few areas (Price & Crapo, 2002). Other cultures care less about color. For example, the Hanunoo people of Midori Island in the Philippines or the Dani in New Guinea have fewer than five words for colors, even though they can recognize many color variations. Eskimos really don’t have hundreds of words for snow, but the Ulgunigamiut Eskimo do have more that 160 words for ice, because they have to recognize ice at different stages of freezing to hunt and live safely in their environment.

My mother grew up on a farm in Wisconsin and she can tell you many different words for horse: mare, foal, stallion, gelding, stud, colt, pony, work horse, jumper. Cultures that care about feelings have many word tools to talk about emotion. Think of the variety of words in English for anger (rage, resentment, disgust, pique, wrath, fury, exasperation, ire, hostility, animosity).

Languages change over time to indicate changing cultural needs and values. The Shoshoni Native Americans have one word that means “to make a crunching sound walking on the sand.” This word was valuable in the past to communicate about hunting, but today new words describing technical tools have been added to the Shoshoni language, as their life moves away from nomadic hunting. To hear hundreds of new 21st century tool words, listen to techies talk about computers (Price & Crapo, 2002).

Vygotsky placed more emphasis than Piaget on the role of learning and language in cognitive development. In fact, Vygotsky believed that language in the form of private speech (talking to yourself) guides cognitive development.

**Vygotsky’s and Piaget’s Views Compared.** If you have spent much time around young children, you know that they often talk to themselves as they play. Piaget called children’s self-directed talk “egocentric speech.” He assumed that this egocentric speech is another indication that young children can’t see the world through the eyes of others. They talk about what matters to them, without taking into account the needs or interests of their listeners. As they mature, and especially as they have disagreements with peers, Piaget believed, children develop socialized speech. They learn to listen and exchange ideas.

Vygotsky had very different ideas about young children’s **private speech.** Rather than being a sign of cognitive immaturity, Vygotsky suggested that these mutterings play an important role in cognitive development by moving children toward self-regulation, the ability to plan, monitor, and guide one’s own thinking and problem solving.

Vygotsky believed that self-regulation developed in a series of stages. First the child’s behavior is regulated by others, usually parents, using language and other signs such as gestures. For example, the parent says, “No!” when the child reaches toward a candle flame. Next the child learns to regulate the behavior of others using the same language tools. The child says, “No!” to another child who is trying to take away a toy, often even imitating the parent’s voice tone. Along with learning to use external speech to regulate others, the child begins to use private speech to regulate her own
behavior, saying “no” quietly to herself as she is tempted to touch the flame. Finally the child learns to regulate her own behavior by using silent inner speech (Karpov & Haywood, 1998). This series of steps is another example of how higher mental functions appear first between people as they communicate and regulate each others’ behavior, and then emerge again within the individual as cognitive processes.

So children using private speech are communicating—they are communicating with themselves to guide their behavior and thinking. In any preschool room you might hear 4- or 5-year-olds saying, “No, it won’t fit. Try it here. Turn. Turn. Maybe this one!” while they do puzzles. As these children mature, their self-directed speech goes underground, changing from spoken to whispered speech and then to silent lip movements. Finally, the children just “think” the guiding words. The use of private speech peaks at around 5 to 7 years of age and has generally disappeared by 9 years of age. Brighter children seem to make this transition earlier (Bee, 1992).

Vygotsky identified this transition from audible private speech to silent inner speech as a fundamental process in cognitive development. Through this process the child is using language to accomplish important cognitive activities such as directing attention, solving problems, planning, forming concepts, and gaining self-control. Research supports Vygotsky’s ideas (Berk & Spuhl, 1995; Bivens & Berk, 1990; Diaz & Berk, 1992; Kohlberg, Yaeger, & Hjertholm, 1969). Children tend to use more private speech when they are confused, having difficulties, or making mistakes. Inner speech not only helps us solve problems but also allows us to regulate our behavior. Have you ever thought to yourself something like, “Let’s see, the first step is . . . ” or “Where did I use my glasses last?” or “If I work to the end of this page, then I can . . . ”? You were using inner speech to remind, cue, encourage, or guide yourself. In a really tough situation, such as taking an important test, you might even find that you return to muttering out loud. Table 4.1 contrasts Piaget’s and Vygotsky’s theories of private speech. We should note that Piaget accepted many of Vygotsky’s arguments and came to agree that language could be used in both egocentric and problem-solving ways (Piaget, 1962).

Self-Talk and Learning. Because private speech helps students to regulate their thinking, it makes sense to allow, and even encourage, students to use private speech in school. Insisting on total silence when young students are working on difficult problems may make the work even harder for them. You may notice when muttering increases—this could be a sign that students need help. One approach,

### Table 4.1

<table>
<thead>
<tr>
<th>Developmental Significance</th>
<th>Piaget</th>
<th>Vygotsky</th>
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<tbody>
<tr>
<td>Represents an inability to take the perspective of another and engage in reciprocal communication.</td>
<td>—</td>
<td>Represents externalized thought; its function is to communicate with the self for the purpose of self-guidance and self-direction.</td>
</tr>
<tr>
<td>Course of Development</td>
<td>Declines with age.</td>
<td>Increases at younger ages and then gradually loses its audible quality to become internal verbal thought.</td>
</tr>
<tr>
<td>Relationship to Social Speech</td>
<td>Negative; least socially and cognitively mature children use more egocentric speech.</td>
<td>Positive; private speech develops out of social interaction with others.</td>
</tr>
<tr>
<td>Relationship to Environmental Contexts</td>
<td>—</td>
<td>Increases with task difficulty. Private speech serves a helpful self-guiding function in situations where more cognitive effort is needed to reach a solution.</td>
</tr>
</tbody>
</table>

called cognitive self-instruction, teaches students to use self-talk to guide learning. For example, students learn to give themselves reminders to go slowly and carefully.

The Role of Learning and Development

Another question in the study of cognitive development concerns the role of learning and development—which one comes first?

Vygotsky’s and Piaget’s Views Compared. Piaget defined development as the active construction of knowledge and learning as the passive formation of associations (Siegler, 2000). He was interested in knowledge construction and believed that cognitive development has to come before learning—the child had to be cognitively “ready” to learn. He said that “learning is subordinated to development and not vice-versa” (Piaget, 1964, p. 17). Students can memorize, for example, that Geneva is in Switzerland, but still insist that they cannot be Genevan and Swiss at the same time. True understanding will happen only when the child has developed the operation of class inclusion—one category can be included in another. In contrast, Vygotsky believed that learning was an active process that does not have to wait for readiness. In fact, “properly organized learning results in mental development and sets in motion a variety of developmental processes that would be impossible apart from learning” (Vygotsky, 1978, p. 90). He saw learning as a tool in development—learning pulls development up to higher levels and social interaction is a key in learning (Glassman, 2001; Wink & Putney, 2002).

Vygotsky’s belief that learning pulls development to higher levels means that other people play a significant role in cognitive development.

The Role of Adults and Peers

Vygotsky believed that cognitive development occurs through the child’s conversations and interactions with more capable members of the culture—adults or more able peers. These people serve as guides and teachers, providing the information and support necessary for the child to grow intellectually. Thus, the child is not alone in the world “discovering” the cognitive operations of conservation or classification. This discovery is assisted or mediated by family members, teachers, and peers. Most of this guidance is communicated through language, at least in Western cultures. In some cultures, observing a skilled performance, not talking about it, guides the child’s
learning (Rogoff, 1990). Jerome Bruner called this adult assistance scaffolding (Wood, Bruner, & Ross, 1976). The term aptly suggests that children use this help for support while they build a firm understanding that will eventually allow them to solve the problems on their own.

**SUMMARY**

**Explain how interpsychological development becomes intrapsychological development.** Higher mental processes appear first between people as they are co-constructed during shared activities. As children engage in activities with adults or more capable peers, they exchange ideas and ways of thinking about or representing concepts. These co-created ideas are internalized by children. Thus children's knowledge, ideas, attitudes, and values develop through appropriating, or "taking for themselves," the ways of acting and thinking provided by their culture and by the more capable members of their group.

**What are the differences between Piaget’s and Vygotsky’s perspectives on private speech and its role in development?** Vygotsky’s sociocultural view asserts that cognitive development hinges on social interaction and the development of language. As an example, Vygotsky describes the role of children’s self-directed talk in guiding and monitoring thinking and problem solving, while Piaget suggested that private speech was an indication of the child’s egocentrism. Vygotsky, more than Piaget, emphasized the significant role played by adults and more able peers in children’s learning. This adult assistance provides early support while students build the understanding necessary to solve problems on their own later.

**Key Terms**

<table>
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<tr>
<th>Co-constructed Process</th>
<th>Scaffolding</th>
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</thead>
<tbody>
<tr>
<td>Cultural Tools</td>
<td>44</td>
</tr>
<tr>
<td>Private Speech</td>
<td>46</td>
</tr>
<tr>
<td>Sociocultural Theory</td>
<td>43</td>
</tr>
</tbody>
</table>

Scaffolding  Support for learning and problem solving. The support could be clues, reminders, encouragement, breaking the problem down into steps, providing an example, or anything else that allows the student to grow in independence as a learner.
1. _______ Sociocultural theory
2. _______ Language
3. _______ Co-constructed process
4. _______ Cultural tools
5. _______ Private speech

a. Guides thinking and action and eventually is internalized as silent inner speech
b. People interact and negotiate to create an understanding or to solve a problem. The final product is shaped by all participants
c. According to Vygotsky, this is the most important cultural tool
d. Emphasizes the role of development of cooperative dialogues between knowledgeable members of society. Children learn the culture of their community through these interactions
e. Computers, scales, numbers, language, graphs, etc. that allow people to communicate, think, solve problems, and create knowledge

6. Piaget's Theory of Cognitive Development and Vygotsky's Sociocultural Theory are different because:
   a. Piaget emphasized the important effects of the child's cultural and social groups
   b. Vygotsky believed that human activities take place in cultural settings and cannot be understood apart from these settings
   c. Piaget emphasized expectations and activities of all cultures, not just Western groups.
   d. None of the above

7. A child cannot find her school shoes. She asked her father for help. The father begins questioning her, "Do you see your shoes under your bed, by the door, in your closet?" To each question she answers, "No!" Finally, the father asks if she checked under the kitchen table and she says, "Yes! That’s where they are." According to Vygotsky, what procedure took place that eventually led to the finding of the shoes?
   a. Cultural tools
   b. Sociocultural theory
   c. Co-constructed process
   d. Private speech

8. According to Vygotsky, children use private speech to:
   a. Regulate their behavior
   b. Alleviate confusion
   c. Organize their thinking
   d. All of the above

9. True or false: Vygotsky believed that the most helpful interactions were those between peers because peers are on an equal basis and can challenge each other's thinking.

10. True or false: Vygotsky emphasized the importance of a teacher insisting on total silence when young students are working on difficult problems.

**REFLECT**

It seems as if every fourth word from the mouths of your 9th grade students is *like* or *you know*. Also, their understanding of the material in your class is limited, because they don’t know the meaning of many words that you assumed high school students would certainly understand, such as *former* and *latter*. What would you do to encourage language development along with teaching your subject?
Piaget did not make specific educational recommendations. He was more interested in understanding children’s thinking. He did express some general ideas about educational philosophy, however. He believed that the main goal of education should be to help children learn how to learn, and that education should “form not furnish” the minds of students (Piaget, 1969, p. 70). Even though Piaget did not design programs of education based on his ideas, many other people have. For example, the National Association for the Education of Young Children has guidelines for developmentally appropriate education that incorporate Piaget’s findings (Bredekamp & Copple, 1997). Piaget has taught us that we can learn a great deal about how children think by listening carefully, by paying close attention to their ways of solving problems. If we understand children’s thinking, we will be better able to match teaching methods to children’s abilities.

**Understanding and Building on Students’ Thinking**

The students in any class will vary greatly in both their level of cognitive development and their academic knowledge. As a teacher, how can you determine whether students are having trouble because they lack the necessary thinking abilities or because they simply have not learned the basic facts? To do this, Case (1985b) suggests you observe your students carefully as they try to solve the problems you have presented. What kind of logic do they use? Do they focus on only one aspect of the situation? Are they fooled by appearances? Do they suggest solutions systematically or by guessing and forgetting what they have already tried? Ask your students how they tried to solve the problem. Listen to their strategies. What kind of thinking is behind repeated mistakes or problems? The students are the best sources of information about their own thinking abilities (Confrey, 1990a).

An important implication of Piaget’s theory for teaching is what Hunt years ago (1961) called “the problem of the match.” Students must be neither bored by work that is too simple nor left behind by teaching they cannot understand. According to Hunt, disequilibrium must be kept “just right” to encourage growth. Setting up situations that lead to errors can help create an appropriate level of disequilibrium. When students experience some conflict between what they think should happen (a piece of wood should sink because it is big) and what actually happens (it floats!), they may rethink the situation, and new knowledge may develop.

It is worth pointing out, too, that many materials and lessons can be understood at several levels and can be “just right” for a range of cognitive abilities. Classics such as *Alice in Wonderland*, myths, and fairy tales can be enjoyed at both concrete and symbolic levels. It is also possible for students to be introduced to a topic together, then work individually on follow-up activities matched to their level. Tom Good and Jere Brophy (2003) describe activity cards for three or four ability levels. These cards

By the time you complete this module, you should be able to answer these questions:

- What are the implications of Piaget’s and Vygotsky’s theories for teaching students of different ages?
- What is active learning? Why is Piaget’s theory of cognitive development consistent with active learning?
- What is assisted learning, and what role does scaffolding play?
- What is a student’s zone of proximal development?
provide different readings and assignments, but all are directed toward the overall class objectives. One of the cards should be a good “match” for each student.

**Activity and Constructing Knowledge**

Piaget’s fundamental insight was that individuals *construct* their own understanding; learning is a constructive process. At every level of cognitive development, you will also want to see that students are actively engaged in the learning process. In his words:

Knowledge is not a copy of reality. To know an object, to know an event, is not simply to look at it and make a mental copy or image of it. To know an object is to act on it. To know is to modify, to transform the object, and to understand the process of this transformation, and as a consequence to understand the way the object is constructed. (Piaget, 1964, p. 8)

This active experience, even at the earliest school levels, should not be limited to the physical manipulation of objects. It should also include mental manipulation of ideas that arise out of class projects or experiments (Ginsburg & Opper, 1988). For example, after a social studies lesson on different jobs, a primary-grade teacher might show the students a picture of a woman and ask, “What could this person be?” After answers such as “teacher,” “doctor,” “secretary,” “lawyer,” “saleswoman,” and so on, the teacher could suggest, “How about a daughter?” Answers such as “sister,” “mother,” “aunt,” and “granddaughter” may follow. This should help the children switch dimensions in their classification and center on another aspect of the situation. Next, the teacher might suggest “American,” “jogger,” or “blonde.” With older children, hierarchical classification might be involved: It is a picture of a woman, who is a human being; a human being is a primate, which is a mammal, which is an animal, which is a life form.

All students need to interact with teachers and peers in order to test their thinking, to be challenged, to receive feedback, and to watch how others work out problems. Disequilibrium is often set in motion quite naturally when the teacher or another student suggests a new way of thinking about something. As a general rule, students should act, manipulate, observe, and then talk and/or write (to the teacher and each other) about what they have experienced. Concrete experiences provide the raw materials for thinking. Communicating with others makes students use, test, and sometimes change their thinking abilities.

**The Value of Play**

Maria Montessori once noted, and Piaget would agree, “Play is children’s work.” We saw that the brain develops with stimulation, and play provides some of that stimulation at every age. Babies in the sensorimotor stage learn by exploring, sucking, pounding, shaking, throwing—acting on their environments. Preoperational preschoolers love pretend play and through pretending form symbols, use language, and interact with others. They are beginning to play simple games with predictable rules. Elementary school-age children also like fantasy, but also are beginning to play more complex games and sports, and thus learn cooperation, fairness, negotiation, winning, and losing as well as developing language. As children grow into adolescents, play continues to be part of their physical and social development (Meece, 2002).

Piaget taught us that children do not think like adults. His influence on developmental psychology and education has been enormous, even though recent research has not supported all of his ideas.
Some Limitations of Piaget’s Theory

Although most psychologists agree with Piaget’s insightful descriptions of how children think, many disagree with his explanations of why thinking develops as it does.

The Trouble with Stages. Some psychologists have questioned the existence of four separate stages of thinking, even though they agree that children do go through the changes that Piaget described (Gelman & Baillargeon, 1983; Miller, 2002). One problem with the stage model is the lack of consistency in children’s thinking. For example, children can conserve number (the number of blocks does not change when they are rearranged) a year or two before they can conserve weight (a ball of clay does not change when you flatten it). Why can’t they use conservation consistently? in every situation? Piagetian theorists have tried to deal with these inconsistencies, but not all psychologists are convinced by their explanations (Case, 1998; Orlando & Machado, 1996; Seigler, 1998). In fairness, we should note that in his later work, even Piaget put less emphasis on stages of cognitive development and gave more attention to how thinking changes through equilibration (Miller, 2002).

Another problem with the idea of separate stages is that, when “viewed from afar, many changes in children’s thinking appear discontinuous; when viewed from close up, the same changes often appear as part of a continuous, gradual progression” (Siegler, 1998, p. 55). For example, rather than appearing all at once, object permanence may develop gradually as children’s memories develop. The longer you make the infants wait before searching, the older they have to be to succeed—so the problem may be with memory and not with knowing that things still exist when out of sight. Siegler notes that change can be both continuous and discontinuous, as described by a branch of mathematics called catastrophe theory. Changes that appear suddenly, like the collapse of a bridge, are preceded by many slowly developing changes such as gradual, continuous corrosion of the metal structures. Similarly, gradually developing changes in children can lead to large changes in abilities that seem abrupt (Fischer & Pare-Blagoev, 2000).

Some psychologists have pointed to research on the brain to support Piaget’s stage model. Epstein (1978, 1980) observed changes in rates of growth in brain weight and skull size and changes in the electrical activity of the brain between infancy and adolescence. These growth spurts occur at about the same time as transitions between the stages described by Piaget. Evidence from animal studies indicates that infant rhesus monkeys show dramatic increases in synaptic (nerve) connections throughout the brain cortex at the same time that they master the kinds of sensorimotor problems described by Piaget. This may be true in human infants as well. Transition to the higher cognitive states in humans has also been related to changes in the brain, such as production of additional synaptic connections (Byrnes & Fox, 1998). Thus, there is some neurological evidence for stages.

Underestimating Children’s Abilities. It now appears that Piaget underestimated the cognitive abilities of children, particularly younger ones. The problems he gave young children may have been too difficult and the directions too confusing. His subjects may have understood more than they could show on these problems. For example, work by Gelman and her colleagues (Carey & Gelman, 1991; Miller & Gelman,
1983) shows that preschool children know much more about the concept of number than Piaget thought, even if they sometimes make mistakes or get confused. As long as preschoolers work with only three or four objects at a time, they can tell that the number remains the same, even if the objects are spread far apart or clumped close together. In other words, we may be born with a greater store of cognitive tools than Piaget suggested. Some basic understandings, such as the permanence of objects or the sense of number, may be part of our evolutionary equipment, ready for use in our cognitive development.

Piaget’s theory does not explain how even young children can perform at an advanced level in certain areas where they have highly developed knowledge and expertise. An expert 9-year-old chess player may think abstractly about chess moves, while a novice 20-year-old player may have to resort to more concrete strategies to plan and remember moves (Seigler, 1998). As John Flavell (1985) noted, “the expert [child] looks very, very smart—very ‘cognitively mature’—when functioning in her area of expertise” (p. 83).

Cognitive Development and Information Processing. As you will see in Module 18, there are alternative explanations for why children have trouble with conservation and other Piagetian tasks. These explanations focus on the child’s developing information processing skills such as attention, memory capacity, and learning strategies. Siegler (1998) proposes that as children grow older, they develop progressively better rules and strategies for solving problems and for thinking logically. Teachers can help students develop their capacities for formal thinking by putting the students in situations that challenge their thinking and reveal the shortcomings of their logic. Siegler’s approach is called rule assessment because it focuses on understanding, challenging, and changing the rules that students use for thinking.

Some developmental psychologists have devised neo-Piagetian theories that retain Piaget’s insights about children’s construction of knowledge and the general trends in children’s thinking, but add findings from information processing about the role of attention, memory, and strategies. For example, Robbie Case (1992, 1998) has devised an explanation of cognitive development suggesting that children develop in stages within specific domains such as numerical concepts, spatial concepts, social tasks, storytelling, reasoning about physical objects, and motor development. As children practice using the schemes in a particular domain (for example, using counting schemes in the number concept area), accomplishing the schemes takes less attention. The schemes become more automatic because the child does not have to “think so hard” about it. This frees up mental resources and memory to do more. The child now can combine simple schemes into more complex ones and invent new schemes when needed (assimilation and accommodation in action).

Within each domain such as numerical concepts or social skills, children move from grasping simple schemes during the early preschool years, to merging two schemes into a unit (between about ages 4 and 6), to coordinating these scheme units into larger combinations, and finally, by about ages 9 to 11, to forming complex relationships that can be applied to many problems (Berk, 2002; Case, 1992, 1998). Children do progress through these qualitatively different stages within each domain, but Case argues that progress in one domain does not automatically affect movement in another. The child must have experience and involvement with the content and the ways of thinking within each domain in order to construct increasingly complex and useful schemes and coordinated conceptual understandings about the domain.
so basic to people of other cultures. For example, when individuals from the Kpelle people of Africa were asked to sort 20 objects, they created groups that made sense to them—a hoe with a potato, a knife with an orange. The experimenter could not get the Kpelle to change their categories; they said this is how a wise man would do it. Finally the experimenter asked in desperation, “Well, how would a fool do it?” Then the subjects promptly created the four neat classification piles the experimenter had expected—food, tools, and so on (Rogoff & Morelli, 1989).

Assisted Learning

There are at least three ways that cultural tools can be passed from one individual to another: imitative learning (where one person tries to imitate the other), instructed learning (where learners internalize the instructions of the teacher and use these instructions to self-regulate), and collaborative learning (where a group of peers strives to understand each other and learning occurs in the process) (Tomasello, Kruger, & Rathner, 1993). Vygotsky was most concerned with instructed learning though direct teaching or through structuring experiences that support another’s learning, but his theory supports the other forms of cultural learning as well. Thus, Vygotsky’s ideas are relevant for educators who teach directly and also create learning environments (Das, 1995; Wink & Putney, 2002). One major aspect of teaching in either situation is assisted learning.

Vygotsky’s theory suggests that teachers need to do more than just arrange the environment so that students can discover on their own. Children cannot and should not be expected to reinvent or rediscover knowledge already available in their cultures. Rather, they should be guided and assisted in their learning—so Vygotsky saw teachers, parents, and other adults as central to the child’s learning and development (Karpov & Haywood, 1998).

Assisted learning, or guided participation in the classroom, requires scaffolding—giving information, prompts, reminders, and encouragement at the right time and in the right amounts, and then gradually allowing the students to do more and more on their own, as Tamara did with her class. Teachers can assist learning by adapting materials or problems to students’ current levels; demonstrating skills or thought processes; walking students through the steps of a complicated problem; doing part of the problem (for example, in algebra, the students set up the equation and the teacher does the calculations or vice versa); giving detailed feedback and allowing revisions; or asking questions that refocus students’ attention (Rosenshine & Meister, 1992). Cognitive self-instruction is an example of assisted learning. Cognitive apprenticeships and instructional conversations (Module 26) are other examples. Look at Table 5.1 on page 56 for examples of strategies that can be used in any lesson.

How can you know what kind of help to give and when to give it? One answer has to do with the student’s zone of proximal development.

The Zone of Proximal Development

According to Vygotsky, at any given point in development there are certain problems that a child is on the verge of being able to solve. The child just needs some structure, clues, reminders, help with remembering details or steps, encouragement to keep trying, and so on. Some problems, of course, are beyond the child’s capabilities, even if every step is explained clearly. The zone of proximal development is the area where the child cannot solve a problem alone, but can be successful under adult guidance or in collaboration with a more advanced peer (Wertsch, 1991). This is the area where instruction can succeed, because real learning is possible.
Private Speech and the Zone. We can see how Vygotsky’s beliefs about the role of private speech in cognitive development fit with the notion of the zone of proximal development. Often, an adult helps a child to solve a problem or accomplish a task using verbal prompts and structuring. This scaffolding may be gradually reduced as the child takes over the guidance, perhaps first by giving the prompts as private speech and finally as inner speech. Let’s move forward to a future day in the life of the girl in the example on page 44 who had lost her toy and listen to her thoughts when she realizes that a schoolbook is missing. They might sound something like this:

“Where’s my math book? Used it in class. Thought I put it in my bookbag after class. Dropped my bag on the bus. That dope Larry kicked my stuff, so maybe...”

The girl can now systematically search for ideas about the lost book without help from anyone else.

Teaching. Students should be put in situations where they have to reach to understand, but where support from other students or from the teacher is also available. Sometimes the best teacher is another student who has just figured out the problem, because this student is probably operating in the learner’s zone of proximal development. Students should be guided by explanations, demonstrations, and work with other students—opportunities for cooperative learning. Having a student work with someone who is just a bit better at the activity would also be a good idea. In addition, students should be encouraged to use language to organize their thinking and to talk about what they are trying to accomplish. Dialogue and discussion are important avenues to learning (Karpov & Bransford, 1995; Kozulin & Presseisen, 1995; Wink & Putney, 2002). The Guidelines give more ideas for applying Vygotsky’s ideas.

### Table 5.1 Assisted Learning: Strategies to Scaffold Complex Learning

- **Procedural facilitators.** These provide a "scaffold" to help students learn implicit skills. For example, a teacher might encourage students to use "signal words" such as who, what, where, when, why, and how to generate questions after reading a passage.
- **Modeling use of facilitators.** The teacher in the above example might model the generation of questions about the reading.
- **Thinking out loud.** This models the teacher’s expert thought processes, showing students the revisions and choices the learner makes in using procedural facilitators to work on problems.
- **Anticipating difficult areas.** During the modeling and presentations phase of instructions, for example, the teacher anticipates and discusses potential student errors.
- **Providing prompt or cue cards.** Procedural facilitators are written on "prompt cards" that students keep for reference as they work. As students practice, the cards gradually become unnecessary.
- **Regulating the difficulty.** Tasks involving implicit skills are introduced by beginning with simpler problems, providing for student practice after each step, and gradually increasing the complexity of the task.
- **Providing half-done examples.** Giving students half-done examples of problems and having them work out the conclusions can be an effective way to teach students how to ultimately solve problems on their own.
- **Reciprocal teaching.** Having the teacher and students rotate the role of teacher. The teacher provides support to students as they learn to lead discussions and ask their own questions.
- **Providing checklists.** Students can be taught self-checking procedures to help them regulate the quality of their responses.

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GUIDELINES  Applying Vygotsky’s Ideas in Teaching

Tailor scaffolding to the needs of students.

Examples
1. When students are beginning new tasks or topics, provide models, prompts, sentence starters, coaching, and feedback. As the students grow in competence, give less support and more opportunities for independent work.
2. Give students choices about the level of difficulty or degree of independence in projects; encourage them to challenge themselves but to seek help when they are really stuck.

Make sure students have access to powerful tools that support thinking.

Examples
1. Teach students to use learning and organizational strategies, research tools, language tools (dictionaries or computer searches), spreadsheets, and word processing programs.

2. Model the use of tools; show students how you use an appointment book or electronic notebook to make plans and manage time, for example.

Capitalize on dialogue and group learning.

Examples
1. Experiment with peer tutoring; teach students how to ask good questions and give helpful explanations.
2. Experiment with cooperative learning strategies described in Module 37.

What is the “problem of the match” described by Hunt?
The “problem of the match” is that students must be neither bored by work that is too simple nor left behind by teaching they cannot understand. According to Hunt, disequilibrium must be carefully balanced to encourage growth. Situations that lead to errors can help create an appropriate level of disequilibrium.

What is active learning? Why is Piaget’s theory of cognitive development consistent with active learning?
Piaget’s fundamental insight was that individuals construct their own understanding; learning is a constructive process. At every level of cognitive development, students must be able to incorporate information into their own schemes. To do this, they must act on the information in some way. This active experience, even at the earliest school levels, should include both physical manipulation of objects and mental manipulation of ideas. As a general rule, students should act, manipulate, observe, and then talk and/or write about what they have experienced. Concrete experiences provide the raw materials for thinking. Communicating with others makes students use, test, and sometimes change their thinking abilities.

What are some limitations of Piaget’s theory? Piaget’s theory has been criticized because children and adults often think in ways that are inconsistent with the notion of invariant stages. It also appears that Piaget underestimated children’s cognitive abilities. Alternative explanations place greater emphasis on students’ developing information processing skills and ways teachers can enhance their development. Piaget’s work is also criticized for overlooking cultural factors in child development.

What is assisted learning, and what role does scaffolding play? Assisted learning, or guided participation in the classroom, requires scaffolding—giving information, prompts, reminders, and encouragement at the right time and in the right amounts, and then gradually allowing the students to do more and more on their own. Teachers can assist learning by adapting materials or problems to students’ current levels, demonstrating skills or thought processes, walking students through the steps of a complicated problem, doing part of the problem, giving detailed feedback and allowing revisions, or asking questions that refocus students’ attention.

What is a student’s zone of proximal development?
At any given point in development there are certain problems that a child is on the verge of being able to solve and others that are beyond the child’s capabilities. The zone of proximal development is the area where the child cannot solve a problem alone, but can be successful under adult guidance or in collaboration with a more advanced peer.

Key Terms

<table>
<thead>
<tr>
<th>Assisted Learning, 55</th>
<th>Zone of Proximal Development, 55</th>
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<td>Neo-Piagetian Theories, 54</td>
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Write the letter of the correct definition beside the word.

1. _______ Assisted learning
2. _______ Zone of proximal development
3. _______ Neo-Piagetian theories
4. _______ “Form not furnish” children’s minds
5. _______ Play
   
   a. According to Piaget, this is one of the main goals of education
   b. Providing strategic help in the initial stages of learning, gradually diminishing as students gain independence
   c. Provides stimulation that allows the brain to develop
   d. Hypothesis about children’s thinking and construction of knowledge integrated with finding from attention, memory, and strategy research
   e. Phase at which child can master a task if given appropriate help and support

6. The National Association for the Education of Young Children (NAEYC) incorporates Piaget’s theories into its standards, by emphasizing
   
   a. Teachers must listen to what children say
   b. The importance of developmentally appropriate education
   c. The essential role parents play in the learning progression of young children
   d. The need to match teaching methods to the abilities of the children

7. “Importance of match” is one of the many implications of Piaget’s theory that states
   
   a. There is a degree of appropriateness in including some material students may consider boring
   b. Students should be placed in classrooms based on their personality “match” with respective teachers
   c. Just the right level of disequilibrium must be fostered to encourage cognitive growth
   d. All of the above

8. Ways to apply Vygotsky’s ideas in teaching include:
   
   a. Tailor scaffolding to the needs of students
   b. Make sure students have access to powerful tools that support learning
   c. Capitalize on dialogue and group learning
   d. All of the above

9. True or false: _______ Piaget and Vygotsky would agree that children should be put in situations where they have to reach to understand, but where support from other students or from the teacher is also available.

Reflect

The students in your 6th grade class persist in memorizing definitions for many of the important abstract concepts you are trying to teach. They insist, “That’s what you have to do to make a good grade.” Even though they can repeat the definitions precisely, they seem to have no conception of what the terms mean; they can’t recognize examples of the concept in problems or give their own examples. It is almost as if they don’t believe there is any real hope of understanding the ideas. What strategies based on the work of Piaget and/or Vygotsky might you use to help these students understand a difficult concept?
Teachers’ Casebook

What Would They Do?

Here is how some practicing teachers responded to the teaching situation presented at the beginning of this cluster about teaching abstract concepts such as “symbol.”

Linda Glisson and Sue Middleton
Fifth Grade Team Teachers, St. James Episcopal Day School, Baton Rouge, Louisiana

To begin the lesson, I would have the students use a dictionary to define the word symbolism (root word—symbol) to discover that it means “something that stands for or represents something else.” I would then give them a brief “across the curriculum” exercise in ways they incorporate symbols and symbolism into their thinking every day. For example: (social studies, American history): The American flag is just a piece of cloth. Why then do we recite a pledge to it? Stand at attention when it passes in a parade? What does it stand for? (English, literature—fables and fairy tales): What does the wolf usually represent (stand for)? The lion? The lamb? (Art): What color stands for a glorious summer day? Evil? Goodness and purity? I would continue with math symbols, scientific symbols, and music symbols and lead the students toward contributing other examples such as symbols representing holidays. I would then tell them about their own examples of symbolism that I had recorded. The students’ participation in and enthusiasm for the exercises would serve to determine whether they were ready for the material.

Madya Ayala
High School Teacher of Preparatoria Eugenio Garza Lagüera, Campus Garza Sada, Monterrey, N.L. Mexico

Since the students’ experience is concrete, they respond using corporal symbols that they can relate to. Thus, rather than using verbal analogies, I would use visual images, which are more concrete. For example, I would use familiar examples, such as a heart drawn on the blackboard, and then ask the students what the heart represents. I would also take the opportunity to invert this approach. For example, I would ask students to think about the beach, and then ask them to represent it with one symbol.

Carol Grosberg
Fifth Grade Teacher, Bates School, Wellesley, Massachusetts

It has been my experience that students at the 5th grade level are capable of understanding and actually enjoy learning about homonyms, homophones, and homographs. After giving these students an explanation about the difference between them, I would challenge them to create a list of as many of them as they can.

Dr. Nancy Sheehan-Melzack
Art and Music Teacher, Snug Harbor Community School, Quincy, Massachusetts

Even very young children can recognize symbols if the symbol is presented first and the explanation required second. A drawing of an octagon on a pole has always elicited the answer, “A stop sign,” whenever I have shown it. Children recognize symbols, but the teacher needs to work from their concrete knowledge to the more abstract concept, and there are a great many symbols in their daily life on which one can draw. Children as young as 1st graders can recognize traffic sign shapes, letters of the alphabet, and numbers, and further recognize that they stand for directions, sounds, and how many. When they talk about these very common symbols, they can also realize they all use them for the same meaning.

Valerie A. Chilcoat
Fifth/Sixth Grade Advanced Academics, Glenmount School, Baltimore, Maryland

Concrete examples of symbolism must come from the students’ own world. Street signs, especially those with pictures and not words, are a great example. These concrete symbols, however, are not exactly the same as symbolism used in poetry. The link has to be made from the concrete to the abstract. Silly poetry is one way to do this. It is motivating to the students to read or listen to, and it can provide many examples of one thing acting as another. This strategy can also be used in lower grades to simply expose children to poetry containing symbolism.

Go to the Companion Website (www.ablongman.com/woolfolk) for additional case studies including audio and video cases, and examples of student work.