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1 THE STUDY OF EDUCATIONAL PSYCHOLOGY

LEARNING OBJECTIVES

After reading this chapter, you should be able to do the following:

1.1 Define *educational psychology* and provide examples of its application in the classroom.

1.2 Explain the psychological study of teaching and learning, including the four tenets of science; the differences among facts, principles, and theories; the determination of a theory's accuracy; and factors affecting the accuracy of judgments.

1.3 Describe four types of research—experimental, single-subject, correlational, and descriptive—that can be used to inform teachers and enhance learning.

1.4 Explain what action research is and provide an example of action research that you might carry out as a future teacher.

Ben Abbas entered a 12th-grade English literature classroom to begin his first day of teaching. Fresh from a rigorous undergraduate program that emphasized a thorough knowledge of subject matter as the key to good teaching, he arrived with thorough lesson plans. Dressed smartly in a shirt and tie, he cleared his throat, smiled at his students, and launched right into his prepared presentation: introduction, outline, and the day's lesson.

He was very taken aback by the reaction he received from the 30 students, all 17 and 18 years old. Several put their heads down on their desks as if sleeping; others turned and began to converse with their neighbors; and some looked at their cell phones under their desks. None seemed to be terribly interested in what he had to say. This pattern continued throughout the first week. No matter how much time he spent on his lesson plans or how thoroughly he understood his subject matter, his students did not seem to stay on task for very long, and no amount of cajoling, scolding, or correction from Ben seemed to change the situation. Worse still was the reaction he received from a couple of his colleagues when he reported on what was taking place each day. Some responded that the district was populated with students who "did not care" or "did not want to learn." This merely added to the anxiety he felt.

After a couple of weeks, Ben took some time to reflect upon what was taking place and what he had learned in his teacher education program, particularly in his educational psychology course. Recognizing the need to change his approach, Ben realized that he must first engage his students and help them to see the value in what he was teaching rather than conceding that his students were not interested in learning. He talked with more teachers and expanded his social network at the school. He discovered that many of his fellow teachers wanted more for their students.

The next Monday, Ben began his classes by discussing solutions with his students about how to establish a classroom environment that was more interesting and conducive to learning. He listened to the concerns and implemented solution-oriented strategies, such as allowing students to read literature that was more relevant to them. These changes reduced many of the occurrences of boredom and off-task behavior in his classes. Over time, he found his students more willing to learn and excited to be exposed to literature. For the first time that year, Ben began to enjoy teaching.

Reflect as a Student

Have you been uninterested in a class before? Why? What could your teacher have done to make you more interested?

Reflect as a Teacher

What did you learn about effective teaching strategies from Ben's experience?

It takes a lot to be a good teacher. Not only are much knowledge and many skills required, but attitudes and feelings also make a difference. Accepting and believing in students—valuing them and advocating for them, regardless of their gender, race, and ethnicity—is part of a teacher's calling. The purpose of this book is to help you become an effective teacher. Educational psychology is a discipline that will support your development as an educator in a changing educational environment.

This book is designed to help you develop the habit of reflection, and you are offered opportunities to apply and reflect on the content you are learning, both as a student and as a teacher throughout the book. These reflection opportunities occur both as questions after each chapter section and also in the boxed feature, Classroom Connection. Opportunities to reflect will help you develop the dispositions necessary to be an effective educator (Allen et al., 2018). Reflection will help you make the connection between the theory and practice (Williams & Xu, 2018). Being reflective also offers teachers the opportunity to examine their own bias(es) and respond by making their classrooms more culturally responsive (Samuels, 2018).

WHAT IS EDUCATIONAL PSYCHOLOGY?

Educational psychology is one of the many fascinating disciplines within the field of psychology. Psychology is the scientific study of behavior and mental processes. **Educational psychology** is the science of human behavior applied to the teaching and learning process. Educational psychology will help you understand important concepts such as how students learn, how to motivate students to learn, how to design instruction that maximizes learning, and how to assess student learning and curricular effectiveness. Educational psychology is a science, and therefore, its findings are generated through research that relies upon the scientific method. There is a practical side of knowing educational psychology. Such practical knowledge can help you become more aware of your thoughts and actions and the effects of your thoughts and actions on others.

The study of educational psychology will help you understand important concepts such as how students learn, how to motivate students, how to maximize learning, and how to assess student learning.

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A teacher's job is rewarding, but it can also be challenging. Educational psychology is intended to help teachers meet these challenges and be more effective practitioners of their craft. Teachers aspire to help students learn and understand ideas while simultaneously helping them feel good about themselves. To do so, they need to communicate with students and create the necessary experiences so that students can learn. Maximizing student learning requires teachers to have knowledge and awareness of human behavior—knowing what to do (and not do), what to look for, and where to look.

APA's Top 20 Principles From Psychology for PreK–12 Teaching and Learning

The value of knowing psychology is particularly beneficial for anyone whose profession involves frequent interaction with others and especially where one has some degree of responsibility for others' cognitive and behavioral outcomes. The role of teacher clearly fits this description. But the knowledge base of psychology is vast, so which parts are essential for teachers to know? Fortunately, in 2015 the Coalition for Psychology in Schools and Education, a group within the American Psychological Association (APA), reviewed the research literature on teaching and learning and compiled a summary of key takeaways on how to deliver effective instruction, create a classroom environment that promotes learning, and follow best practices for assessment. These 20 principles have been translated into more than a dozen languages and are being utilized by educators around the globe. Table 1.1 identifies the target subject area for each principle and the corresponding chapter(s) within this text where the subject area is covered.

TABLE 1.1 ■ APA's Top 20 Principles From Psychology for PreK–12 Teaching and Learning

APA Principle*	Key Concept	Corresponding Textbook Chapter
1. Students' beliefs or perceptions about intelligence and ability affect their cognitive functioning and learning.	Ability mindsets	10: Motivating Learners
2. What students already know affects their learning.	Previous knowledge	7: Cognitive Approaches to Learning 12: Designing Instruction
3. Students' cognitive development and learning are not limited by general stages of development.	Cognitive development	2: Cognitive and Language Development
4. Learning is based on context, so generalizing learning to new contexts is not spontaneous but instead needs to be facilitated.	Context and transfer	8: Metacognition, Problem-Solving, and Creativity
5. Acquiring long-term knowledge and skill is largely dependent on practice.	Deliberate practice	12: Designing Instruction
6. Clear, explanatory, and timely feedback to students is important for learning.	Feedback	12: Designing Instruction 13: Classroom Assessment of Student Learning
7. Students' self-regulation assists learning, and self-regulatory skills can be taught.	Self-regulation	10: Motivating Learners
8. Student creativity can be fostered.	Creativity	8: Metacognition, Problem-Solving, and Creativity
9. Students tend to enjoy learning and perform better when they are more intrinsically than extrinsically motivated to achieve.	Intrinsic motivation	10: Motivating Learners

APA Principle*	Key Concept	Corresponding Textbook Chapter
10. Students persist in the face of challenging tasks and process information more deeply when they adopt mastery goals rather than performance goals.	Mastery goals	10: Motivating Learners
11. Teachers' expectations about their students affect students' opportunities to learn, their motivation, and their learning outcomes.	Expectations	5: Learners With Exceptionalities 9: Group Processes in Instruction 10: Motivating Learners
12. Setting goals that are short term (proximal), specific, and moderately challenging enhances motivation more than establishing goals that are long term (distal), general, and overly challenging.	Goal setting	10: Motivating Learners
13. Learning is situated within multiple social contexts.	Social contexts	3: Moral, Personal, and Psychosocial Development 4: Learner Diversity
14. Interpersonal relationships and communication are critical to both the teaching–learning process and the social–emotional development of students.	Interpersonal relationships	3: Moral, Personal, and Psychosocial Development 9: Group Processes in Instruction 11: Effective Learning Communities
15. Emotional well-being influences educational performance, learning, and development.	Emotional well-being	3: Moral, Personal, and Psychosocial Development 11: Effective Learning Communities
16. Expectations for classroom conduct and social interaction are learned and can be taught using proven principles of behavior and effective classroom instruction.	Classroom management	6: Behavioral Approaches to Learning 9: Group Processes in Instruction 11: Effective Learning Communities
17. Effective classroom management is based on (a) setting and communicating high expectations, (b) consistently nurturing positive relationships, and (c) providing a high level of student support.	Structure	6: Behavioral Approaches to Learning 9: Group Processes in Instruction 11: Effective Learning Communities
18. Formative and summative assessments are both important and useful but require different approaches and interpretations.	Formative and summative assessment	13: Classroom Assessment of Student Learning
19. Students' skills, knowledge, and abilities are best measured with assessment processes grounded in psychological science with well-defined standards for quality and fairness.	Reliable and valid assessments	5: Learners With Exceptionalities 14: Standardized Assessment and Grading
20. Making sense of assessment data depends on clear, appropriate, and fair interpretation.	Fair interpretation of assessment	5: Learners With Exceptionalities 14: Standardized Assessment and Grading

*Note: APA Principles column taken from American Psychological Association. (2015). *Top 20 principles from psychology for preK–12 teaching and learning*. http:// www.apa.org/ed/schools/cpse/top-twenty-principles.pdf

Reflective Teaching

To become an expert teacher, you need to continuously examine your attitudes, practices, and outcomes. The process of asking questions about your teaching and attempting to identify answers is called **reflective teaching**, and prospective teachers would be well served to begin this process during their preservice training. Reflective teaching is a very important aspect of preparation (Carlson, 2019). You should also reflect on your students' thinking and understanding as well (Kayapinar, 2018).

The process of reflective teaching includes not only asking questions about your own teaching practices but also reflecting on your students' behaviors and comprehension in the classroom.

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Reflection is particularly important when you are confronted by something unexpected or out of the ordinary. For example, a child who ordinarily behaves well in class suddenly becomes angry and starts yelling or throwing things or hitting another student. As a teacher, you have to deal with it. You might take the student aside but be unable to calm the student down. You might call the parent or parents to come to school and take the child home. Afterward, you might think about how you handled the situation and perhaps some alternative ways you might have handled it better. Perhaps you write about it in a journal. The next time you encounter a similar situation, you can use your past experience and reflections on it to handle things better than the first time.

CLASSROOM CONNECTION: A REFLECTIVE TEACHER

Sandy Robinson was a Title I teacher in an elementary school. Title I is a federally funded program that provides resources to schools who serve students from low-income families. In addition to a variety of other duties, every afternoon Sandy worked with small groups of third graders who were reading below grade level. The goal that she had been given was to raise the reading level of the students with whom she worked to help enable her school to ascend from its "academic emergency" status under the state's education rules.

Jeremy was in one of Sandy's afternoon reading groups, and he was not improving. Jeremy lacked patience and often lost focus, at which point he became disruptive, primarily to amuse himself, or so it seemed. When Jeremy lost focus, it was difficult for Sandy to teach him or the other six students in the reading group.

Sandy was a highly motivated and conscientious teacher, and she spent a lot of time thinking about how she could help Jeremy keep his focus and be successful. After much reflection, she decided to get his impression of how the reading group was going. When they met later that week, Jeremy said something that really surprised her. He shared that he felt like she needed to be more patient with him when he sounded out words he was reading to the group. He knew he was not good at it, and it made him nervous and want to get away from the group.

That evening after school, Sandy reflected on what Jeremy had said. She thought about the fact that research told her she needed to increase the amount of words he was reading so that his ability to sound out words would increase. The next day she told him she would meet with him for some on-on-one reading instruction in addition to the small-group time. In those one-on-one meetings, she let him select a book from a handful of books that were at his reading level. Then she would read a paragraph out loud and then have Jeremy read one. They would continue to swap back and forth. Slowly but surely, they saw improvement.

Over time, they were able to increase the reading level of the books as Jeremy's ability to sound out words improved. Sandy also noticed that Jeremy came to reading group with his classmates and started to make it through the entire lesson without becoming disruptive or feeling anxious. More than anything, his newfound confidence made him want to try and read other books!

Reflect as a Student

Can you describe a learning experience where you and other students were struggling and where you felt the teacher was not paying attention to how you and others felt or what you didn't understand? What do you wish the teacher would have done differently?

Reflect as a Teacher

Why is it important that teachers reflect over how the students react to their lessons?

REFLECTION QUESTIONS

1. What are two of the biggest challenges you believe you will face as a future teacher?
2. Which of the APA 20 Principles is most important to you as a student?
3. Which of the APA 20 Principles do think will be the most challenging to implement for you as a future teacher?

EDUCATIONAL PSYCHOLOGY AND THE STUDY OF TEACHING AND LEARNING

Educational psychologists do not rely upon intuition and unsystematic observation as a method to study teaching and learning. Instead, they use a very specific way of knowing about the world that has been perfected over hundreds of years. That way of knowing is referred to as science.

The Tenets of Science

Science is the identification, description, and explanation of naturally occurring phenomena. It is important to recognize that science is based on four general principles: observation, testability, replication, and parsimony.

Researchers can use observations to evaluate how students work together in group projects.

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Observation

Making observations is the foundation of science. **Observation** is the process of recording something (such as observing student test anxiety, math achievement, or misbehavior) with reliable and valid instruments. Sometimes scientific observation is referred to more formally as empiricism. One of the main ways that science is different than other ways of knowing things—for example, intuition, philosophy, expert opinion—is that science relies upon direct observation. Observation helps to provide data necessary to answer questions.

Testability

Making observations is not the only requirement of the scientific process. Science also requires that the research questions that one wants to answer through the observation(s) must be phrased in a specific manner. The observation must be phrased as a **testable question**. What we mean by testable is that the

questions are falsifiable. Falsifiable questions are questions for which the proposed answers are capable of being disproved. Human behavior is such that we often seek to confirm our own ideas and beliefs. Therefore, we naturally seek information that confirms our beliefs while ignoring information that might lead us to question our beliefs. Thus, science is purposely organized to reduce the bias of confirmation by challenging scientists to disprove their proposed answers or hypotheses instead of attempting to prove them.

Replication

While posing research questions that rely on direct observation and are testable in a potentially falsifiable way are two necessary components of the scientific paradigm, or model, there are two other necessary conditions of science. Findings from research must be reproducible. Therefore, if a **hypothesis** or proposed answer to a research question was disproved in one study, it must be disproved in subsequent studies before scientists can have confidence in the results. **Replication** involves conducting studies several times and collecting information over a period of time that consistently yields the same results. Replication helps to increase confidence in scientific findings.

Parsimony

The fourth tenet of science is **parsimony**. The odd thing about parsimony is that in such a complicated world, science strives for an outcome that literally means "simplicity." The law of parsimony, often referred to as Ockham's razor, finds its origin with a Franciscan scholar named William of Ockham. The law of parsimony is the scientific rule that the simpler of two competing theories is the preferable theory. Therefore, contrary to popular misperception, science values simple (parsimonious) explanations over complicated ones. However, scientists try to "make things as simple as possible, but no simpler," as Einstein stated.

In conclusion, psychology is a science based upon data. Therefore, the pedagogical (teaching) principles that are valued and taught in educational psychology are those that have been held up to the rigorous standards of science.

Facts, Principles, and Theories

The psychological study of human behavior focuses on facts, principles, and theories, while focusing primarily on the latter two. **Facts** are disconnected pieces of knowledge and information. For example, it is a fact that anticipating a stressful situation makes a person anxious. **Principles** expand upon and connect several facts. They help to create meaning and to establish associations between facts. Gagné (1985; Gagné & Medsker, 1996) used the term *rules* (as an alternative to principles) to describe these connections or associations (see Chapter 12). In his description, they are "If . . . then" statements, such as, "If you push a round object, then it will roll (the principle or rule being "round things roll"). In the case of the fact that a person expecting to be placed in a stressful situation was observed to become anxious, the principle or rule would be: Expectations affect emotions, or more specifically, expected stress produces anxiety.

Theories are collections of principles (which are based on facts) and are even more general and more inclusive than principles. They are what may be called comprehensive because their scope and range are inclusive enough to enable people to use them to better understand the world around them.

A theory that says that people use other people's reactions to help them judge and understand their own, particularly in uncertain settings, is called the social comparison theory (Festinger, 1954; Buunk & Mussweiler, 2001). This theory helps teachers comprehend the relationship between perceived student stress and their desire to be with others. By watching the reactions of others and sharing their feelings with them, students in a stressful situation can determine whether or not they should be anxious (Gibbons et al., 2002). Teachers might then be inclined to use a cooperative learning approach when the assigned task is likely to be anxiety-provoking (such as making a class presentation or preparing for a test) so that students would have ready access to others for comparison and support purposes. Teachers might also be less inclined to ask John why he could not do his work as well as Joan did if they knew the power and importance of social comparison to John's sense of well-being.

Sometimes there is a tendency to hear the word "theory" and think "useless" or "abstract" or "irrelevant" because it is part of the word "theoretical." But theoretical means predictive—that is, explanatory of why a particular fact or set of facts occurs. In other words, theories are not only comprehensive, but they are also predictive. They attempt to explain the why of something, not merely to note its existence. Students sometimes get anxious; that is a fact. They often get anxious when they expect something they do not like (like a test); that is another fact. When students get anxious, many of them like company—third fact. Why do people like company when they get anxious? Perhaps because they can see then whether it is okay to be anxious—they can use social comparison. This last statement is not a fact. It is an attempt at an explanation. It is predictive. It is theoretical.

Is this theoretical explanation relevant? The answer is yes if it helps teachers know how to handle stressful situations that arise in their classes. If the theory can be translated into action, then it becomes practical. What is also practical is that there will be many fewer theories than facts because theories both subsume or include facts as well as explain them. Through an understanding of a small number of theories, most of the behavior that goes on in classrooms (and probably in life as well) can be explained.

Hence, the focus on theories has three bases. The first is that theories are comprehensive or inclusive, so each one can subsume or include a lot of facts. The second is that because they are so broad-based, only a small number of theories need to be learned. The third is that theories are predictive or explanatory and so can be used to explain, in a wide variety of situations, what will happen, why it will happen, and how to be able to deal with it when it does happen. Learning about theories, therefore, helps learners organize information better and use it more easily than simply learning a collection of facts. See Table 1.2 for a Concept Review of the relationship between facts, principles, and theories.

TABLE 1.2 ■ CONCEPT REVIEW: What We Know—Facts, Principles, and Theories

Facts	Principles	Theories
Based on observation	Based on inference	Based on prediction (about facts)
Discrete, specific, and numerous	Fewer in number than facts	Comprehensive and fewest in number
Elemental and unitary	Made up of connected facts	Made up of connected principles
Actual behavior that can be seen	Help relate behaviors to one another	Help explain behavior

In this text, we present a number of theories and explanatory principles relevant to teaching and learning, each one unique in what it addresses. The explanations vary because there are different ways to describe an outcome or a phenomenon. They vary in what they try to explain because no theory, and especially no single principle, is likely to apply equally well to all aspects of behavior, nor is any one model likely to be universally useful. Remember, there are neither quick fixes nor simple recipes in educational psychology.

Some theories fit certain aspects of behavior better than others. It is analogous to needing different tools for different projects. No one tool will be needed for every project. And in order to best complete any project, having access to a wide variety of tools will make completion of the project easier and result in a higher quality finished product. As each aspect of educational psychology is covered within the chapters of this text, the theories and explanatory principles that help make that aspect understandable, and the models that help make it most manageable will be explored. You will be adding to your toolbox. Our hope is that after finishing this book you will have much of the prerequisite knowledge, as well as an understanding on how that knowledge can be applied, to help you become a successful teacher.

How Do We Know if a Theory Is Accurate?

Since theories are based on facts, we can test theories by gathering facts that relate to the theory. On the basis of theories, hypotheses or predictions are made about what is expected to happen or what facts are expected to be observed in a given situation. We can then test these hypotheses by making observations and collecting the relevant facts.

Research is the process used to test whether or not the facts that theories tell us to expect are accurate. Doing research means making observations or collecting data (in contrast to induction and deduction, which are modes of thinking). The purpose of this research is to test the hypotheses or hunches about what will happen in a given situation based on a theory. Supportive evidence collected by research helps validate or invalidate the theory being tested.

The approach used to test a theory is called a **paradigm**. A paradigm is a design or framework that can be used repeatedly for testing the relationships within a set of **variables** (that is, things that can change or be changed) or factors that affect behavior. Later in this chapter, four research paradigms are described: experimental research, single-subject research, correlational research, and qualitative or observational research.

Teachers are expected to interpret and apply research that they learn from courses such as educational psychology, from continuing education or professional development, and, perhaps, from conducting research of their own. In evaluating knowledge, it is helpful for teachers to know how it was discovered and if it is likely to apply under the circumstances in which they may use it. Teachers are also likely to draw their own conclusions about students as well as about the circumstances of their behavior, so it is important that they realize what factors affect the validity of these conclusions.

Two Factors That Affect the Accuracy of Judgments

Two factors that affect the accuracy of judgments are called internal and external validity, or certainty and generalizability (Tuckman, 1999). **Internal validity** refers to the confidence one holds in the conclusion that the teacher's or researcher's action, rather than some other variable, has caused the student to behave or perform differently. How certain can you be that Variable A has caused the observed change in Variable B? To conclude that Variable A is indeed the cause of the change in Variable B when in fact a third factor, Variable C, is the true cause is to make a false conclusion. It is important to try to maximize internal validity in order to decrease the chances of a false judgment.

Consider a new program for teaching reading that a teacher is trying for the first time. If the students taught with this program perform better on a subsequent reading test than last year's students did on the same test after being taught with the old program, can the teacher conclude with certainty that the new program works? Perhaps not! Perhaps this year's students were brighter or more motivated than last year's. Perhaps the teacher was more enthusiastic about the new program than the old and devoted more effort to teaching it. Perhaps the teacher expected it to work better. The new program may indeed work better than the old one, but it is difficult to be certain about that conclusion under the given circumstances. Therefore, the internal validity, or certainty, of the research is questionable.

In addition to wanting to be certain about conclusions based on the soundness of the resign design, we also want to be able to clearly articulate to whom the results apply—that is, to have **external validity**, or generalizability. If a teacher concludes that the new reading program works better than the old one, should other teachers expect the same results? Can they conclude that it is likely to work for them too? What if their students are not as capable or as motivated? What if their students face additional barriers or challenges that moderate the efficacy of the intervention? Studies should be careful to explicitly report important characteristics of the study participants. Consumers of research studies should be careful to intentionally look at those characteristics and consider their alignment with the students they are teaching.

Educational psychology, as has already been said, focuses on attempting to discover and transmit knowledge about student behavior and performance. That means transmitting information about the factors that affect student behavior and performance for which there is a high degree of certainty and generalizability. To understand if the findings on which educational psychology research and theories are applicable to you and your students, it is important to critically examine the manner in which these conclusions have been reached.

REFLECTION QUESTIONS

1. Explain in your own words why each of the four tenets of science is important.
2. Explain in your own words the difference between facts, principles, and theories.
3. Television commercials and social media ads often makes claims about the effectiveness of particular products. How might your understanding of validity help you analyze the accuracy of their claims?

USING RESEARCH TO INFORM TEACHERS AND ENHANCE LEARNING

Research can be conducted in a number of ways, each of which has its own specific purposes and its own set of operations and methodology. In this section, we will describe four widely used methods: experimental research, single-subject research, correlational research, and observational/qualitative research.

Experimental Research

One way to do research or test a hypothesis (an expectation of what you expect the result to be) is to conduct an experiment. In **experimental research**, the impact or effect of one variable on another variable is studied. By conducting an experiment, the researcher attempts to maximize certainty in the outcome by holding constant other factors. The researcher does not wait for the causative or *independent variable* to occur naturally or under its own initiative. Instead, the researcher makes the independent variable happen by imposing (by manipulation) a treatment or intervention.

To be certain about whether the intervention caused the outcome or dependent variable, the researcher must provide the treatment for only some of the students rather than for all of them. In this way, two groups, those receiving the intervention and those not, can be compared to see whether the manipulation or treatment has actually caused a change in the outcome. In evaluating a new reading program, for example, not all of the students should be given the new program.

Internal validity refers to the confidence one holds in the conclusions drawn from a research study.

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In addition, insofar as possible, everything must be exactly the same for and about both groups—the one that receives the treatment and the one that does not. If any aspect of the experience other than the presence or absence of the treatment differed between groups, the researcher would not know which aspect had caused the difference in the outcome. Additional possible causes would then "confound" the relationship between the independent and dependent variables and reduce internal validity or certainty.

In determining which students should be given the treatment and which ones should not, the researcher should pick the names out of a hat to randomize the assignment to groups and ensure that one group is not more capable or more motivated than the other. **Random assignment** is important because it increases the likelihood that one group will not be different from the other to begin with. If students are permitted to pick their own groups, then the groups might not start out on an equal footing.

Let us consider a reading program example. Comparing two classes, one that uses a new program and one that uses the old one, would not result in an accurate or certain conclusion if the students in one class were brighter or already had better reading skills than the students in the other class. In that case, one program might appear to be more effective than the other, but only because the students who used it were more capable; those students would probably do well regardless of which reading program were used. It would be better to have originally assigned students to the two classes on a random basis so

that they would be likely to be the same or to assign the new program to half the students in each class, chosen by chance, with the remaining halves using the old program. In that way, any differences in outcome would be more certainly a function of program differences than of student differences.

It is also important, especially for internal validity, that students are unaware that anything special or out of the ordinary is being done when a treatment is being tried. That lack of awareness is called being blind to the treatment. When people realize that they are being given special treatment, they often respond differently than they ordinarily would. The teacher using the new reading program in this example would be advised to avoid having the students respond to their treatment as being new or special.

Five recommendations of experimental research are (1) make the independent variable happen by manipulation, (2) include a control group, (3) except for the treatment, treat the experimental and control groups the same, (4) assign subjects randomly to experimental and control groups, and (5) keep participants unaware of what group they are in (Tuckman, 1999).

Single-Subject Research

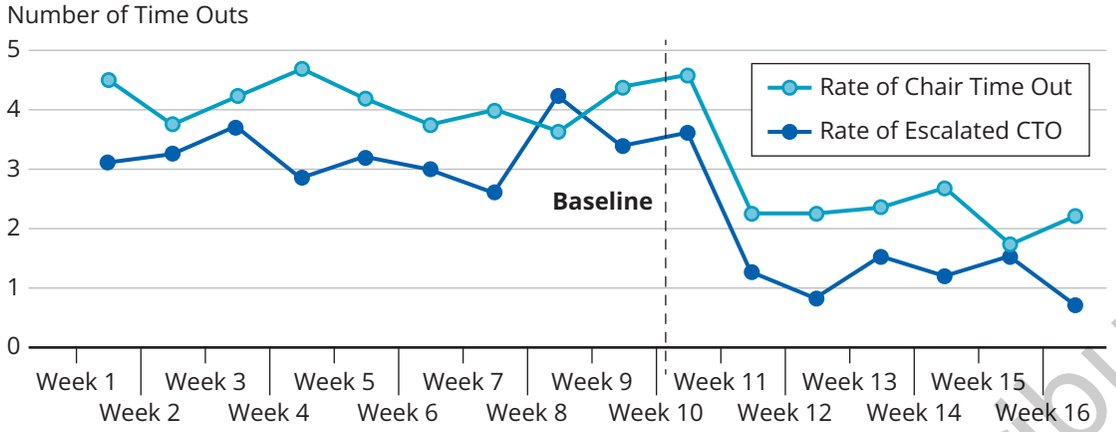
While the majority of educational studies involve groups of participants, there are situations in which the use of groups is neither appropriate nor possible. Examples of such situations are where there are not enough participants to use a group approach or where intensive data collection on one or a small number of participants is necessary, such as in special education. Here, the small number and uniqueness of students, as well as the nature of the data to be collected make **single-subject research** the better choice.

Single-subject research involves a minimum of two necessary phases: the baseline phase and the treatment phase. During the baseline phase, the researcher measures the subject's behavior under typical or ordinary circumstances. Everything remains the same as it would if no research were taking place. During the treatment phase, the researcher measures the subject's behavior under the special circumstances that the researcher is interested in studying. The baseline condition, for example, could be punishing unacceptable behavior, while the treatment condition would be ignoring unacceptable behavior but rewarding acceptable behavior. Because the same participant or participants will be subjected to both conditions, only one condition can be studied at a time. Variations of the single-subject approach can be used, but only the three most common ones will be described here. In the first, the simplest, the participant experiences the baseline (A) and the treatment (B) once each, creating the A-B version of the design. What this means is that after experiencing the normal or typical situation and having measures taken, the participant then experiences the new or trial situation and has the measures taken again. Results following the treatment are compared to those following the baseline. In the A-B-A version, the baseline is experienced both before *and* after the treatment to see if any treatment effect that occurs persists after the treatment has been completed. Finally, the A-B-A-B version represents the simpler A-B version done twice in succession, primarily to see if the results are stable enough to occur a second time.

An example of the use of the A-B approach is shown in Figure 1.1. It involved a single participant or subject, a seventh-grade boy, and took 16 weeks to complete. The first 10 weeks were used to establish the baseline ("A" in the design), the remaining 6 to test the treatment or trial program ("B"). During this time, two measures that reflected disruptive behavior were taken each week, the first being *rate of chair time out* (CTO), represented in the figure by the solid line. After the student had committed three disruptive behaviors, he was disciplined by having to sit in a chair at the back of the classroom for 5 minutes. The second measure was rate of escalated chair time out (ETO), the dashed line in the figure. If the disruptive behavior continued, not only did the student have to remain seated in the back of the classroom, but after the second ETO, he lost the privilege of participating in a special end-of-week activity.

The treatment consisted of rewarding the student subject with bonus points for no CTOs and no ETOs for an entire day. The bonus points could be exchanged for prizes during the special end-of-week activity. As can be seen in Figure 1.1, the treatment clearly was accompanied by a reduction in disruptive behavior by the student subject.

FIGURE 1.1 ■ Baseline and Treatment Incidence of Disruptive Behavior (Tuckman, 1999)



The single-subject approach is also experimental, only with a sample of one person participating in both the control and experimental condition (called baseline and treatment). Because of the small sample, the single-subject approach lacks the generality of experiments done with more participants because of the greater likelihood of uniqueness of one or a few people in contrast to a greater number.

Correlational Research

In the **correlational research** paradigm, a researcher collects data about two or more sets of variables from a group of participants for analysis and then attempts to determine the relationship between them. The data are based on test scores or observational measures, and their relationship is determined using a statistic called a **correlation coefficient**. For example, to determine the relationship between *time spent studying* and *grades*, a group of students could be asked to report the number of hours they spent studying per week over the course of a school term, and then those data could be related to the grade point averages (GPAs) they earned that term in school.

The correlation coefficient is a measure of the degree of relationship between two scores, or the extent to which one score predicts the other. It is represented as a number between –1 and 1, with both extremes reflecting a perfectly linear relationship or complete predictability. By comparison, a correlation coefficient of 0 indicates a total lack of relationship or no predictability. Therefore, other than in the unlikely circumstance of a perfect relationship, the correlation coefficient will be a decimal, the size of which reflects the strength of the relationship between the variables. A positive correlation indicates the two variables vary in the same direction (e.g., more studying, higher grades or less studying, lower grades), while a negative correlation means that the variables covary in the opposite direction (e.g., more time spent on social media, lower grades or less time spent on social media, higher grades).

An important rule in research to be aware of is that correlation does not necessarily imply causation. In other words, the fact that two variables are highly correlated does not necessarily mean that one causes the other. Because there is a study of the amount of time spent watching violent videos to correlate highly with the extent of a person's own aggressiveness, that does not necessarily mean that watching violent videos causes one to become violent. An alternative explanation would be that people who are aggressive are attracted to violent videos. A correlation between variables *X* and *Y* is as likely to mean that *Y* causes *X* as that *X* causes *Y*. It is also possible that both are caused by a third variable, *Z*. The high correlation between infant mortality and the amount of road repairs required does not necessarily mean that potholes in the road cause infants to die or that infants dying ruins the roads. What the correlation may be mean is that heat, a third variable, causes both.

Let us look at an actual example of a correlational study, one particularly relevant to teaching. Tuckman and Kennedy (2009) studied the relationship between the GPAs of students taught study

An important rule to remember is that correlation does not necessarily imply causation.

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skills during their first term in school and the GPAs earned by those same students at the end of their second and third years in school to see if the initial gains were carried over in time. They found the correlation between first-term and second-year academic performance to be .082 and between first-term and third-year performance .074. These positive correlations indicated that first-term results following study skills instruction were associated with (but did not necessarily cause) high academic performance 2 and 3 years later.

Overall, then, correlational studies, in and of themselves, are not adequate for establishing causal relationships between variables, but they can be highly useful steps in that direction. They can suggest causal links and spark the need for future experimental studies to examine potential causation.

Descriptive Research

While the formal tests of theories may come in the form of experiments, the foundations on which theories are built are often based on less formal methods—**descriptive research** such as **observational research**, or **survey research**. Descriptive research focuses on describing characteristics related to a variable of interest or a specific research question, such as these:

1. What percentage of students have internet access in their homes?
2. How many students qualify for free/reduced lunch?
3. How do students react to kids playing on the playground outside a classroom window during the afternoon class period?
4. What is the range of magnitude for test anxiety experienced by students in high school algebra?

Observational research is where the researcher observes and records the behaviors of subjects in their natural environment (e.g., Question 3). Observing behavior in various naturally occurring situations can be less precise and more subjective than doing controlled experiments. If such observations can be made without altering the behavior being observed, then the researcher can be confident that the behavior is real and not being staged for their benefit or detriment. Unlike experimental research, where subjects may behave differently because they know they are in an experiment, observational research should provoke no such effect if the researcher is unobtrusive enough. Survey research is where participants are asked to answer questions about variables of interest (e.g., Questions 1 and 4). It is common to see surveys given to a subset of students, a class, and entire school system. In education settings, surveys are also given to teachers, administrators, and parents.

It may be important to note, descriptive research often does not aspire to make statistical inferences like correlational or experimental research; therefore, it does not employ inferential statistics to help understand the meaning of the observations as often as experimental or correlational research. Instead, it primarily uses descriptive data (e.g., range, averages, percentages) and employs the perceptions and judgments of the researcher to help understand the meaning of the data. Nevertheless, the research is planned and conducted systematically.

An example of a descriptive study is the one conducted to examine K–12 teachers' beliefs about and reactions to students' off-task technology use (Wininger et al., 2024). In this study, teachers across several school systems were asked to complete a survey assessing their perceptions about how often students engaged in off-task technology use, how it impacts their students' learning, how it impacts their teaching, and how they react to it. Results revealed an average of 21 observations per

day for high school teachers, an average of 14 for middle school teachers, and an average of 4 for late elementary teachers. Most teachers believed students' off-task technology use hindered student learning and that it was a barrier to their teaching efforts. Last, many teachers reported experiencing negative emotions in response to observing students' off-task technology use, reporting feeling frustration, annoyance, sadness, disappointment, and even anger. Survey research, like the study referenced here, can provide school administrators with valuable information to inform needed changes in classroom technology policies and targeted professional development training for teachers. See Table 1.3 for a Concept Review of the types of research and how they work.

TABLE 1.3 ■ CONCEPT REVIEW: Different Types of Research

Type of Research	How It Works
Experimental	Two or more groups, one receiving an intervention, the other not, are compared on outcomes. Ideally, students are assigned at random to one of the two groups.
Single subject	The behavior of one student is measured in its original state (baseline) and again after having received an intervention or treatment.
Correlational	Two or more sets of variables, based on test scores or observations, are compared statistically to see if there is a relationship between them.
Descriptive	Behavior is either observed in naturally occurring situations, or participants are surveyed and descriptive results are reported.

REFLECTION QUESTIONS

1. Why is random assignment important in experimental research?
2. Describe educational situations in which each research type would be more effective (or easier to accomplish) than the other three.

THE TEACHER AS RESEARCHER

Educational research, much of it done by university researchers, represents a rich body of information that can be very helpful to classroom teachers in influencing their practice of teaching. That information is accessible to teachers, but its value to them depends on their ability to interpret and critically appraise it. Many, however, contend that in addition to this body of work, research by teachers themselves can be an equally significant way of knowing about teaching.

Action research in education refers to applying traditional research approaches to specific classroom questions or issues in order to facilitate a better understanding of the question or issue and to improve learning or the learning experience for the teacher and/or students (Johnson, 2012). It is a systematic process (Mills, 2011). This process entails identification of the research question or problem, formulation of hypotheses, data collection, and analysis. There are myriad benefits to teachers conducting actions research. Glanz (1999) cites the following: creates a commitment to improvement, informs decision-making, promotes reflective teaching, and directly impacts teaching practice.

The kind of research that teachers typically do is observational research, although single-subject research and correlational research are possible but less common. (Even experiments can be done under certain circumstances; see Table 1.4 for examples of all four types). Observational research has the following five features:

1. It is done in a natural setting.
2. The researcher is the key data collection "instrument."

3. It is concerned as much or more with events that transpire than with product or outcome.
4. Data are "analyzed" inductively by trying to make sense of what they mean.
5. The focus is on *why* events occur as well as what happens. (Bogdan & Biklen, 2003).

Four kinds of data or documentation common to research by teachers are as follows: (a) field notes and journals that describe and reflect on observations of classroom events, interactions, or other class-related activities; (b) notes, audiotapes, or transcripts of *interviews* with students, teachers, or conferences with parents; (c) classroom documents (e.g., students' seatwork, homework, test papers, and scores; teachers' plans or handouts); and (d) recordings (audio and video) of ongoing class activities, extracurricular activities, or presentations.

TABLE 1.4 ■ A Thematic Example of Action Research Across the Four Types of Research

Type of Research	Action Research Example
Descriptive	A teacher surveys students to assess how they feel about seeing other students engaging in off-task technology use.
Correlational	A teacher looks at the correlation between students' off-task technology use and grades.
Single subject	A teacher initiates a behavior modification program for a student with ADHD and monitors the effect on reduction in off-task technology use.
Experimental	A teacher compares grades of students in a classroom with (a) a "no technology use" policy, (b) a "no off-task technology use" policy, and (c) a policy wherein students can use any technology for any reason at any time.

REFLECTION QUESTIONS

1. What is action research, and what are the benefits of doing action research for teachers?
2. What are some ideas you have for future action research projects in your classroom?

REFLECT AND CONNECT

Learning Objectives

1.1 Define *educational psychology* and provide examples of its application in the classroom.

- Educational psychology, the science of human behavior applied to the teaching and learning process, helps teachers to understand issues such as how students learn, how to motivate students to learn, how to design instruction that maximizes learning, and how to assess student learning.
- APA's Top 20 Principles are a summary of the academic research literature on key takeaways about how to deliver effective instruction, create a classroom environment that promotes learning, and best practices for assessment.

1.2 Explain the psychological study of behavior, including the four tenets of science; the differences among facts, principles, and theories; the determination of a theory's accuracy; and factors affecting the accuracy of judgments.

- Psychologists study behavior using the scientific method. The scientific method is based upon four principles: observation, testability, replication, and parsimony.

- In this book, the approach is to focus on principles and theories rather than on discrete facts. Principles are more general than the facts that make them up, and theories, by combining principles, are more comprehensive yet. Theories are predictive: They attempt to explain the why of something and help both to organize information and to apply it in a variety of situations (unlike facts, which simply represent information itself).
- In order to determine whether theories are accurate, we can deduce hypotheses or predictions from them and then test these by doing research. The models used to do research or collect data are called paradigms.

1.3 Describe four types of research—experimental, single-subject, correlational, and observational—that can be used to inform teachers and enhance learning.

- Some of the specific research methods that educational psychologists utilize include experimental, single-subject, correlational, and observational research.
- Experimental research is often used to determine the effectiveness of different instructional methods. The impact of one variable (e.g., a new reading strategy) is examined to determine its effect on a second variable (e.g., reading proficiency). Experimental research is the main type of research design that allows us to infer causality.
- In the single-subject approach, participants are compared with themselves rather than with members of a control or comparison group as in most experimental research (e.g., A-B-A-B designs).
- In correlational research, a researcher collects data for two or more sets of variables from a group of participants for analysis and then attempts to determine the relationship between them. The data are based on test scores or observational measures, and their relationship is determined using a statistic called a correlation coefficient.
- Observational research involves observing behavior in various naturally occurring situations, while trying to be as unobtrusive as possible and recording one's observations.

1.4 Explain what action research is and provide examples of action research that you might do as a future teacher.

- Action research in education refers to applying traditional research approaches to specific classroom questions or issues in order to facilitate a better understanding of the question or issue and to improve learning or the learning experience for the teacher and/or students (Johnson, 2012). Teachers might conduct any of the types of research described such as descriptive, correlational, single subject, or experimental.

KEY TERMS

action research
correlation coefficient
correlational research
descriptive research
educational psychology
experimental research
external validity
facts
hypothesis
internal validity
observation
observational research
paradigm
parsimony
principles
random assignment
reflective teaching
replication
science
single-subject research
survey research
testable question
theories
variables

CRITICAL THINKING QUESTIONS

1. How will your study of educational psychology help you become a better teacher?
2. Which of APA's 20 Principles do you believe is the most challenging to study? Why?
3. What is something new you learned about science from the section in this chapter?
4. Explain the needed conditions of research study that would allow a researcher to make causal inferences.
5. Which aspects of teaching are you most likely to conduct action research on? Why?

2 COGNITIVE AND LANGUAGE DEVELOPMENT

LEARNING OBJECTIVES

After reading the chapter, you should be able to do the following:

2.1 Explain general principles of development and the relationship between the brain and cognitive development.

2.2 Describe intellectual development according to Piaget and the four factors that influence cognitive development.

2.3 Explain and illustrate the four stages of Piaget's model of cognitive development.

2.4 Apply Piaget's conception of cognitive development to the process of education.

2.5 Articulate criticisms and limitations of Piaget's theory.

2.6 Explain Vygotsky's theory of cognitive development in terms of its main concepts and characteristics and apply it to teaching.

2.7 Describe language development and explain how language development can be facilitated in the classroom.

Madeline had wanted to be an elementary school teacher for a long time, and she was looking forward to her first college education courses. She held some strong opinions about how young children learned best and how she wanted to conduct her future classroom. She envisioned a classroom in which she presented all the children with the same information in a specific sequence, and then they could all complete the same assignment independently. She thought that this would be the fairest arrangement and would also create an orderly classroom environment. Then Madeline took her first college education course, and she learned about the benefits of organizing classrooms for young children in different ways.

The more Madeline read about the learner-centered orientation to teaching, the more she realized that each of her young students would come to her class with different needs. Instead of using a one-size-fits-all approach, she realized that she should arrange classroom learning centers based on different aspects of her instructional unit. She could then allow her students to select a center area. She began to envision the students moving and experimenting with different instructional materials of their choosing, all while learning different aspects of the lesson at their own pace.

Madeline's education classes taught her that autonomy is an important psychological need for students. Once she identified this, she realized that she could allow her students to have choice in the activities they engaged in during instruction. Madeline also learned that when students refuse to do work, underachieve, daydream, or misbehave, often one of the causes is having no voice or choice in their school life.

Reflect as a Student

How would a choice in the assignments you complete for your college courses affect your motivation in the class?

Reflect as a Teacher

What factors might lead a teacher to change their teaching methods?

Chapter 2 focuses on the development of thinking skills and language among children and adolescents. Understanding how the capacity for thinking grows and develops as children mature makes it possible for teachers to provide instructional experiences that will enhance their students' developmental process. We begin this chapter with an examination of cognitive development and a brief overview of how the brain works to provide us with an anatomy framework to understand the nuanced process of cognitive development. You will then read about two popular theories of cognitive development: one proposed by Jean Piaget and the other by Lev Vygotsky. Lastly, language development will be explored and the relationship between language and thought will be discussed.

COGNITIVE DEVELOPMENT AND THE BRAIN

We live in an exciting time where technology has permitted researchers to learn much about how the brain processes information and allows us to interact with the world around us. Although we acknowledge that the study of the brain's incredible design and complexity could merit a separate chapter (and in some fields of study, an entire text), that is beyond the scope of our introductory text. Instead, we

provide a general overview of the brain's anatomy and how it functions as a foundation of understanding cognitive, as well as other types, of human development. In this section, we begin with a description of the principles involved in cognitive and other types of development in children. We then look at the cellular activity within students' brains that allows them to process information.

General Principles of Cognitive Development

Four general principles of cognitive development (and, again, other types of development) that are important for teachers to know and understand follow:

1. **All children do not develop at the same rate.** Although average ages have been identified for the attainment of various developmental milestones (e.g., puberty tends to occur between ages 8–11; Hurwitz et al., 2017), some children achieve these milestones sooner and some later. Age alone is not a sufficient basis for judging individual development. As a teacher, you will notice differences among your students concerning many variables, such as height, learning ability, and ease in working with others.
2. **Development as a process is continuous and relatively orderly.** Though there are occasionally spurts and plateaus—that is, periods of more rapid or less rapid growth—for the most part children's growth is continuous rather than spasmodic or "jumpy" (Berk, 2013). For example, as we shall see when we examine Piaget's four stages of development, children invariably learn how to master less complex ideas before they can comprehend more complex ones, just as they generally learn how to crawl before they learn how to walk and how to do algebra before they do calculus.
3. **Learning, experience, and social interaction all contribute to development.** The two important researchers in the study of children's cognitive development—Piaget and Vygotsky—clearly demonstrated this principle. When children interact with one another by doing group work in school and are exposed outside of school to experiences like libraries and museums and being read to by their families, there is an impact on their cognitive development compared with children who lack the same opportunities (Siegler & Alibali, 2005).
4. **Development is affected by both heredity and environment.** The environment, which includes both school on the one hand and home, family, and culture on the other, interacts with a child's genetic predispositions to influence development (Gottleib, 2000). For example, a child's intelligence—a genetic factor—can enhance development, while a poor diet—an environmental factor—can delay development. In the realm of the classroom, it makes sense to focus on environmental factors that are easier to control than genetic ones.

Neural Activity in the Brain

The brain and the rest of the nervous system are composed of different types of cells, but the primary cell is the **neuron**; researchers estimate that the brain has between 100 and 200 billion of them. All sensations, movements, thoughts, memories, and feelings are the result of signals that pass through neurons. The neuron consists of three parts: (1) the **cell body**, which contains the nucleus, where most of the molecules that the neuron needs to survive and function are manufactured; (2) **dendrites**, which extend out from the cell body like the branches of a tree and receive messages from other nerve cells; and (3) **axons**, which receive signals from the dendrites and transmit them to other neurons in the brain or to cells in some other organ.

When a neuron's dendrites are stimulated, the dendrites become "electrically charged," and if the charge is sufficient, the neuron will "fire," resulting in an "electrical impulse" being sent to the axon (actually to its tips, which are called **terminal buttons**). Neurons do not touch one another; they are separated by tiny spaces or gaps called **synapses**. When an "electrical impulse" travels along a neuron's

axon, it causes the terminal buttons at the end of the axon to release chemicals called **neurotransmitters**, which then cross the synapses and stimulate the dendrites of adjacent neurons. A single neuron may have synaptic connections to a very large number of other neurons.

Infants are born with fairly immature brains, which will significantly change over time. Young children's brains continue to cognitively develop after they are born, whereas other animals tend to have more development occur before birth. This may explain why it generally takes babies about a year before they can walk, while some animals can do so a short time after birth. One of the biggest changes that occurs is that the neurons in the brain get more connected, with neurons learning to communicate with one another. Neurons and synapses that are not used, because there are more than are necessary, are removed or "pruned," which enables cognitive development. Home environments that are stimulating may facilitate the pruning process in early life and lead to increased synapse production in adulthood. The changing of the interconnections among neurons may be an important basis for cognitive development in that it involves strengthening or eliminating existing synapses or forming new ones. Though not yet proven, neuron formation may be stimulated by new learning experiences.

The Cerebrum

Now that we have looked at the activity and communication of neurons, we want to turn our attention to the structure of the brain itself. The **cerebrum** is the front part of the brain. When you see pictures of a brain and it is a pinkish-colored and wrinkled cluster, you are looking at the cerebrum. Some of the major functions controlled by the cerebrum are body movement and coordination, body sensation, vision, hearing, language, behavior, and complex thinking.

Two Hemispheres

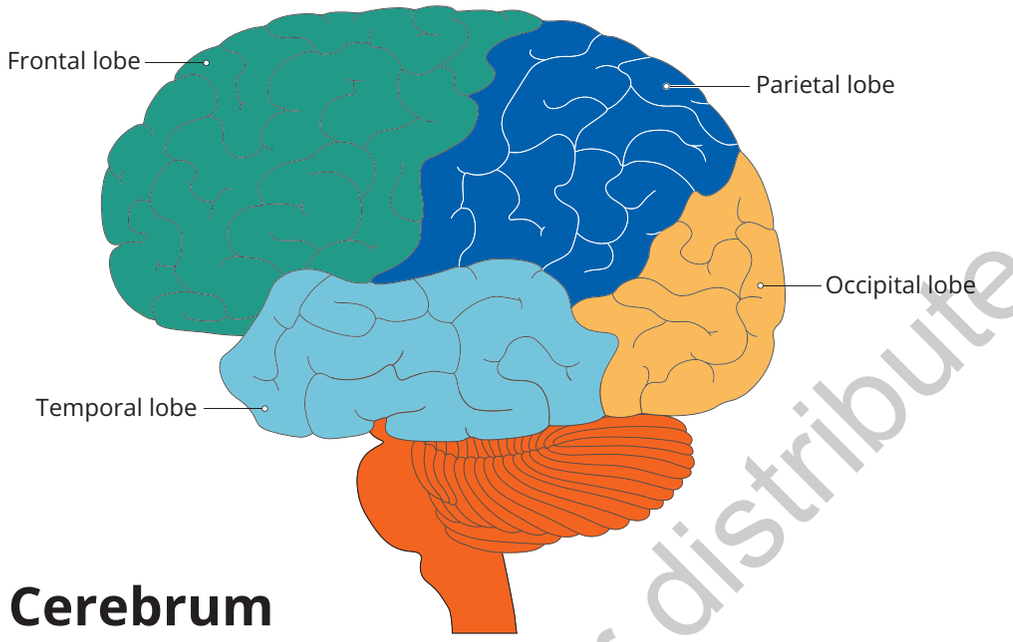
The cerebrum is divided into two "halves" or hemispheres. The **left hemisphere** is the half of the cerebrum involved primarily with language and thinking, while the **right hemisphere** is the half of the cerebrum associated with spatial relations and emotions. This specialization of each of the two hemispheres is referred to a **lateralization**, with each half of the brain controlling the opposite side of the body. Thus, your left hemisphere controls the right side of your body, and the right hemisphere controls the left side. The two hemispheres are connected by a bundle of neurons called the **corpus callosum**, which allows the left and right hemisphere to communicate with one another. When one part of the cerebrum is damaged (as perhaps the result of an automobile accident), other parts of the brain tend to compensate by taking over the functions of the damaged area. Moreover, no mental activity is exclusive to a specific part of the brain, so the potential for retaining a specific function is still there.

Four Lobes

The cerebrum is made up of four parts or lobes. Each lobe has a left and right part. The **frontal lobe** is located directly behind the forehead, at the front of the cerebrum (see Figure 2.1). It is responsible for complex thinking. When a student of yours is planning how to complete a project in your class, the area that is most at work is the frontal lobe. The **parietal lobe** is located at the top of the cerebrum behind the frontal lobe. It is responsible for receiving information from the senses. The **temporal lobe** is at the bottom of the cerebrum. It is responsible for hearing and understanding speech. The **occipital lobe** is at the back of the cerebrum. It is responsible for taking in visual information from your eyes.

We conclude our brief overview of the brain's activity and major components. The brain's functioning provides the physiological foundation for further exploration of cognitive and other areas of human development. Interestingly, however, based on what we currently know, brain structure and physiology do not provide specific guidance for facilitating either cognitive development or learning. Most psychologists agree that what we know about learning and development is the result of research studies on actual behavior rather than on neurological studies of the brain. Two enduring theories of cognitive development—Piaget's and Vygotsky's—each depict a version of how children's thought processes develop.

FIGURE 2.1 ■ Cerebrum

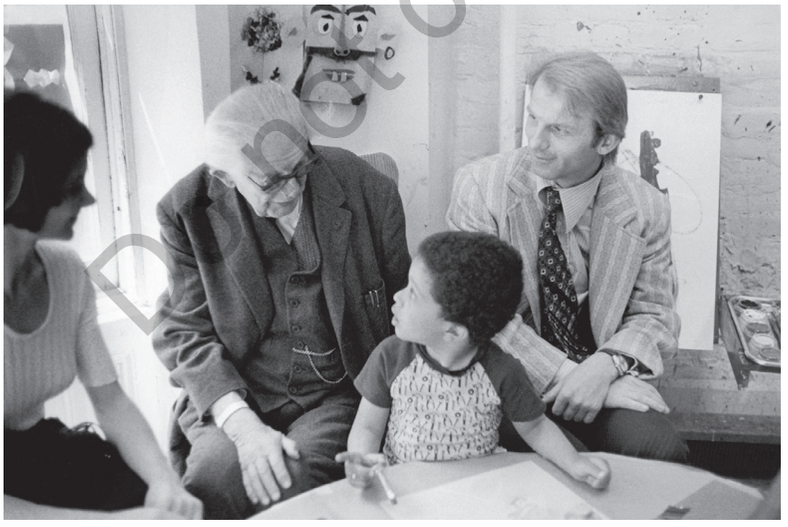


iStock.com/ Rujirat Boonyong

REFLECTION QUESTIONS

1. Which of the general principles of cognitive development most resonates with you as you plan for teaching?
2. How might the idea of neural pruning be important in understanding child development?
3. When teaching a complex topic, how might you ensure that all four lobes of a child's cerebrum are fully engaged?

THE DEVELOPMENTAL PSYCHOLOGY OF JEAN PIAGET



The work of Jean Piaget (the older man in the photo) helps teachers consider how knowledge changes and grows in children over time.

Science History Images/Alamy Stock Photo

A major contribution to our understanding of cognitive (or intellectual) development (and even moral development) was made by Swiss biologist Jean Piaget. Piaget (1896–1980) spent 60 years observing children and reporting on their growth in well over 200 books and articles. Although trained in biology and philosophy (which both greatly influenced his thinking about and terminology he used to describe development), Piaget turned to psychology to try to understand the development of intelligence in children. In this section, we examine Piaget's major concepts and principles for explaining the behavior he observed, his hypothetical four developmental stages of development, and his principles as applied to education.

Piaget's methodology involved observational research—making meticulous observations and then reporting on what he observed (see Chapter 1).

He began with observations of his own three children and then expanded to observe many other children and young adults as they engaged in a variety of tasks, many of which he posed for them. From his extensive observations, he fashioned his detailed theory of development.

The Basic Structure of Cognitive Organization: The Schema

Piaget, and others who followed him, perceived the **schema** to be the basic unit needed for mental organization and functioning. Piaget (1952; also Flavell, 1963) defined a *schema* as "a cohesive, repeatable action sequence possessing component actions that are tightly interconnected and governed by a core meaning." In simple terms, a schema is like a mental blueprint or framework that our brains create to understand and organize information about the world. Schemata (plural for schema) help people classify or categorize an object or event and decide how to act toward that object or react to that event. Often, the initial necessary act is to label or recognize a situation so that the appropriate response can be made. An example is if you are given a list of grocery items and the cost of each, and then you are asked what the total cost will be. You have a schema that enables you to recognize that addition is the appropriate arithmetic process and another schema that enables you to carry out the addition process to arrive at a solution.

As children develop, they increase the quantity of schema and they increase the number of connections within and between schema. An infant would start out with few or no schemas. Adults, by comparison, would have large numbers and connections. From the teaching and learning perspective, as you teach students and as they naturally develop, their schemata continue to be refined as a result of new experiences and instruction.

Another way to think about schema development is like the process of adding files to your new computer. With a new computer, you might initially begin adding files separately with very little organization. Over time, as you accumulate more files you begin to develop folders (think, a folder is a schema) in which to organize similar files. Consider how you rely on your computer or other device as a college student. You might choose to organize files and folders around semesters or courses or similar subject matter—whichever organizational structure makes most sense to you. Similarly, as you have new experiences in other areas of your life, you continue to add ideas and information into schemata—or the files or folders you have developed to hold information about the new experience that you had. As you will see, sometimes experiences are placed in existing schemata; at other times, experiences lead us to develop a new schema or reorganize the schemata we already have.

When Piaget talked about the development of a person's mental processes, he was referring to increases in the number and complexity of the schemata that individuals had learned. Once learned, those schemata were available for individuals to use to deal with, or identify and react to, whatever objects and events they encountered.

Intellectual Development as Adaptation

The basic tenet of Piaget's theory of development is that the organism interacts with the environment in a relationship called **adaptation**. In adaptation, the organism develops schemata that enable it to continue to function in that environment. The very essence of life is a continuing and repeatable interaction between the organism and its environment that enables the organism to function.

A bit simplistic perhaps, but let's think of adaptation as how we might organize information into a "mental filing system" (similar to our earlier "computer file" analogy) in order to respond effectively to the world around us. Suppose you encounter a friend's new pet. Do you already have a mental file to recognize the pet (as in, "My friend has a dog")? Do you need to "update" an existing file (as in, "My friend has a breed of dog I have never seen, so I need to update my *dog* file to include this breed")? Or is your friend's pet an animal you have never encountered (as in, "My friend says this animal is a sugar glider, so I need to create a new mental *sugar glider* file to store information about this new animal")?

Assimilation and Accommodation

Piaget (1952; see also Wadsworth, 2004) posited two mechanisms to carry out adaptation. The first, **assimilation**, is a process used to incorporate new information into existing schemata that are sufficient

to understand it. What this means is that when people encounter something new, they will try to deal with it (that is, recognize it or react to it) by using an existing schema or action plan. As a result, the schema is not changed essentially, but it is expanded to include the new experience and the result of the reaction to it. This coincides with your friend's breed of dog you had never previously encountered.

Assimilation is somewhat similar to the behavioral concept of stimulus generalization (see Chapter 6), in which students, after having learned to respond to one stimulus, such as the teacher clapping her hands to get attention, respond similarly to other stimuli that are like the original, such as the teacher holding up her hand. This tendency increases if the outcome of responding to the new but similar stimulus is as satisfactory (students give their attention to the teacher) as it was when they responded to the original.

Suppose you are teaching and a student who has not completed their work gives you an excuse you have never heard before. You already have a schema to deal with incomplete work, and you assimilate this experience into it and react to the student by giving them an additional assignment, as you would any other noncompleter, regardless of the circumstances. You have adapted to the new situation by using an already existing plan for dealing with it. You have not added a new schema; you have simply made an existing one fit.

By contrast, Piaget's second adaptive mechanism, **accommodation**, is a process used to modify an existing schema in order to be able to understand information that would otherwise be incomprehensible with existing schemata. This time, the person having the new experience cannot deal with it by using an existing schema; none fits it closely enough. That person must change an existing schema to create an essentially new schema in order to be able to make an adaptive response. This coincides with your friend's pet sugar glider. When what is known does not work in a given situation, something new must be tried.

To continue the earlier "mental filing system" and pet illustration, accommodation means that a person creates a new file by finding the closest existing one and then modifying it—in this case, you may choose your *flying squirrel*, or perhaps your *possum,* file to help you create your new *sugar glider* file. Similarly, as a new teacher, you may not have a schema for dealing with a student's incomplete work, but you might remember how your supervising teacher dealt with this issue and then modify that approach to fit the situation you are facing. Once you have done this, you will then have a schema for dealing with incomplete work and will probably be able to use it to assimilate future instances when the problem arises again.

Assimilation and accommodation are processes that enable children to grow and adapt to their environment continually. Assimilation helps children make better use of the schemata they have, and accommodation helps them alter their schemata to fit new situations. In assimilation, the situation is made to fit existing schemata, and in accommodation, existing schemata are changed or new ones developed to fit the situation. **Play**, according to Piaget (1952; Wadsworth, 2004), is an example of essentially pure assimilation in that something is done as it always has been—that is, as a simple, repetitive activity. **Imitation**, by comparison, is an example of essentially pure accommodation in that children do something that they have never done before by watching and copying it from someone else. All other experiences would fall somewhere in between.

Equilibration

According to Piaget, a balance must exist between assimilation and accommodation as well as between oneself and one's environment. Life cannot be all play because then nothing new would be learned. Neither can it be all imitation because then there would be no self or stability. There must be enough accommodation to meet and adapt to new situations and enough assimilation to use one's schemata quickly and efficiently. In other words, a state of equilibrium must exist between these two processes, which, in turn, makes possible a state of equilibrium between oneself and one's environment. When equilibrium or balance does not exist, something must be done to achieve it. That something is either accommodation or assimilation, depending on the circumstances. Carrying out these processes in an effort to restore equilibrium is called **equilibration**, and it represents the major source of motivation in Piaget's system. Equilibration is discussed further is the section Developmental Factors.

The basis for development of the increasing intellectual capacity of a child is equilibration. As new experiences occur, the young child is motivated to develop new schemata to deal with them through accommodation. Once these new schemata are developed, the young child is then motivated to use them through assimilation. The "index card file" is continually expanding, with each new development laying the foundation for subsequent developments in an orderly and progressive way. Since equilibrium is always only momentary and each new encounter creates disequilibrium, the process of equilibration or trying to attain equilibrium serves as a constant motivator of intellectual development throughout childhood.

Intelligence

To Piaget, intelligence is a combination of all of an individual's schemata (Siegler & Alibali, 2005). These schemata enable individuals to maintain equilibrium between themselves and the environment—to adapt to and deal with circumstances as they arise. Intelligence, therefore, is the regulating or adapting force, and as such is the result of assimilations and accommodations between a person and the surrounding world. Moreover, to Piaget intelligence does not represent content, or the amount of knowledge a person has. Rather, it represents *structure* or how what is known is organized so that it can be used. The particular organizational structures of intelligence are schemata, structures formed as the result of assimilation and accommodation.

This view of intelligence as adaptability, or capability of dealing with a changing environment, is quite different from the more common view of intelligence (described in Chapter 4) as either general or specific knowledge. To Piaget, intelligence is more like procedural knowledge, or knowing what to do, than it is like declarative knowledge, or simply knowing facts (these types of knowledge are described in Chapter 7).

Because intelligence is both the result of and the basis for assimilation and accommodation, it can be expected to vary considerably from age to age. As children have more and more experiences, they develop the structures or schemata that help them adapt to their environment. Piaget divided the development of intelligence into discrete stages, each with its own intellectual challenges to equilibrium.

Operations

What is intelligence used for—or put another way, what are its outputs? For Piaget, the answer was **operations**. Operations are systems or coordinated sets of actions for dealing with objects or events. Identification would be an operation, as would *addition* or *classification*. All of the actions a person can take within the systems of logic or mathematics constitute operations (Piaget, 1950; Wadsworth, 2004). As children mature, their thinking gets organized into more and more well-defined systems. That is to say, as children grow, they can perform more and more operations, and these operations become more and more complex.

Developmental Factors

Piaget's theory is a theory of development, or a theory of changes in intelligence over time. These changes, as we will see, are represented by stages that children go through and that are characterized by different adaptations as a function of existing schemata and the development of new schemata. Before these stages are described, it is useful to examine the four factors that Piaget (1961; Wadsworth, 2004) cites as contributing to cognitive development.

The first factor is **heredity**, or inheritance, which affects a child's rate of maturation. According to Piaget, maturation does not cause cognitive structures to develop. Rather, it determines the range of possibilities at a specific stage—that is, whether a particular structure can *possibly* develop at a specific stage, not necessarily whether it *will*. Hence, maturation places broad constraints on cognitive development. It provides the potential for the appearance of specific structures; but whether or not they do in fact appear depends on the next three factors.

The second factor is **active experience**, or children's actions in their environment. These actions can be physical or mental, and they can be with objects or people. Children who have a childhood rich in active experiences will be more likely to develop the structures that characterize each stage and to proceed through all four stages than will children whose experience base is limited or impoverished. Early school programs such as Head Start and participation or imitation-type television programs such

In the early years of life, social interactions with parents and caregivers are particularly instrumental in a child's development.

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as *Sesame Street* serve to increase the active experiences of children who, in particular, may lack the opportunity for such experiences in their everyday lives.

The third factor is **social interaction**, or the exchange of ideas among people. This is especially important in the development of ideas that do not have a physical referent—that is, ones that cannot be seen or heard, such as the idea of freedom or of fairness. Socially defined concepts depend very heavily on social interaction for their development. (This aspect of development will be covered in the next chapter.)

The fourth factor is equilibration, introduced earlier. Equilibration, according to Piaget (1977), accounts for the coordination between the other three factors. But beyond that, equilibration serves as a self-regulating device that enables the child to process new information through either assimilation or accommodation and to always be moving toward a balance with the environment.

These four factors, taken together, account not only for the continuous process of development but also for the dramatic changes that occur from one period or stage of development to another.

REFLECTION QUESTIONS

1. Besides those posed in the text, what other analogies could you use to explain how the brain organizes information?
2. How would your understanding of assimilation and accommodation guide how you might introduce a new topic to your students?
3. How might the four development factors guide your instructional practices to enhance student learning?

PIAGET'S FOUR STAGES OF COGNITIVE DEVELOPMENT

The four stages of development are not absolute in terms of either their timing or their characteristics. Rather, they represent a set of tendencies brought about by the four developmental factors described previously. Each is described in the following sections and in Table 2.1.

TABLE 2.1 ■ Piaget's Four Cognitive Development Stages

Stage	Approximate Age	Overview
Sensorimotor	0–2	Behavior is primarily motor, involving action schemata such as reaching and grasping. Circular reactions feature learning by repetition. Preverbal and prethinking. Ends with object permanence.
Preoperational	2–7	Development of language and prelogical thought. Focuses on self and own perspective with no ability to vary one's point of view. Unable to reverse operations.
Concrete operations	7–11	Development of ability to apply logic on the basis of concrete correspondence between event and explanation. Ability to conserve is developed.
Formal operations	11–15	Thinking structures reach their highest level of development, making possible the use of logical reasoning. Can think out explanations for events by considering combinations of variables.

Sensorimotor Stage (Infancy–Toddlerhood)

The sensorimotor stage extends from birth to the acquisition of language. At its inception, newborns do not distinguish themselves from surrounding objects; at its close, young children recognize themselves as one part of a much larger world (Piaget, 1967). The major themes of this stage relate to the progressive growth of children's concepts of *object* (things outside of oneself) and causality (cause–effect relationships). Piaget divides this stage into six periods, each of which features the appearance of more complex behaviors involving the connections between the senses (seeing, hearing, touching) and actual movements, or motor behavior.

The major assimilation activity of this stage is what Piaget (1950) called the **circular reaction**, in which infants try to reproduce interesting events or make interesting sights last. This repetition of events enables infants to assimilate experience and to make new adaptations, such as increasing their awareness of the existence of specific objects and understanding the relationship between cause and effect. Up to the fourth month of age, the **primary circular reaction** appears, with its focus on infants' own bodies and directed toward the manipulation of some object.

Piaget's method for discovering the characteristics and features of this stage was to observe his own children and report on their behavior at different ages. From about 4 to 8 months of age, the **secondary circular reaction** appears and is a clear illustration of what Piaget calls **reproductive assimilation**, or making interesting sights and events last. A familiar example is the infant throwing a toy out of the crib, entreating someone to give it back, and immediately throwing it out again. The whole sequence is repeated over and over until it becomes tiresome.

Following a period (age 8–12 months) that features the coordination of schemata and the appearance of intentionality of action, the **tertiary circular reaction** is exhibited (age 12–18 months), evidenced by the invention of new means, through active experimentation, to accomplish ends. Children now intentionally vary repetitions to see if similar actions have the same effect. They may, for example, drop a rubber object and then wait for it to bounce. These children have discovered that people as well as objects can cause outcomes that are completely independent of their own actions.

When the sensorimotor stage ends (18–24 months), children have begun to learn how to talk and have become able to represent objects and events mentally by thinking about them. New learning can now be accomplished without active physical experimentation but by the representation of action through thinking.

A major capstone of the sensorimotor stage, representing an important state of equilibrium, is the emergence of schemata that make possible the realization of **object permanence**, even when the objects are out of sight and hearing. Heretofore, a child was unable to represent objects in the mind; hence, when objects could no longer be seen or heard, they no longer existed. Now, with the emergence of the ability to store ideas, object permanence becomes a reality. The same is true for **causality**. The availability of thought makes possible the awareness of causality.

When children reach age 2, they are quite different from the newborns. As infants proceed through the six sensorimotor periods, new and more sophisticated capabilities emerge, each making them better equipped to deal with life's demands. The development and use of each new schema through assimilation and accommodation is a reflection of the adaptive process that Piaget viewed the development of intelligence to be.

Preoperational Thought Stage (Early Childhood–Early Elementary)

The ability to represent ideas in the form of symbols and signs, such as words and numbers, makes its appearance during this stage and helps distinguish the actual thinking of this stage from the mere sensory and physical coordination of the preceding one. Piaget describes the four essential features of preoperational thought (Piaget, 1951, 1952; Piaget & Inhelder, 1969).

Egocentrism

Egocentrism is a preoccupation with oneself and one's own point of view. Egocentric preoperational children cannot take another's point of view; they believe that everyone sees and thinks the same things as they do. Moreover, preoperational children do not question their own thoughts even when presented with evidence to the contrary. They believe, although not intentionally, that their ideas and perceptions

are right. Hence, reasoning with them ranges from difficult to impossible. It is not uncommon for preoperational children to talk to themselves and to fail to listen to someone who is speaking to them.

Egocentrism is a factor that acts to limit development, and it manifests itself in some form in every stage. Just sensorimotor children are initially egocentric in failing to distinguish themselves as an object from other objects, preoperational children are initially egocentric in failing to differentiate between their own thoughts and the thoughts of others. This tendency lessens as children proceed through this stage.

Centration

Centration occurs if preoperational children, when presented with a visual stimulus, focus or center all their attention on only one aspect or dimension of the stimulus at a time. Any thinking task is dominated by perception, or what things look like, since children focus on *appearance*. Consider the following two arrays in Figure 2.2.

FIGURE 2.2 ■ Two Arrays

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When asked which array has more objects, preoperational children typically pick Array 2, even though it has fewer objects and they "know" that. Array 2 is seen as having "more" because preoperational children center on the appearance or length of the two arrays, and Array 2 looks longer.

Nontransformational Reasoning

Preoperational children do not focus on the transformation of an object from an original state to a final state. Instead, they focus on the elements in the sequence or each successive state, not on the changes that have occurred between states, which is known as **nontransformational reasoning**. For example, when 4-year-old children were shown a glass of water that was then poured into another glass hidden behind a screen, many correctly realized that the unseen glass had as much water in it as the original glass. However, when the water in the first glass was poured into a smaller glass that the children could see, they all said that the second, shorter glass held less water than the original (Bruner, 1961, 1964). The preoperational children were focusing on only the original state and the final state, disregarding the transformation between them. Nontransformational reasoning makes logical thinking impossible.

Irreversibility

Irreversibility, the inability to reverse thought or follow a line of reasoning back to where it started, is, according to Piaget (1954), one of the most important characteristics of this stage. In order to realize that something that has changed in appearance but has not changed in amount, children must be able to reverse the operation of change in their mind and mentally restore that thing to its original appearance. If someone runs into your car and dents it, you can still tell that it is your car and imagine or visualize what it looked like without the dent. That is because operational thinking enables you to reverse an event, to think backward. Preoperational thinking does not. For a preoperational child, thinking is irreversible. Once something has changed, it is a "new" thing, different from the original.

If preoperational children are given two equal-length rows of eight coins each, they will recognize that the two rows are equal. If one of the rows is lengthened while they are watching, children will perceive that the lengthened row has more coins (Wadsworth, 2004). Preoperational children cannot reverse or undo the lengthening in their mind to "see" that it still contains the same number of coins

it did before—only now they are further apart. Children at this stage cannot reverse an action, so they depend solely on perception or appearance to make judgments.

Piaget's four concepts of egocentrism, centration, nontransformational thinking, and irreversibility are all closely related. When children focus on themselves, judge things by a single dimension, and ignore the transformations or actions that cause things to change, it follows that they will be unable to do reverse thinking or to visualize a thing as it once was. Since physical reality usually goes in one direction only—forward—preoperational children lack physical models for reverse thinking. It is only when maturation and experience combine to help these children overcome egocentric, centered, nontransformational patterns that the mental capability for reverse thought becomes possible.

CLASSROOM CONNECTION: LITERACY PARTY FOR CHILDREN IN THE PREOPERATIONAL STAGE

A rural elementary school held monthly meetings where teachers and administrators brainstormed solutions to challenges that the school faced. One of the challenges they identified was how to encourage literacy among their kindergarten classes. They were a small school district and only had two kindergarten classes with 15 students in each class.

One idea that a teacher offered was having the high school students in the district give a literacy party for the kindergarten students. The other teachers thought this might be a good start since the younger children really looked up to the high school students. They consulted with the high school leadership team, and they decided that pairing one high school student with a kindergarten student might be a good way to organize the party. After the elementary and high school teachers collaborated to plan the party, the day finally arrived. First, they played a game to introduce the elementary and high school students. Then the school media specialist read her favorite story to the group. Next, they played a game where the media specialist called out a word and the students clapped out the syllables in the word. The excitement of the day made everyone hungry and thirsty, even the high school students, so next they prepared the table for refreshments.

The 30 high school students poured punch into different-shaped cups. There were 30 very wide cups and 30 narrow ones. They filled them so that the narrow glasses were filled just a bit higher than the wide ones. When the kindergarten students went up to the table to get food and punch, they checked out the level of each glass. The kindergarten students quickly reached for the narrower glasses, laughing and saying that they had more punch than any of the high school students. To a kindergarten child, a narrower, taller cup appeared to contain more punch than a wider, shorter cup.

Reflect as a Student

How does Piaget's theory of cognitive development help you to understand why the kindergarten students all quickly reached for the narrower cups?

Reflect as a Teacher

What are two or three specific ways you might apply Piaget's theory of cognitive development in a kindergarten classroom?

Concrete Operational Stage (Elementary–Middle School)

The concrete operation stage is the stage when children develop the capacity for logical operations—thinking characterized by mental actions or internalized thoughts that are reversible and therefore allow children to arrive at logical conclusions.

According to Piaget (1970), logical operations have four characteristics: (1) They are actions that can be carried out in the head; (2) they are reversible; (3) they assume some invariance or conservation (defined later); and (4) they are part of a system.

Up until this stage, the child's thinking has been rooted in the visible or perceptual world. Any discrepancy between perception and logic has been resolved in favor of perception. In the concrete operational stage, however, thinking shifts to the cognitive, logical realm, enabling children to solve concrete problems in their head. Concrete operational thinking is less egocentric and less centered than preoperational thinking. Moreover, it is both transformational and reversible, enabling children to solve a wide variety of conservation problems.

Although concrete operational thought is more advanced and logical than preoperational thought, it still has its limitations. Its logic can be successfully applied only to real, observable objects in the immediate present (Inhelder & Piaget, 1958; Piaget, 1972). Its logic cannot be applied with the same degree of success to solve problems that are hypothetical or abstract, such as those that involve both multiple variables and the application of abstract principles.

Conservation is a key milestone indicating a child has moved from the preoperational to the concrete operational stage.

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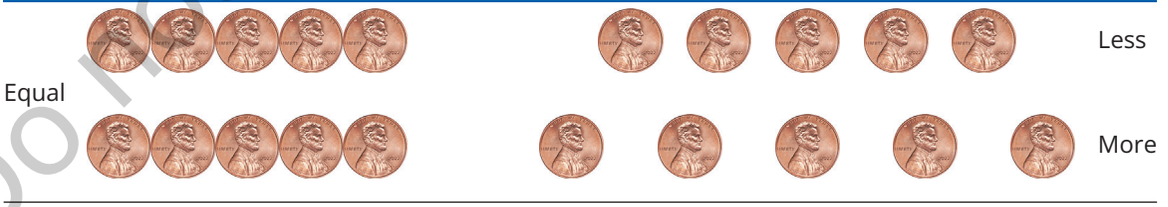
Conservation

Conservation is the development of a schema that enables children to realize or recognize that the amount or quantity of something stays the same even when its shape or arrangement is changed (i.e., regardless of changes in any dimension irrelevant to the amount or quantity; Wadsworth, 2004). As the transition occurs from preoperational thought to concrete operational thought, the ability to conserve appears. It is not likely to appear while the preoperational child's thinking is strongly characterized by egocentrism, centration, nontransformational thinking, and irreversibility because these patterns are antithetical to being able to perform a mental operation like conservation, which is both logical and independent of the way things look. Therefore, the ability to conserve does not appear until near the end of the preoperational stage and does not become developed until children enter the stage of concrete operations.

However, the emergence of conservation is a gradual process. It stretches from about age 5 or 6, when conservation of number appears, to about age 11 or 12, when conservation of solid volume appears. Within this period, conservation of area and of liquid volume appears (ages 7–8).

Children can conserve when they can recognize that the number of pennies or dots in each of two rows is the same, even when those in one row are further apart than those in the other row (as shown in Figure 2.3). This is called **conservation of number**.

FIGURE 2.3 ■ Conservation of Number Example



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Children can also conserve when they can recognize that the area within two shapes is the same, even if the shapes are arrayed differently (as shown in Figure 2.4). This is called **conservation of area**.

Finally, children can conserve when they can recognize that the amount of water in two glasses of different shapes is the same, even though the level of one is higher (as shown in Figure 2.5). This is called **conservation of volume**.

Piaget contended that conservation ability cannot be taught directly and cannot be acquired until children are ready developmentally. He believed that development of conservation depended on a

FIGURE 2.4 ■ Conservation of Area Example

When the squares below are arranged in a similar fashion, most young children agree that the combined area of A and B squares paired in the first column is the same as the combined area of A and B squares paired in the second column.

However, when the two pairs of A and B squares are rearranged so that they do not look alike, such as seen in the example in the third column, children who have not learned conservation of area will believe that one of the arrangements below has more (or less) area than the other arrangement.

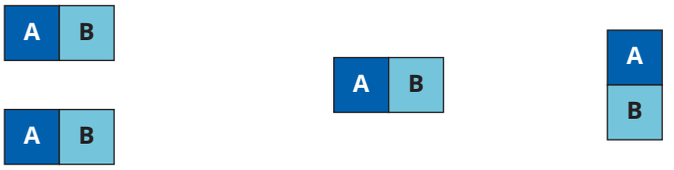
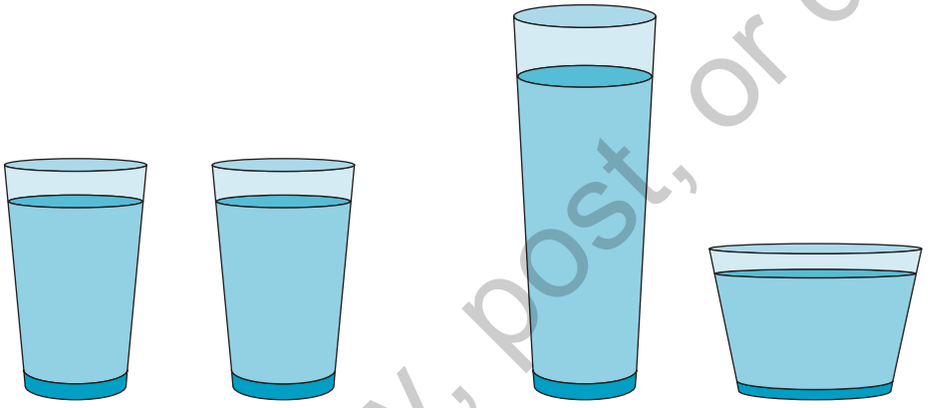


FIGURE 2.5 ■ Conservation of Volume Example



These two look the same.

This one (tall glass) looks like more than this (wide glass), and this one (wide glass) looks like less than this (tall glass).

combination of maturation and relevant direct experience that enabled it to evolve "spontaneously." However, others have shown that the mastery of conservation skills can be accelerated somewhat through teaching (Halford & Andrews, 2006; Pasnak et al., 1987).

Inversion and Compensation

One form of reversibility used by concrete operational children Piaget (1967) called **inversion**. Inversion is the application of reversibility to problems of order or sequence. Wadsworth (2004) reports on a study in which three Ping-Pong balls were put in a tube: first a black ball, then a white ball, then a striped ball. Both preoperational and concrete operational children realized that the balls would both exist within the tube and exit the tube in the same order in which they entered: (1) black, (2) white, (3) striped. Then the tube was inverted, turned upside down. Now, while the preoperational children still thought the balls would exit in the order they entered, the concrete operational children realized that, because of inversion, the balls would exit in the opposite order: (1) striped, (2) white, (3) black.

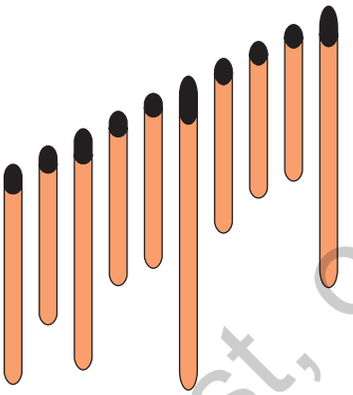
Concrete operational thinking also features a second kind of reversibility called **compensation**, which reflects the logic of one dimension compensating equally for another. For example, in conservation of volume, when the liquid is poured from the short, squat container into the tall, thin one,

concrete operational children realize that the amount of water is the same because the increased height of the container is compensated for by its narrowness. They recognize the relationship between height and width when estimating volume. If height becomes taller and width compensates for it by becoming thinner, then volume can remain the same.

Seriation

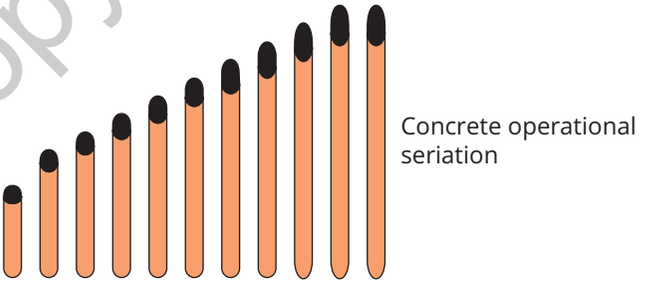
Seriation is the ability to mentally arrange a set of elements in increasing or decreasing order along some dimension, such as size, weight, or volume. Typically, researchers test this by having children arrange a set of sticks in order of length. Preoperational children, because of their inclination toward physical centering, tend to align the sticks according to the heights of their tops, with little regard to the alignment of their bottoms, as shown in Figure 2.6.

FIGURE 2.6 ■ Preoperational Seriation



Children at the stage of concrete operation order the sticks correctly by maintaining an equal alignment at the bottom, as shown in Figure 2.7.

FIGURE 2.7 ■ Concrete Operational Seriation



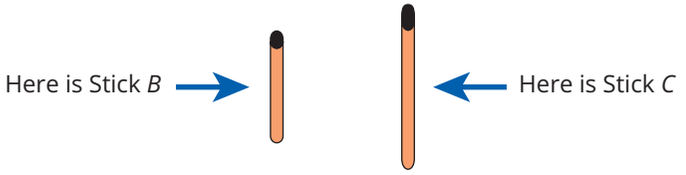
To perform seriation correctly, children must understand the principle of *transitivity.* Transitivity, as illustrated in Figure 2.8, is the realization that if *B* is greater than *A*, and *C* is greater than *B,* then *C* is greater than *A.* Using transitivity, children would recognize in the example in Figure 2.8 that the correct increasing order of the three quantities would be *A, B, C.*

Classification

Classification (in child development) is the ability to put together objects that are alike, such as geometric shapes (Piaget, 1972; Piaget & Inhelder, 1969). To accomplish this, children must understand the principle of *class inclusion*—namely, that objects of the same class or overlapping classes can be combined and that a class includes all possible subclasses. Using a concept to label things that are alike

FIGURE 2.8 ■ Demonstrating the Principle of Transitivity in Solving Seriation Problems

1. Which one is longer, A or B?



(Cover up stick A.)

2. Which one is longer, B or C?

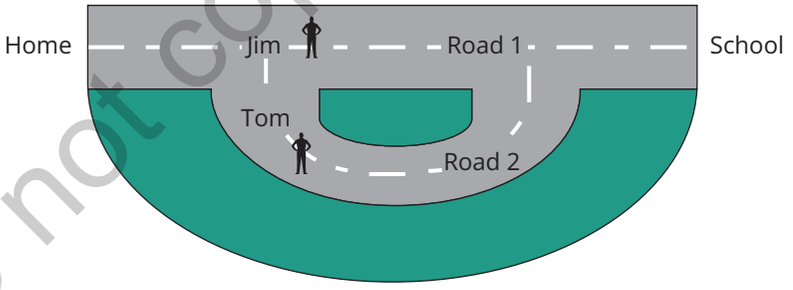
3. Which one is longer, A or C?

(Transitivity is required for students to be able to answer Question 3; preoperational children are not likely to answer it correctly.)

in some respect—say, all kinds of fish—is an example of classification. Gagné et al. (1992) included both concrete and defined concepts as categories of intellectual skills (see Chapter 12).

Consider this experiment by Piaget (1952): A child is given 20 brown wooden beads and 2 white wooden beads and is asked, Are there more wooden beads or more brown beads? Concrete operational children realize that the class "wooden beads" includes the classes of brown beads and white beads. In this experiment, there are 22 wooden beads (20 brown beads plus 2 white beads) compared to just 20 brown beads. The number in a total class includes the sum of the numbers in all of its distinct subclasses. This is class inclusion. Without this capability, preoperational children believe that brown beads outnumber wooden beads because they compare brown beads to white beads, not to total beads. This stage also features the development of the ability to combine dimensions such as time and distance, as illustrated in Figure 2.9.

FIGURE 2.9 ■ Demonstrating the Principle That Distance = Speed x Time



Note: Tom and Jim are brothers. They leave home at the same time and arrive at school at the same time, even though Jim takes Road 1 and Tom takes Road 2. Did they travel at the same speed? If not, which boy traveled faster? (Preoperational children are not likely to answer this correctly.)

Formal Operational Stage (High School–College)

In the **formal operational stage**, children are able to reason in a logical manner using abstract schemata and can use this reasoning power to solve scientific problems (Moshman, 1998). However, not all students reach this stage of logical reasoning. Only about half of the U.S. student population attain this level of formal operations, the remainder staying in the preceding stage of concrete operations (Schwebel, 1975).

Whereas concrete thought is limited to solving tangible problems in the present, formal thought makes it possible to go beyond experience to solve complex, hypothetical problems such as the ones that will be illustrated later in this chapter. Using formal operations, a student can make hypotheses about what is going to happen based on general or abstract principles and then can test those hypotheses in a scientific manner.

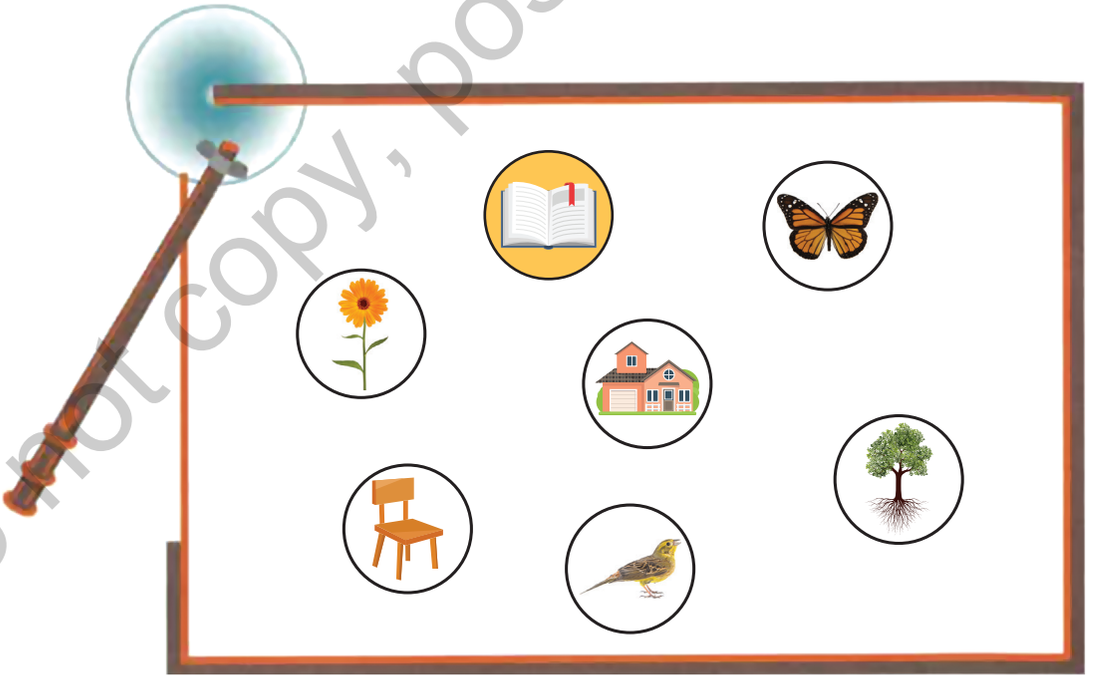
According to Inhelder and Piaget (1958), formal operational schemata enable students to engage in (1) hypothetical deductive reasoning—that is, reasoning in which specific inferences or conclusions are drawn from a set of general premises; (2) scientific-inductive reasoning, or reasoning in which general conclusions are drawn from a set of specific facts; and (3) combinatorial reasoning, or reasoning about a number of variables at the same time. These processes cannot be carried out with concrete operational schemata.

Some of the formal operations of this stage are described in the next section in the context of specific experiments conducted by Piaget and his coworkers to illustrate these operations (as reported by Inhelder & Piaget, 1958). These experiments can be recreated by both elementary and secondary school teachers in their classrooms to help their students discover and develop both concrete and formal operations. (The discovery learning approach is also discussed in Chapter 12.)

Reciprocal Implication

The principle of compensation has already been introduced in conjunction with concrete operational thought. In solving conservation problems, concrete operational children realize that quantities can remain the same even though one dimension increases if a second dimension compensates for it by decreasing to the same degree. In formal thought, the conservation principle can be extended to more complex relationships in which one dimension is the reciprocal of the other, being equal to and opposite from it, known as **reciprocal implication** (see Figure 2.10).

FIGURE 2.10 ■ The Billiard Game



Note: The principle of the billiard game is used to demonstrate the angles of incidence and reflection. The tubular spring plunger can be pivoted and aimed. Balls are launched from the plunger against the projection wall and rebound to the interior of the apparatus. The circled drawings represent targets placed successively at different points.

In The Billiard Game, shown in Figure 2.10, balls are shot from a plunger and banked off a cushion in an effort to hit balls already positioned on the table. The operating principle, which the children must discover, is that the angle at which the ball hits the cushion (or angle of incidence) is equal to the

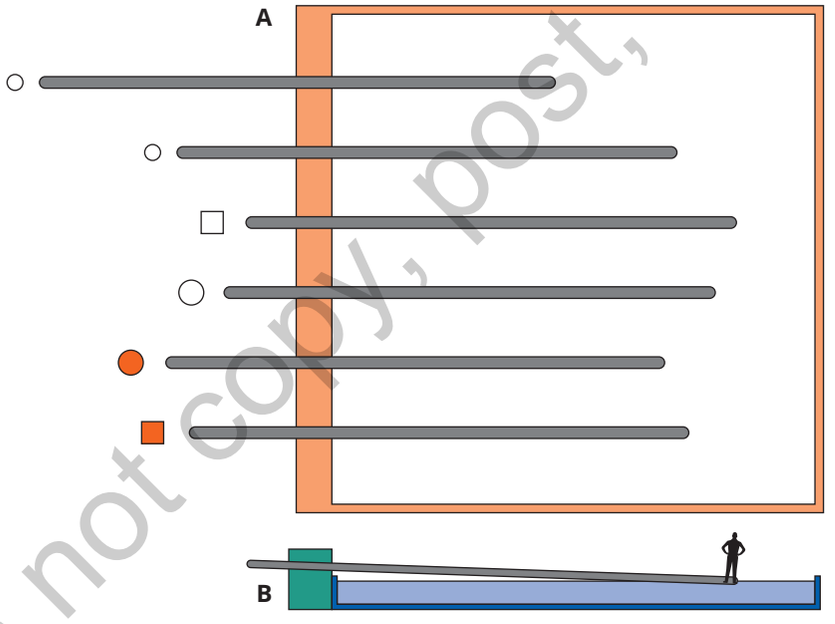
angle at which the ball comes off the cushion (or angle of reflection). Each angle implies or leads to its own reciprocal or exact opposite. Preoperational children, in this as in all the experiments, can describe only what they see or what they do ("I think it works because it's in the same direction!' or "It always goes over there").

Concrete operational children discover the **concrete correspondence** between what they do and what results from their action ("the more I move the plunger this way—to the left—the more the ball will go like that—on that sharp angle"). It is only at the stage of formal operations that students discover and report that the two angles, the one striking the cushion and the one coming off it, are, in fact, the same. They see the necessary reciprocity between the inclination of the plunger and the angle made by the trajectory of the ball off the cushion.

Separation of Variables

The flexibility experiment is used to illustrate the ability of formal operational students to separate out the independent effect of a number of variables at the same time. The idea is to control the effects of all of these variables at the same time, except one—the independent variable. The apparatus is shown in Figure 2.11. The rods can be (1) extended in length (long) or retracted (short); (2) thick or thin; (3) round or square in cross-section; (4) wood or metal; or (5) fitted with a light or heavy object at the unattached end. The objective is to determine which combination of these five variables yields the greatest flexibility, or bend. If each rod is thought of as a "diving board," the question becomes this: Which combination of variables would make a diving board that bends the most toward the water when jumped on?

FIGURE 2.11 ■ The Flexibility Experiment



Note: Diagram A illustrates the variables used in the flexibility experiment. The rods can be shortened or lengthened by varying the point at which they are clamped (see A for apparatus used). Cross-section forms are shown at the left of each rod; shaded forms represent brass rods, and unshaded forms represent non-brass rods. Dolls are used for the weight variable (see B). These are placed at the end of the rod. Maximum flexibility is indicated when the end of the rod touches the water.

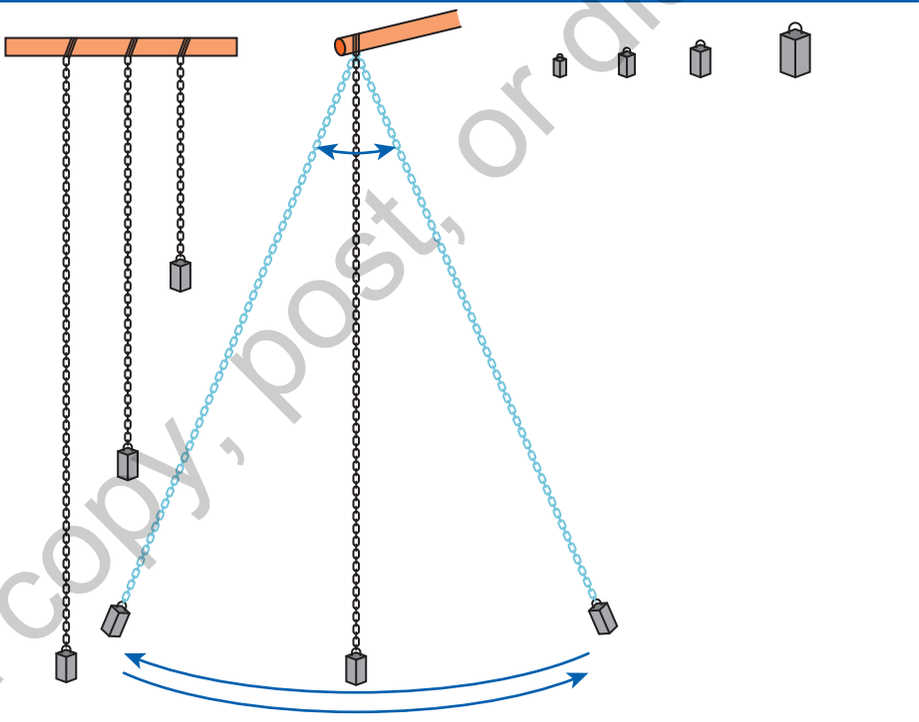
Preoperational children try random combinations and report what they see regardless of contradictions ("It doesn't work because it's too high!"). Concrete operational students try different combinations but fail to see how one dimension compensates for another because they vary more than one dimension at a time. If the rods are made longer and thinner at the same time, it is impossible to tell whether both dimensions contribute to flexibility or only one does. If a rod is made longer and thicker at the same time and there is no change in bend, the concrete operational student might think that neither matters; in fact, both do, but the changes are actually compensating for one another.

Formal operational students understand that the key is the **separation of variables**—testing or varying one variable or dimension at a time while holding all the others constant. In this way, they discover, for instance, that "a rod made of the same material as another but thicker rod may bend an equal amount providing it is lengthened" (Inhelder & Piaget, 1958, p. 63). By being systematic and separating variables, students figure out the extent to which one dimension can compensate for another.

Exclusion

The principle of **exclusion** is illustrated by the pendulum problem, shown in Figure 2.12. To create a pendulum, the teacher or researcher simply suspends a weight from a string. The student then causes the weight to move back and forth, or oscillate, by pulling it back and applying a force. The variables that can be changed are (1) the length of the string; (2) the amount of weight at the end; (3) the height of the dropping point—that is, the distance the weight is pulled back (see the dashed lines in the figure); and (4) the force with which the weight is pushed forward. The objective is to determine which variables affect the number of times the pendulum will swing back and forth (the frequency of oscillations: the number of swings per minute, not the size of the swing or how far the weight swings).

FIGURE 2.12 ■ The Pendulum Problem



Note: The pendulum problem uses a simple apparatus consisting of a string, which can be shortened or lengthened, and a set of varying weights. The other variables that at first might be considered relevant are the height of the release point and the force of the push given by the subject.

Think of the pendulum as a child's swing in the park. A parent is pushing the swing and wants to push it so that it swings back and forth the most number of times during the next full minute. The parent can vary (1) the length of the swing by picking a short one or a long one; (2) the weight of the child (perhaps putting one child or two on the swing); (3) how far the swing is pulled back; and (4) how hard the swing is pushed forward. Which combination should the parent choose?

In this experiment, as in the preceding one with the bending rods, it is important that the student vary only one of the variables at a time to avoid being misled by compensating relationships between variables. If length were increased and weight decreased, and length and weight happened to compensate for one another, the relationship would never be discovered because the result would be no change.

Weight, pull distance, and push force must all be held constant while length is varied. Then length, pull distance, and push force must all be held constant while weight is varied and so on, until each variable has been tested by itself, independent of the others. Only then can the effect of each variable be discovered. (Again, this is the basic principle of experimental research described in Chapter 1.)

Preoperational children cannot separate or dissociate the force they apply from the motion of the pendulum, which is independent of their action ("If you put it very high, it goes fast"). Concrete operational students vary several variables at the same time and hence cannot separate those that have an effect from those that do not ("You have to try to give it a push/to lower or raise the string/to change the height and the weight").

It is at the stage of formal operations that students realize they must vary only one variable at a time while holding the others constant. By so doing, they discover the principle of exclusion: that only the length of the string, not any of the other variables, affects the frequency of oscillations ("When the string is short, the swing is faster"). Three of the variables or factors must be excluded from the explanation because only the fourth—length of the string—affects the outcome, and this discovery can be made only if factors are tested one by one.

REFLECTION QUESTIONS

1. What are potentially effective (or ineffective) teaching strategies when working with children in the sensorimotor stage?
2. What are potentially effective (or ineffective) teaching strategies when working with children in the preoperational stage?
3. What are potentially effective (or ineffective) teaching strategies when working with children in the concrete operational stage?
4. What are potentially effective (or ineffective) teaching strategies when working with children in the formal operational stage?

APPLYING PIAGET TO EDUCATIONAL PRACTICE

Several practical characteristics of school can be derived from the work of Piaget. By understanding Piaget's work, teachers can critically reflect on their teaching practices and better organize their classrooms to help students develop and learn. Teacher actions based on Piaget's ideas include helping children learn through exploration, learner-centered instruction, using themes, and helping students develop schemata. Teachers encourage student development by giving students the opportunity to learn by doing, participating in activities aligned to their needs, and exploring how concepts fit together through themes.

Learning Through Exploration

According to Piaget (1973), intellectual development depends on constructive activity, with all the errors that may result and the extra time that may be required. Assimilation and accommodation require an active learner, not a passive one, because problem-solving skills cannot be taught, they must be discovered (Piaget, 1958). Hands-on classroom activities are recommended for teaching students the process of learning through exploration (sometimes termed ***discovery learning***) in a way that is appropriate to their level of development because they increase the likelihood that they will develop necessary problem-solving skills (Isaacson et al., 2016; Wu & Albion, 2019).

Exploration also means experimentation. Building things, using things, trying them out, making them work, "playing" with them, and trying to answer questions about how and why they work is the essence of Piaget's approach to development. The opposite of his approach is simply transmitting knowledge to students verbally in lecture or "cookbook" form.

Piaget believed schoolchildren learn best by doing, exploring, and actively participating, much like they learned in infancy and toddlerhood.

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Lesson plans based on Piaget's work would not be simple summaries of content to be transmitted. They would include activities for children to engage in, demonstrations for them to watch, and questions for them to answer. Student roles would be both active and self-directed, much more like the model of discovery learning than like the model of direct instruction or most of the other models described in Chapter 12. Piaget's approach, in fact, can be best described as an example of constructivism because of its emphasis on active learning and the construction of knowledge (Wadsworth, 2004).

Learner-Centered Instruction

In learner-centered instruction, the learner, rather than the curriculum or any national testing program, should be the basis for teaching. Instructional choices, rather than a strictly defined or prescribed set of skills to be mastered, would reflect where the individual learner was in the developmental sequence. The learner-centered orientation would also be reflected in the approach to evaluation, which would be individualized and based primarily on observation rather than on any large-scale or lockstep testing program. Much learning would take place individually or in small groups engaged in different learning activities or tasks, rather than through whole-class instruction with the teacher being available to answer individual questions and to function as a guide.

In addition, the physical structure of the classroom should also be designed to enhance student activity and self-direction. The learner-centered classroom would be divided into learning centers where students would go to interact directly with a set of specific learning materials. Students would move from center to center to be exposed to and learn about different ideas.

One way to provide students with activities in conjunction with learning centers is to provide **task cards**. Each task card presents students with a concrete task that enables them to apply many of the Piagetian processes appropriate to their grade level. Tasks should be relevant to the children's experiences, inherently motivating to do, and connected to topics and content that are important for the children to learn.

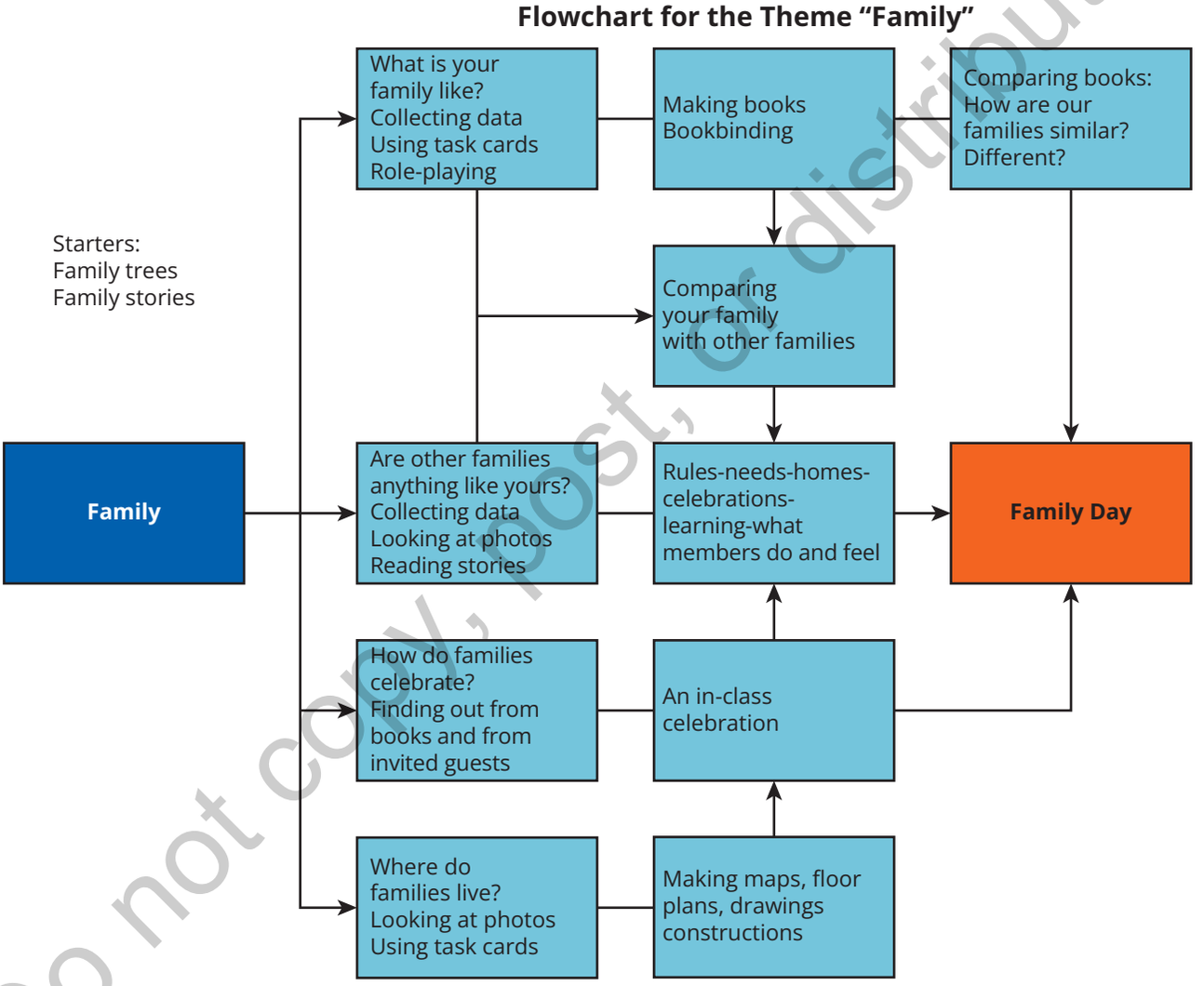
Much like learning through exploration, learner-centered instruction builds on the Piagetian principles and his underlying theory that children are innately geared to explore, adapt, and develop. Thus, from this perspective, teachers should be less directive in their instruction; instead, they should rely on and cooperate with their students' natural desire to interact with and understand their world. The teacher's role then becomes more of an orchestrator and facilitator of learning experiences and opportunities for discovery and less of a disseminator of information.

The teacher is available to answer individual questions and to function as a guide while each small group of children engages in different learning tasks based on the various environmental sources. Several cooperative learning approaches that are learner-centered are described in Chapter 9.

Using Themes

If one follows Piaget, then the resulting curricular emphasis will be less on discrete subject-matter knowledge and more on integrated, interdisciplinary topics, or **themes**. Themes like probability, trees, ecology, the family, and the automobile provide vehicles for learning about and using science, mathematics, social science, and language arts in an integrated way. With a thematic approach, it is the process of acquiring information rather than the information itself that takes on the greatest importance. In other words, the important skills become the "how-to" skills. Figure 2.13 shows a "flowchart" for a unit on the theme of family.

FIGURE 2.13 ■ Flowchart for the Theme "Family"



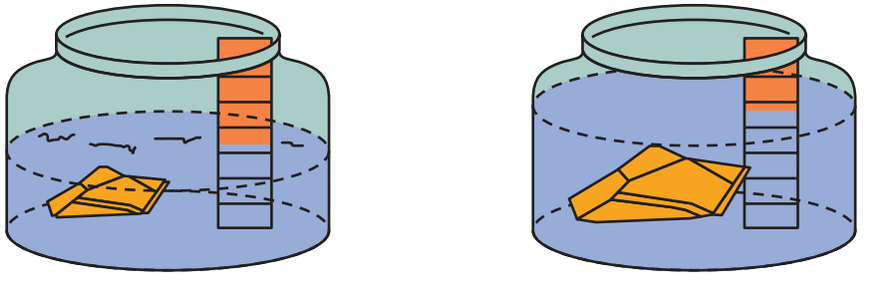
Focus on Developing Schemata

Similar to the idea of using themes, at the appropriate time developmentally, instruction in mathematics and science would focus on helping children with developing schemata aid their problem-solving (see Chapter 8). In the early and middle elementary grades, for example, children could be taught to solve conservation problems correctly (Gelman & Gallistel, 1978) or even problems involving proportional reasoning (Fujimora, 2001). In the late elementary and early middle grades, the conceptual focus would be on tasks involving seriation, classification, inversion, compensation, and the use of concrete correspondence. Starting in the final grades of middle school and extending through high school, the emphasis would be on teaching logical reasoning and critical thinking rather than on rote memorization of facts

and formulas. In every instance, the teaching focus should be on helping students to develop schemata that would enable them to understand and explain phenomena in the world around them.

Some examples of teaching concrete correspondence through measurement and comparison in the elementary grades are shown in Figure 2.14. Such measurement activities help children develop the various schemata required for concrete operations. For the development of formal operational schemata, experiments patterned after those described on the preceding pages can be used.

FIGURE 2.14 ■ Examples of Teaching Concrete Correspondence Through Measurement and Comparison



Volume of stone (a) is 3 "spinks"

Volume of stone (b) is 4½ "spinks"

Stone (b) is larger — 4½ : 3
4½ – 3 = 1½

REFLECTION QUESTIONS

1. What educational opportunities or challenges might arise if teachers choose to use learning through exploration in their classrooms?
2. How is learner-centered instruction different from more traditional curriculum-driven instruction?
3. Why would teachers want to use themes in their instruction?

A CRITIQUE AND UPDATE OF PIAGET'S THEORY

Piaget's theory of cognitive development is rich and descriptive in detail and deals with a wide array of situations. Its conception of developmental stages has survived scrutiny for many decades. Many of its concepts are currently in use today, and many of its findings have been supported by more recent research (Siegler & Alibali, 2005).

One aspect of Piaget's theory, however, has been contradicted by new studies—namely, descriptions of the cognitive capabilities of infants and young children. Some researchers argue that we must continue to study child's philosophizing (Walczak, 2019). The work of scholars, including Baillargeon (2004), Cohen and Cashon (2006), and Gelman (1990), show that aspects of concepts such as object permanence and conservation appear earlier than proposed by Piaget. Other recent scholarship, suggests that Piaget's explanation of equilibration changed over time (Burman, 2016). While accurately describing these concepts, Piaget's observations reflected a tendency to underestimate their age of origin.

Recent studies of capabilities, such as object permanence (related to the game of "peek-a-boo"), suggest infants and children develop some cognitive skills earlier than Piaget proposed.

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Another aspect of the theory that has not been entirely supported by newer studies is the clear demarcation between the stages. For example, Siegler and Alibali (2005) report studies that found that search skills required for locating lost or hidden objects develop over a long period, stretching from the ages of 1 to 4. On more advanced conservation tasks, while characteristic ways of reasoning have been found to be associated with specific narrow age ranges, ages at which specific problems are solved tend to vary more than suggested by Piaget's work. Moreover, some research suggests that children can learn more than supposed by Piaget, depending on the task and the nature of the instruction provided (Beilin, 1977). A review of studies showed that when a task is simplified, some students at the elementary school level are able to solve relatively abstract problems (Metz, 1995).

Additional research suggests that today's high school students may not demonstrate formal operational thinking skills comparable to those reported by Piaget (Kuhn & Franklin, 2006). However, if training in these skills is provided, students have been found to reach higher levels of reasoning at a faster rate than reported by Piaget (Kuhn, 2006).

Piaget has been criticized for failing to consider cultural influence on development since culture has a pervasive effect on children's language, experience, and interactions (Halford & Andrews, 2006; Rogoff, 2003). Vygotsky's theory, discussed next, makes up for this by its heavy emphasis on cultural factors. Despite possible shortcomings such as those described, Piaget's theory still merits close attention because it provides a clear, overall view of how children think. It has also helped those who followed Piaget to identify the questions about children's cognitive development that remain to be answered. Additionally, recent research argues that Piaget's developmental stages remain useful for identifying developmental change (Lourenco, 2016).

Regarding the updating of Piaget's theory, the best known neo-Piagetian theory was developed by Case (1985, 1992). His description of the four stages is similar to Piaget's but with the preoperational

stage renamed "representational operations" and the concrete operational stage renamed "logical operations." His view of the developmental sequence is also similar to Piaget's. However, he differs somewhat in his idea that children's thinking is organized into three central conceptual structures or internal networks of concepts that focus on numbers, space, and stories (Case & Griffin, 1990). The greatest difference between Case and Piaget is Case's incorporation of the information-processing approach (which you will encounter in Chapter 7). Working memory functions with increasing efficiency as children develop, based on amount of practice and biological maturation, the latter resulting in changes in electrical activity in the brain (Case, 1985, 1992).

REFLECTION QUESTIONS

1. How might some of the critiques of Piaget's theory influence how you would use the theory to guide your classroom instruction?
2. Do you think Piaget's theory is still useful for teachers to understand child development and plan their classroom instruction? Why or why not?

THE DEVELOPMENTAL PSYCHOLOGY OF LEV VYGOTSKY

Lev Vygotsky studied the development of children's thinking from the1920s to his untimely death in 1937. His work ultimately became well-known and popular in the 1970s and 1980s when it was translated into English (Vygotsky, 1978, 1987a, 1987b). He proposed that adults contribute to the cognitive development of children by helping them perform challenging tasks and then talking with them about the experiences. In particular, he emphasized the importance of society and culture in promoting children's cognitive growth, thus leading his approach to be regarded as a **sociocultural perspective**.

Vygotsky's sociocultural perspective emphasizes how adults, society, and culture contribute to a child's cognitive development.

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Social Interaction: Its Critical Role in Acquiring Meaning

Social interaction with adults, such as parents and teachers, was proposed by Vygotsky (1978) as the way children learn about the meanings and cultural interpretations associated with objects, events, and experiences. In particular, language—either spoken or written—is what mediates between the situations encountered and the meanings they convey, but music, art, or various kinds of symbols can help play that role as well. This is regarded as the **social construction** (or co-construction) of meaning and represents the foundation of Vygotsky's approach.

For example, when adults read a book to a child, explaining and answering questions as they go along, aspects of the book (e.g., situations, characters, actions, consequences) take on meaning to the child in the child's social and cultural context. This represents an informal way to provide information and interpretations, in contrast to the formal ways used by teachers through lessons and projects and other classroom-related activities. A teacher bringing her collection of Mexican art to class to illustrate aspects of Mexican life and culture, for example, can help to convey meaning to her students of the relation between art and the values and interests of the people who make it.

Internalization: Evolving of Social Activities Into Mental Activities

In addition to learning meaning, according to Vygotsky, the **cognitive tools** for acquiring meaning also come from the social interaction process through the process of **internalization**. As a result of

internalization, children begin to give themselves the instructions to guide their behaviors that heretofore have been provided by others. Thought and language, to Vygotsky, start out as independent functions in young children but eventually become intertwined. In other words, what started as **social speech** (talking to others) is transformed into **self-talk or private speech** (talking aloud to oneself) and ultimately into **inner speech** ("talking" to oneself mentally rather than aloud).

The Role of Language and Other Cultural Tools

According to Vygotsky, in addition to social interaction, human behavior is affected by culture, the context in which development occurs (Glassman, 2001). Culture provides **cultural tools**, including both technical tools (that act on the environment) and psychological tools (that facilitate thinking), that are passed on from generation to generation. Cultural tools help children make sense of the world.

An important cultural tool proposed by Vygotsky is language, which can be used by children for a variety of mental functions such as regulating behavior, solving problems, and understanding the world around them. Language, particularly children talking to themselves, gives them a means for reflecting on their own thinking (Winsler & Naglieri, 2003). When children articulate their experiences or explain the actions of other children, both their learning and development are positively affected (Pine & Messer, 2000). Vygotsky claimed the integration of language and action as "the most significant moment in the course of intellectual development" (Vygotsky, 1978, p. 24). Vygotsky also argued that two important aspects of language—word meaning and the sounds that we produce when saying words—should not be disconnected (Eun, 2018).

Additional psychological tools that have evolved include maps, number systems, programming languages, calendars, and clocks, to name just a few, that help children organize and remember information to which they have been exposed. Material artifacts, such as books, abacuses, rosary beads, and Lego blocks represent other psychological tools available to children (Siegler & Alibali, 2005).

CLASSROOM CONNECTION: MIDDLE SCHOOL MULTICULTURAL EDUCATION

Middle school language arts teacher, Anthony Rossi, was in his second year of teaching outside of a metropolitan area in New Mexico. During his first year, he learned a lot and adjusted his teaching, but he was not engaging all of his students.

In Anthony's first year, he used many of the stories and poems that the school had been using with the seventh grade. Because many of the stories were well-known, he thought the students would be interested in them. He created a spreadsheet of all the literature he was presenting to his students in his first year, including the title, the author, and the year published. He was surprised by the results. As he looked down the columns of the spreadsheet, he realized his selections turned out to be very narrow geographically. In addition, almost none of the authors reflected the cultures of the vast majority of the students in his class. His class had a significant number of children who were either from one of the nearby pueblos or of Hispanic descent.

Anthony did a lot of weekend reading and research to try and figure out how to choose characters, stories, and authors that reflected the cultural backgrounds of his students. He also included works from numerous other cultural groups, including his own Italian American culture. He found the students' engagement seemed to increase. They really liked seeing themselves reflected in what they were doing in class. They also were interested in learning more about Anthony's background, traditions, and experiences.

Anthony started to post student-created stories on his classroom wall. Many of these emphasized written connections to their cultures. This not only created a climate of equity and recognition of culture, but it made Anthony's teaching more engaging for the students and more enjoyable and informative for him.

Reflect as a Student

Why do you think you are more interested in a class when your professor learns about you and the unique characteristics you bring to the classroom?

Reflect as a Teacher

What approach might you take to Anthony's problem if the students in your classroom were from many different multicultural backgrounds?

Zone of Proximal Development

Vygotsky distinguished between the level of tasks children can perform on their own, without any help (actual development), and the level of tasks they can perform with assistance from someone more competent, either adults or peers (potential development). The range of tasks that lie between these two levels was labeled by Vygotsky as the **zone of proximal development**. The very basis of cognitive development, in Vygotsky's view, is **social collaboration** between adults and children, or children and more competent peers, in enabling children to successfully complete tasks that lie within their zone of proximal development.

The concepts of the zone of proximal development and the social collaboration that helps students to constantly move through it can play an important role in designing school environments. The key to enabling children to continually proceed through their zone of proximal development (which itself advances every time the next level of potential is reached) is assistance provided by others—namely, adults such as teachers or more competent peers. This is often provided by a technique referred to as **scaffolding** (this and the other techniques briefly described in this section will be covered in more detail in Chapter 8). You may be familiar with this term in another context. In building construction, painting, and window cleaning, workers gain access to otherwise inaccessible parts of the structure by standing on wooden frames called "scaffolding." As sections of the building are completed, scaffolding surrounding them are taken down. When a teacher helps students to recognize shapes or solve a puzzle or complete some other task, the teacher is providing scaffolding. When students reach the point where they can recognize the shapes, solve the puzzle, or complete the task, the teacher no longer provides help, hence the scaffolding "comes down." See Table 2.2 for a Concept Review of Vygotsky's theory of development.

TABLE 2.2 ■ CONCEPT REVIEW: Vygotsky's Theory of Development

Major Concepts	What It Means
Social construction of meaning	Teachers, parents, and peers interacting with children to help them learn and develop
Internalization: Changing social into mental activities	Children giving themselves instruction to guide their own behavior; transforming social speech into inner speech
Language and other cultural tools	Using language and cultural context as psychological tools for problem-solving, reflection, and understanding
Zone of proximal development (ZPD)	The range of tasks that lies between those children can perform on their own and those they can perform only with assistance
Scaffolding	Adults and/or peers helping children proceed through their ZPD

Applying Vygotsky to Teaching

What follows is a list of techniques for teaching and working with children and adolescents that are suggested by Vygotsky's ideas:

1. *Provide learners with challenging tasks*. Students will not be placed in a zone of proximal development, nor scaffolding made possible, if students are not confronted by tasks that initially require assistance to perform.
2. *Have learners work cooperatively on tasks*. In this way, more competent peers will be able to assist those with less competence. (We will encounter this again in Chapter 9 on Group Processes.)
3. *Provide learners with cognitive models*. These can be teachers or peers who can be observed performing the task while providing verbal instructions. Learners can learn to internalize these instructions and give them to themselves. (This will come up again in Chapter 6 under Social Learning.)
4. *Provide learners with opportunities to work on tasks likely to be encountered in the real world* (such as planning a budget or repairing a broken toy). These help them relate what they are learning in school to "real life" situations and provides additional opportunities for scaffolding.
5. *Relate your instructional style to the cultural background of learners.* Vygotsky emphasizes the relevance of the learner's cultural context since learning does not occur in isolation from it. Tharp (1989) has shown, for example, that Hawaiian, Anglo, and Navajo students react differently to different styles of instruction, Hawaiian children preferring collaborative activities while Navajo children prefer to wait their turn.

A comparison of the application of Piaget's and Vygotsky's theories appears in Table 2.3.

TABLE 2.3 ■ CONCEPT REVIEW: Comparing the Application of Piaget's and Vygotsky's Theories in the Classroom

Applying Piaget	Applying Vygotsky
Provide opportunities for play and communicating through symbols (e.g., writing, drawing)	Use guided participation, apprenticeship, modeling, and verbal cues
Use actual experiences and concrete objects as tools for learning concepts	Give students increasing responsibility for doing activities on their own
Encourage students to follow their interests and experiment (i.e., hands-on learning)	Use peers as role models and promote collaboration in exploring ideas
Provoke students to examine alternative explanations for their experiences and to share feedback with peers	Provide instructional support within the zone of proximal development and then gradually reduce such support

REFLECTION QUESTIONS

1. How might Vygotsky's focus on the role of language in development affect how you would teach young children?
2. How could teachers use the concept of zone of proximal development to adjust what they are teaching to a student?
3. Which of the suggested techniques for applying Vygotsky's ideas to teaching resonates with you? Why?

LANGUAGE DEVELOPMENT

Children engage in a wide variety of mental activities that help them to produce and understand speech. Based on what they hear, they are able to divide speech into individual words. Hearing other people talk and having the ability to imitate what they hear enables children to learn how to pronounce words

correctly. Moreover, children pay attention to what they hear and are able to remember the order of words they hear in particular phrases. Most particularly, children attend to the meanings of words, both the meanings that they want to convey and the meanings that other people are trying to convey to them. Phrases become expanded into sentences and gradually language, a tool for functioning in a social world, is acquired. This process is facilitated by others: parents, siblings, other children, and adults (e.g., teachers).

Language development and thinking are so intertwined that experts wrestle with which shapes which.

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Language and Thinking

Siegler raised the following question about the relationship between language and thinking: "Does children's learning of new words trigger the formation of new concepts, or does ability to understand new terms demand that the relevant concepts already be in place?" (Siegler, 1998, p. 169). It is the old "chicken and egg" question: Do you need the words to learn the concepts, or do you need the concepts to learn the words? Three alternative positions present themselves.

The first alternative explanation is that language shapes thought—a culture's language shapes the way members of that culture interpret information about the world, and cultural differences produce differences in the way that members of each culture view the world (Sapir, 2004).

The second possible explanation is just the reverse: that *thought shapes language*. Piaget (1926) proposed that representational ability—that is, the ability to represent objects and events at the beginning of the preoperational stage—makes possible the development of language. Thus, Piaget believed that language development required the necessary cognitive development rather than cognitive development requiring the necessary language development.

Finally, the third possible explanation is a combination of the first two—that is, language and thought influence each other. According to Vygotsky (1962), at first language and thought develop independently, but then they begin to influence each other. The child's thoughts become expressed in language, and language begins to influence thoughts and actions with thought becoming internalized language. The evidence tends to favor the third explanation (Siegler, 1998).

Four Main Aspects of Language

We will now examine the four main aspects of language development (see Table 2.4 for a Concept Review of the four aspects).

TABLE 2.4 ■ CONCEPT REVIEW: The Four Main Aspects of Language

Aspect	What It Means
Phonology	The production and comprehension of speech sounds in a language and the tacit or unstated rules governing pronunciation; the knowledge of how words are pronounced
Meaning	The relation between words and what they describe; what a person is trying to express; understanding and producing words; acquiring a vocabulary
Grammar	The ordering of words into sentences (also referred to as syntax), and the specification of tense and number; sentences themselves are the basic unit of grammar
Communication	The ultimate purpose of language; using the above three aspects to impart information, interchange thoughts and opinions, express intentions or needs, and elicit reactions

Phonology

Phonology deals with the distribution and patterning of speech sounds in a language and the tacit or unstated rules governing pronunciation. In other words, it represents the knowledge of how words are pronounced. Turning sounds into language is affected by the difficulty in making particular sounds. The progression of sounds made by babies follows a typical pattern (Kent & Miulo, 1995): (1) crying (from birth), presumably to communicate that they want something, with parents attempting to infer what it is they want, usually from the context; (2) cooing (between 1–2 months), the sound resembling the *uh* sound, as in the word "fun"; (3) simple articulation (at about 3 months), with an increase in consonant sounds; (4) babbling (at about 6 months), including a production of syllables (e.g., *babababa*); (5) patterned speech (at about 1 year), including less babbling and first words.

Achieving phonological competence requires considerable practice. Usually, it is not achieved until school age. Before that, pronunciation is inconsistent in that the same words may sometimes be pronounced correctly and other times incorrectly. Some sounds, like *sh* and *th*, are difficult to make. Leonard (1995) reports that toddlers with small vocabularies, when choosing a word from among options, tend to select a word that is easiest to pronounce. But once children become able to make a particular sound, they tend to use words that include that sound (Vihman, 1992). Rvachew et al. (2007) found that children who enter kindergarten with age-appropriate pronunciation skills also achieve age-appropriate phonological skills—that is, the ability to distinguish and blend parts of speech by sound. They recommend that teachers monitor children who enter kindergarten with delayed pronunciation skills to insure age-appropriate development of phonological awareness, which is a predictor of literacy.

Meaning

Between 12 and 18 months of age, children acquire a small vocabulary of single words, the most common of which are *dada, mama, juice, milk, cookie, water, dog, cat, shoes, ball, car, bottle*, and *more* (Nelson, 1996). Because the difficulty of pronunciation limits the **meaning** that they express, toddlers usually speak in single words. But the single words usually convey meanings beyond the word itself. The single words are called *holophrases* since they have extended meanings. If the toddler wants juice, for example, they will simply say "juice" rather than "I want juice" (Greenfield & Smith, 1976). The word "juice," by itself, conveys the meaning of what the toddler wants.

Children's vocabulary size more than doubles between the ages of 18 and 21 months and doubles again between 21 and 24 months. By first grade, a typical child understands at least 10,000 words and by fifth grade, 40,000 (Anglin, 1993). Learning at such a fast pace means that children must determine the meanings of new words on the basis of being exposed to them a relatively small number of times—for example, only 10 times for a 1-year-old (Woodward et al., 1994).

Markman (1992) hypothesized that children's guesses as to the meaning of a word are based on the belief that, when told the name of an object, the name refers to the whole object rather than one of the object's features or properties (e.g., color). She called this the whole-object constraint. She also hypothesized that children's judgment of the meaning of a word is based on the belief that when a new word is used to label an object—for example, a German Shepard being called a "dog"—the word also applies to other objects of the same class—for example, a collie being called a "dog." She called this the taxonomic constraint. Finally, she hypothesized that when children hear an unfamiliar word that might refer to one of two objects and they already know a name for one of them, the first guess they tend to make is that the unfamiliar object word applies to the object whose name they do not know. She called this the mutual-exclusivity constraint. For example, if 3-year-olds already know the word "plate" but not the word "platter" and are asked to point to the platter, more often than not they point to the platter (Markman & Wachtel, 1988).

A deficiency in language has been overwhelmingly reported by kindergarten teachers as the problem that most restricts children's school readiness (Boyer, 1991). To overcome this deficiency, Hadley and colleagues (2000) completed a study to determine whether kindergarten and first-grade children enrolled for 6 months in two English-language-enriched (experimental) classrooms designed to

enhance the development of vocabulary and phonological awareness (pronunciation of sounds and words) skills would show greater (a) vocabulary development and (b) phonological awareness and letter–sound associations than children enrolled for 6 months in two standard practice (control) classrooms.

There were 46 students distributed among the two experimental classes and 40 students distributed among the two control classes. Overall, 83% of the students were economically disadvantaged—that is, they qualified for free or reduced school lunches. The participants' ethnicities included 56% Hispanic Americans, 28% Caucasians, 7% Native Americans, 6% Asian Americans, and 3% African Americans. The native languages of the students were 47% Spanish and 37% English, with the remainder divided up among eight different languages; 41% had limited English proficiency.

Each of the four classrooms had a regular education teacher. In addition, each of the two experimental classrooms had a certified speech-language pathologist for 2.5 days per week, while each of the control classrooms had a paraprofessional for 2.5 days per week. The two experimental classrooms used a collaborative service delivery model, including joint curriculum planning with a language focus on a weekly basis between the two teachers and the speech language pathologist. Most importantly, teachers in these two classrooms focused on strategies to increase students' vocabulary and phonological awareness while teachers in the two control classrooms followed their existing curricular plans.

The results showed that, at the end of the 6-month period, children in the experimental classrooms showed significantly greater gains in vocabulary, beginning sound awareness, and letter–sound associations than children in the control classrooms. These results demonstrate that the use of a collaborative teaching model with a focus on improving vocabulary and phonological awareness indeed facilitate the language abilities of inner-city children who are at risk for academic difficulties in the early elementary grades.

CLASSROOM CONNECTION: USING EXIT TICKETS TO HELP VOCABULARY DEVELOPMENT

Andrew Lowe's high school English class was in the third week, but he could already sense that his students did not know many of the words that they needed in order to understand the nonfiction literature and poetry they were reading and analyzing in class. He also knew that the students would be taking college entrance exams in a few months, and he recognized that vocabulary would be represented on those tests.

He remembered back in school when his language arts teacher had him copy a list of 20 vocabulary words off the whiteboard, look them up in the dictionary, and then write down the definitions. Unfortunately, that approach did not work well for him as a student; Andrew did the dictionary assignments and promptly forgot the words after turning in the work. Fortunately, there were more effective ways he could teach the vocabulary to his students.

His district was experimenting with a school improvement approach where students have to answer a question or accomplish a task in order to leave the class. This is referred to as an "exit ticket." Andrew figured that he could incorporate vocabulary instruction into his class exit tickets. Andrew created exit ticket sheets that had a space for a word at the top. Then there was a place for the student's understanding of the definition of the word. The students would then create a picture to depict what the vocabulary word means.

Instead of giving the students lists of words from the story that they needed to work on, he would let each student select words that they were unfamiliar with. Then he would give them the exit ticket and walk around class explaining to students the words they did not know. He would also let them use the class laptops to look up information about the words. They would then complete their exit tickets and turn them in when they left class.

Andrew could then review the students' tickets and determine how many of them were accurate. He could go back and reteach words that the students misunderstood, and he could also give students a listing of the words the class did not understand to discuss in pairs.

Reflect as a Student

Have you tried any of the strategies in the case study to learn new vocabulary in your college courses?

Reflect as a Teacher

What ways could you use exit tickets in your future teaching?

As students become more proficient in language skills, they become capable of thinking about the nature of language itself, called **metalinguistic awareness**. An example of this would be understanding the nonliteral meanings of words and expressions and the symbolism associated with them.

Grammar

Grammar represents rules for forming sentences (also referred to as **syntax**), and in most of the world's languages, these rules are highly complex. The sentences themselves, therefore, are the basic unit of grammar. Examples of two grammatical conventions would be to form past tenses and to ask questions. For most verbs in the English language, the past tense is produced by adding *-ed* to the infinitive (e.g., carried, spilled, helped), but there are many exceptions (e.g., eaten, heard, went, ran). Once children learn the *-ed* rule, they tend to use it not only in cases where it fits but also in cases where it does not fit (e.g., eated, runned; Marchman & Bates, 1994). The ability to use the correct past-tense form appears at about age 7 (Kuczaj, 1978).

After children start using two-word phrases, they begin to learn common grammatical forms for asking questions, often beginning with the question "What dat" (Reich, 1986) and following soon after with "where" questions ("Where shoe"), yes–no questions ("Go home?"), and questions involving doing ("What Nanny doing?"). Abbreviated questions grow over time into more grammatical ones.

Pinker (1984) proposed that children's learning of grammar is based on what may be called **semantic bootstrapping**—that is, children first identify the person or thing that produces the action, then the name of the action, and lastly the person or thing affected by the action. They then use these common categories of meanings in the sentences they hear to form rules for ordering words in sentences. This works because grammatical categories tend to be associated with particular meanings (i.e., names are nouns, actions are verbs, and attributes or properties are adjectives). For example, in sentences such as "Mrs. Prim opened the door," the actor is named at the beginning of the sentence, the action is in the middle, and the recipient of the action is at the end. This agent-action-recipient framework enables children to order words in sentences.

Communication

At about the age of 8 or 9, the majority of students have mastered the sounds of English, but not necessarily the idea of the listener's point of view as compared to their own (McDevitt & Ford, 1987). The latter is especially important in being able to communicate effectively. Equally important for communicating effectively are the social conventions or rules of etiquette as applied to carrying out conversations, called **pragmatics**. Some examples would be not interrupting someone when they are talking, as well as knowing how to change the topic of conversation and how to present an argument. A lack of these skills can affect students' relationships with teachers and peers. As students develop, though, they become more aware of taking those with whom they are communicating into account (Sonnenschein, 1988).

Communication is also affected by visual access to one's communication partner. Alibali and Don (2001) found that kindergartners use more gestures when speaking to someone face-to-face than to someone sitting behind a curtain. As more and more communication is done by cell phone, visual access may become an important factor.

Facilitating Language Development in the Classroom

The American Speech-Language and Hearing Association recommends the following techniques that teachers can use for improving children's language abilities (De Maio, 2000; Evans, 2007):

- *Modeling*—Restating a child's comment by adding additional words to make it more mature and grammatically correct—for example, if a child says, "Him talking," the teacher can model, "Yes, he is talking."
- *Expansion*—Adding information to a child's comment, thus showing the child how to use more advanced vocabulary and language structures—for example, if a child says, "The ball is rolling," the teacher can expand by saying, "Yes, the red, rubber ball is rolling very quickly."
- *Self-Talk*—Talking about what you are doing at the same time that you are doing it—for example, as the teacher puts a jigsaw puzzle together, she can say, "First, I pick up a puzzle piece and try to fit it into the pieces of the puzzle that have already been put together. If it doesn't fit, I'll try another piece. Now let's see if we can fit this piece I am holding in my hand into the puzzle."
- *Parallel Talk*—Talking about what the child is doing while the child involved in an activity—for example, as the child puts the next piece in the puzzle, the teacher says, "You just picked the large blue piece with a part of the moon on it and tried to see if it fit into the other part of the moon, which is already in the puzzle! Yes, it did fit in, right?"

It has also been suggested that teachers can promote students' language development by (a) encouraging them to describe verbally what they are learning, particularly in mathematics and science (Gauvain, 2001), and (b) creating a supportive emotional climate to help them articulate what they are learning (Kuhn & Dean, 2004).

REFLECTION QUESTIONS

1. How might your understanding of pragmatics affect how you would work with young children as they develop their language skills?
2. Which of the proposed language and thought relationships seemed most plausible to you? Why?
3. What is one method you could use in the classroom to facilitate language development?

REFLECT AND CONNECT

Learning Objectives

2.1 Explain general principles of development and the relationship between the brain and cognitive development.

- Development is a continuous process, affected by both heredity and environment and contributed to by learning, experience, and social interaction; all children do not all develop at the same rate.
- The primary cells of the brain are neurons. When the neuron fires, an impulse travels through a space called a synapse, resulting in the axon transmitting the impulse to other neurons. The cerebral cortex is made up of four parts or *lobes*: the frontal lobe, parietal lobe, occipital lobe, and temporal lobe, and the left hemisphere and right hemispheres.

2.2 Describe intellectual development according to Piaget and the four factors that influence cognitive development.

- Piaget formulated a theory of cognitive development with the schema as the basic unit. He theorized that the basis for intellectual development is adaptation (being able to function in a given environment) with two adaptive mechanisms: assimilation, or incorporating new information into existing schemata, and accommodation, or modifying an existing schema when new information cannot be understood with existing schemata.
- To ensure that a balance or equilibrium exists between oneself and one's environment, children equilibrate—that is, they sometimes assimilate and sometimes accommodate in dealing with the situations they encounter. According to Piaget, this force toward attaining and maintaining equilibrium is what motivates the developmental process.

2.3 Explain and illustrate the four stages of Piaget's model of cognitive development.

- The first stage, the sensorimotor stage (0–2 years of age), is characterized by the appearance of progressively more complex behaviors involving the connections between the senses and motor behavior. The second stage, preoperational thought (2–7 years of age), is characterized by four features of prelogical thinking: (1) egocentrism, (2) centration, (3) nontransformational reasoning, and (4) irreversibility.
- The stage of concrete operations (7–11 years of age) is characterized by logical operations. They represent thinking, are reversible, assume conservation, and are part of a system but are still limited to what can be perceived. In the final stage, formal operations (11–15 years of age), logical reasoning appears without concrete limitations, enabling students to solve both hypothetical-deductive and scientific-inductive problems.

2.4 Apply Piaget's conception of cognitive development to the process of education.

- To apply Piagetian principles to educational practice, teachers would adopt the processes of (1) learning by exploration, by active engagement with learning materials; (2) learner-centered instruction, making use of both individual and small-group instruction and learning centers; (3) using themes or integrated, interdisciplinary topics for teaching subject-matter skills; (4) focus on the development of schemata such as seriation, conservation, and classification in the elementary and middle grades and formal, abstract problem-solving in the high school grades.

2.5 Recognize criticisms and limitations of Piaget's theory.

- Current research suggests that object permanence and conservation tend to appear earlier than Piaget proposed; that the four stages are not as clearly differentiated as he proposed; that the ages at which specific types of problems are solved, particularly with regard to formal operational thinking skills, tend to vary more than he proposed; that he ignored cultural influences; and that children's capacity to learn is greater than he proposed.

2.6 Explain Vygotsky's theory of cognitive development in terms of its main concepts and characteristics and apply it to teaching.

- Vygotsky's theory represents a sociocultural perspective; he viewed social interaction and cultural context as playing a critical role in the social construction of meaning. He saw thought and language becoming intertwined through the process of internalization, enabling children to function cognitively in the world around them. He labeled the range of tasks that lie between what students can do on their own and can do with help as the *zone of proximal development*.
- The very basis of cognitive development, in Vygotsky's view, is social collaboration between children and adults or more competent peers as the basis of cognitive development in enabling children to successfully complete tasks that lie within the their zone of proximal development. To facilitate this process, teachers are encouraged to use scaffolding (ways of helping students use new skills), challenging tasks, cooperative groups, real-world tasks, and be sensitive to the role of cultural factors.

2.7 Describe language development and illustrate how language development can be facilitated in the classroom.

- Language development includes learning phonology (pronunciation of words), meaning of words, grammar, and communication, within the framework that language and thought influence each other.
- Teachers can help children's language development by using modeling (restating a child's comment), expansion (adding information to a child's comment), self-talk (talking about what you're doing at the time you're doing it), and parallel talk (talk about what children are doing when they are doing it).

KEY TERMS

accommodation
active experience
adaptation
assimilation
axons
causality
cell body
centration
cerebrum
circular reaction
classification (in child development)
cognitive tools
compensation
concrete correspondence
conservation of area
conservation of number
conservation of volume
conservation
corpus callosum
cultural tools
dendrites
discovery learning
egocentrism
equilibration
exclusion
formal operational stage
frontal lobe
grammar or syntax
heredity
imitation
inner speech
internalization
inversion
irreversibility
lateralization
left hemisphere
meaning
metalinguistic awareness
neuron
neurotransmitters
nontransformational reasoning
object permanence
occipital lobe
operations
parietal lobe
phonology
play
pragmatics
primary circular reaction
reciprocal implication
reproductive assimilation
right hemisphere
scaffolding
schema
secondary circular reaction
self-talk/private speech
semantic bootstrapping
separation of variables
seriation
social collaboration
social construction of meaning
social interaction
social speech
sociocultural perspective
synapses
task cards
temporal lobe
terminal buttons
tertiary circular reaction
themes
zone of proximal development

CRITICAL THINKING QUESTIONS

1. Explain how the cells in the brain communicate with one another.
2. According to Piaget, how does cognitive development occur?
3. What are three ways that teachers could use their knowledge of Piaget's theory to inform a learner-centered approach in the classroom?
4. Provide an example of how a teacher could demonstrate knowledge of the zone of proximal development.
5. How do the four main aspects of language help children navigate the social world?