CHAPTER

10

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THE LEARNING SCIENCES AND CONSTRUCTIVISM

WHAT WOULD YOU DO?

TEACHERS' CASEBOOK: Dilemma on Day 1

You have finally landed a job teaching English and writing in a high school. The first day of class, you discover that a number of students appear to be just beginning to learn English. You make a mental note to meet with them to determine how much and what kind of reading they can handle. To get a sense of the class's interest, you ask them to write a review of the last book they read, as if they were on TV doing a "book talk" program. There is a bit of grumbling, but the students seem to be writing, so you take a few minutes to try to talk with a student who seems to have trouble with English.

That night you look over the book reviews. Either the students are giving you a hard time, or no one has read anything lately. Several students mention a text from another class, but their reviews are one-sentence evaluations—usually containing the words *lame* or *useless* (often misspelled). In stark contrast are the papers of three students—they are a pleasure to read, worthy of publication in the school literary magazine (if there were one), and reflect a fairly sophisticated understanding of some good literature.

CRITICAL THINKING

- How would you adapt your lesson plans for this group?
- What will you do tomorrow?
- What teaching approaches do you think will work with this class?
- How will you work with the three students who are more advanced and with the students who are just learning English?

OVERVIEW AND OBJECTIVES

In the past three chapters, we have analyzed different aspects of learning. We considered behavioural, information processing, and cognitive science explanations of what and how people learn. We examined complex cognitive processes such as metacognitive skills and problem solving. These views of learning focus on the individual and what is happening in his or her "head." In this chapter, we expand our investigation of learning to include insights from a relatively recent interdisciplinary approach called the *learning sciences*. This approach brings together work in many fields that study learning, including educational psychology, computer science, neuroscience, and anthropology. One of the foundations of the learning sciences is constructivism, a broad perspective that calls attention to two critical aspects of learning: social and cultural factors. In this chapter, we examine the role of other people and the cultural context in learning. Sociocultural constructivist theories have roots in cognitive perspectives, but have moved well beyond these early explanations. We will explore a number of teaching strategies and approaches that are consistent with cognitive perspectives—inquiry, problem-based learning, cooperative learning, cognitive apprenticeships, and service learning. Finally, we will examine learning in this digital age, including the considerations about learning in technology-rich environments.

By the time you have completed this chapter, you should be able to:

10.1 Describe the collaborative approach that led to the interdisciplinary field of learning sciences.

10.2 Explain different perspectives on constructivism as a theory of learning and teaching.

10.3 Identify the common elements in most contemporary constructivist theories.

10.4 Apply constructivist principles to classroom practice.

10.5 Evaluate the use of community-based activities/service learning.

10.6 Describe positive and negative influences of technology on the learning and development of children and adolescents.

The Learning Sciences

In the previous three chapters, psychologists were responsible for most of the theory and research we discussed. But many other people have also studied learning: Today, there are multiple perspectives included in the learning sciences.

What Are the Learning Sciences?

The interdisciplinary field of the **learning sciences** brings together research in psychology, education, computer science, philosophy, sociology, anthropology, neuroscience, and other fields that study learning. You already have explored some of the foundations of the learning sciences in Chapters 8 and 9, including the make-up of working memory and the role of cognitive load in learning; how information is represented in complex structures such as schemas; what experts know and how their knowledge is different from that of novices; metacognition; problem solving; thinking and reasoning; and how knowledge transfers (or doesn't transfer) from the classroom to the world beyond.

Learning sciences An interdisciplinary science of learning based on research in psychology, education, computer science, philosophy, sociology, anthropology, neuroscience, and other fields that study learning.

No matter what their focus, knowledge workers in the learning sciences are interested in how deep knowledge in subjects like science, mathematics, and literacy is acquired and applied in the real world of scientists and mathematicians and writers. In the *Cambridge Handbook of Learning Sciences*, R. Keith Sawyer (2006) contrasts what it takes for deep learning to occur with traditional classroom practices that have dominated schooling in many countries for decades. Look at Table 10.1 to see the differences.

TABLE 10.1 • **How Deep Learning Contrasts With Learning in Traditional Classrooms**

LEARNING IN TRADITIONAL CLASSROOMS	BUT FINDINGS FROM COGNITIVE SCIENCE SHOW THAT DEEP LEARNING REQUIRES THAT:
Class material is not related to what students already know. Example: Teacher says, *"Igneous rocks are . . . "*	Learners relate new understandings to what they already know and believe. Example: Teacher says, *"Have any of you seen granite counter tops on TV home shows? Or maybe you have one in your house. What do they look like . . .?"*
Class material presented and learned as disconnected bits of knowledge. *"The definition of metamorphic rocks is. . . ."*	Learners integrate and interconnect their knowledge in expanding conceptual systems. *"We already have learned about two kinds of rocks. We also learned last week about how the earth has changed over the centuries, with some ocean floors becoming land areas. Today we will learn about how marble and diamonds. . . . "*
Lessons involve memorizing facts and doing procedures without understanding how or why. *"To divide fractions, invert and multiply . . ."*	Learners search for patterns and recognize or invent underlying principles. *"Remind me what it means to divide. . . . Okay, so ¾ divided by ½ means how many sets of what are in. . . .?"*
Learners have trouble understanding ideas that are not straight from the textbook or explained in the same way. *"What does your textbook say about . . ."*	Learners evaluate new ideas, even if not in the text, and integrate them into their thinking. *"On TV yesterday there was a story about a new drug that is effective in curing one out of eight cases of . . . . What is the probability of a cure?"*
Authorities and experts are the source of unchanging and accurate facts and procedures. *"Scientists agree. . . ."*	Learners understand that knowledge is socially constructed by people, so ideas require critical examination. *"Here is an excerpt from the political debates last week. Let's think about how you would determine what statements are more supported by evidence . . ."*
Learners simply memorize everything instead of thinking about the purpose of learning and the best strategies for that purpose. *"This will be on the test."*	Learners think about why they are learning, monitor their understanding, and reflect on their own learning processes. *"How could you use this concept in your own life? How can you tell if you are understanding it?"*

Source: Based on Sawyer, K. (2006). The new science of learning. In R. K. Sawyer (Ed.). The Cambridge handbook of the learning sciences *(p. 4). New York: The Cambridge University Press. New York: Oxford University Press.*

Basic Assumptions of the Learning Sciences

Even though the different fields in the learning sciences approach their study from varying perspectives, there is growing agreement about some basic assumptions (Sawyer, 2006):

- **Experts have deep conceptual knowledge.** Experts know many facts and procedures, but just learning facts and procedures will not make you an expert. Experts have deep conceptual understanding that allows them to put their knowledge into action; they are able to apply and modify their knowledge to fit each situation. Experts' deep conceptual knowledge generates problem finding and problem solving.
- **Learning comes from the learner.** Better instruction alone will not transfer deep understandings from teachers to students. Learning is more than receiving and processing information transmitted by teachers or texts. Rather, students must actively participate in their own personal construction of knowledge. We are knowledge inventors, not copy machines (de Koek, Sleegers, & Voeten, 2004).

- **Schools must create effective learning environments.** It is the job of the school to create environments where students are active in constructing their own deep understandings so they can reason about real-world problems and transfer their learning from school to their lives beyond the school walls.
- **Prior knowledge is key.** Students come into our classrooms filled with knowledge and beliefs about how the world works. Some of these preconceptions are right, some are part right, and some are wrong. If teaching does not begin with what the students "know," then the students will learn what it takes to pass the test, but their knowledge and beliefs about the world will not change.
- **Reflection is necessary to develop deep conceptual knowledge.** Students need to express and perform the knowledge they are developing through writing, conversations, drawings, projects, skits, portfolios, reports, and so on. But the performance is not enough. To develop deep conceptual knowledge, students need to reflect—thoughtfully analyze their own work and progress.

Embodied Cognition

Recently a new theme has emerged in the cognitive and learning sciences that "the way we think about and represent information reflects the fact that we need to interact with the world" (Ashcraft & Radvansky, 2010, p. 32). This view, called **embodied cognition**, acknowledges that these interactions occur through our senses and bodies, and the way our bodies interact with the world to achieve our goals affects our thinking. In other words, our cognitive processes have deep roots in the interactions of our bodies with the real world—what develops cognitively depends on our sensorimotor engagement with the world. Consequently, the body, not the mind, is primary, but the body needs the mind to successfully interact in the world. In some ways, this perspective is similar to Piaget's idea that thinking emerges early on from the infant's sensorimotor interaction in the world. Instead of being just simple conduits for outside world sounds and images, our senses and motor responses are central to how we think. So we have to understand how our physical body interacts with the world in order to understand our mind (Wilson, 2002).

Actually, it appears that humans are capable of both real-time, situation-by-situation, adaptive, ever-changing interactions (where the *mind is serving the body* to succeed—for example, driving in traffic or doing a jigsaw puzzle) and abstract thinking using symbols and representations developed in earlier times to solve current problems (where *the body-brain control system is serving the mind*—for example, in using images or analogies to learn a new language). Humans' abilities to mentally represent and manipulate symbols that are not present in real time is critical. In fact, Margret Wilson (2002) suggests:

> This takeover by the mind, and the concomitant ability to mentally represent what is distant in time or space, may have been one of the driving forces behind the runaway train of human intelligence that separated us from other hominids. (p. 635)

In educational psychology, these fundamental assumptions of the learning sciences and embodied cognition all lead to the conclusion that thinking is constructive. In the next section we look at both cognitive and social constructivism—topics you will hear about repeatedly in your preparation for teaching.

Cognitive and Social Constructivism

Consider this situation:

> A young child who has never been to the hospital is in her bed in the pediatric wing. The nurse at the station down the hall calls over the intercom above the bed, "Hi, Chelsea, how are you doing? Do you need anything?" The girl looks puzzled and does not answer. The nurse repeats the question with the same result. Finally, the nurse says emphatically, "Chelsea, are you there? Say something!" The little girl responds tentatively, "Hello wall—I'm here."

Embodied cognition Theory stating that cognitive processes develop from real-time, goal-directed interactions between humans and their environment.

Chelsea encountered a new situation—a talking wall. The wall is persistent. It sounds like a grown-up wall. She shouldn't talk to strangers, but she is not sure about walls. She uses what she knows and what the situation provides to construct meaning and to act.

Here is another example of constructing meaning. This time, Kate and her 9-year-old son Ethan co-construct understandings as they buy groceries:

Ethan: (running to get a shopping cart) Do we need the big one?

Kate: We might—better too big than not big enough. Here is our list—where do we go first?

Ethan: We need ice cream for the party! (Ethan heads toward frozen foods.)

Kate: Whoa! What happened to the ice cream carton you left out on the kitchen counter?

Ethan: It melted, and it wasn't out that long. I promise!

Kate: Right, and we may be in this store awhile, so let's start with things that won't melt while we are shopping—I usually buy produce first.

Ethan: What's "produce"?

Kate: Things that grow—fruits and vegetables "produced" by farmers.

Ethan: Okay, the list says cucumbers. Here they are. Wait there are two kinds. Which do you want? The little ones say "local." What's local?

Kate: Local means from around here—close to us, close to our "location." Hmmm—the big ones are 75 cents *each*, and these smaller ones are $1.15 *a pound*. How would you decide which is a better deal?

Ethan: I guess bigger is better, right? Or is local better?

Kate: Well, I wonder if they cost the same for the amount you get—per pound. How could you figure that out?

Ethan: I don't know—the price for a pound isn't on the big ones, just the price each.

Kate: When the doctor wants to know how many pounds you weigh, she puts you on a scale. What if you weighed a big cucumber over there on that food scale?

Ethan: Okay—it weighs half a pound.

Kate: So half a pound costs 75 cents—what would a whole pound cost—that's two halves make a whole?

Ethan: 75 cents plus 75 cents—$1.50. Gee, the bigger ones are more expensive. So the smaller ones are better and they are "local"—that's good, too, right?

Kate: Maybe. I like to support our local farmers. Where are the small cucumbers from? Look at the tiny print on the label.

Ethan: Delta. Is that close to us?

Kate: Pretty close—it is just about an hour's drive from the market here at Univercity . . .

Look at the knowledge being co-constructed about planning ahead, vocabulary, math, problem solving, and even geography. Constructivist theories of learning focus on how people make meaning, both on their own like Chelsea and in interaction with others like Ethan.

Constructivist Views of Learning

Constructivism is a broad term used by philosophers, curriculum designers, psychologists, educators, and others that emphasizes the active role of the learner in building understanding and making sense of information. Ernst von Glasersfeld calls it "a vast and woolly area in contemporary psychology, epistemology, and education" (1997, p. 204). Constructivist perspectives are grounded in the research of Piaget; Vygotsky; the Gestalt psychologists; Bartlett, Bruner, and Rogoff; as well as the philosophy of John Dewey and the work in anthropology of Jean Lave, to mention just a few intellectual roots.

There is no one constructivist theory of learning, but most constructivist theories agree on two central ideas:

Central Idea 1: Learners are active in constructing their own knowledge.

Central Idea 2: Social interactions are important in this knowledge construction process (Bruning, Schraw, & Norby, 2011).

Constructivism View that emphasizes the active role of the learner in building understanding and making sense of information.

Constructivist approaches in science and mathematics education, in educational psychology and anthropology, and in computer-based education all embrace these two ideas. But even though many psychologists and educators use the term *constructivism,* they often mean very different things (Martin, 2006; McCaslin & Hickey, 2001; Phillips, 1997).

One way to organize constructivist views is to talk about two forms of constructivism: psychological and social construction (Palincsar, 1998; Phillips, 1997). We could oversimplify a bit and say that psychological constructivists focus on how individuals use information, resources, and help from others to build and improve their mental models and problem-solving strategies—see Central Idea 1. In contrast, social constructivists view learning as increasing our abilities to participate with others in activities that are meaningful in the culture—see Central Idea 2 (Windschitl, 2002). Let's look a bit closer at each type of constructivism.

CONSTRUCTIVIST VIEWS Constructivist theories are based on the ideas that learners actively develop their knowledge, rather than passively receive it, in package form, from teachers or outside sources.

PSYCHOLOGICAL/INDIVIDUAL/COGNITIVE CONSTRUCTIVISM. Many psychological theories include some kind of constructivism because these theories embrace the idea that individuals construct their own cognitive structures as they interpret their experiences in particular situations (Palincsar, 1998). These psychological constructivists "are concerned with how individuals build up certain elements of their cognitive or emotional apparatus" (Phillips, 1997, p. 153). Because they study individual knowledge, beliefs, self-concept, or identity, they are sometimes called *individual constructivists* or *cognitive constructivists;* they all focus on the inner psychological life of people. When Chelsea talked to the wall in the previous section, she was making meaning using her own individual knowledge and beliefs about how to respond when someone (or something) talks to you. She was using what she knew to impose intellectual structure on her world (Piaget, 1971; Windschitl, 2002). When children observe that most plants need soil to grow and then conclude that plants "eat dirt," they are using what they know about how eating supports life to make sense of plant growth (Linn & Eylon, 2006).

Using these standards, most recent information processing theories are constructivist because they are concerned with how individuals construct internal representations (propositions, images, concepts, schemas) that can be remembered and retrieved (Mayer, 1996). The outside world is viewed as a source of input, but once the sensations are perceived and enter working memory, the important work is assumed to be happening "inside the head" of the individual (Schunk, 2012; Vera & Simon, 1993). Some psychologists, however, believe that information processing is "trivial" or "weak" constructivism because the individual's only constructive contribution is to build accurate internal representations of the outside world (Derry, 1992; Garrison, 1995; Marshall, 1996; Windschitl, 2002).

In contrast, Piaget's psychological (cognitive) constructivist perspective is less concerned with "correct" representations and more interested in meaning as an individual constructs it. As we saw in Chapter 2, Piaget proposed that as children develop, their thinking becomes more organized and adaptive and less tied to concrete events. Piaget's special concern was with logic and the construction of universal knowledge that cannot be learned directly from the environment—knowledge such as conservation or reversibility (Miller, 2011). Such knowledge comes from reflecting on and coordinating our own cognitions or thoughts, not from mapping external reality. Piaget saw the social environment as an important factor in development, but did not believe that social interaction was the main mechanism for changing thinking (Moshman, 1997). Some educational and developmental psychologists have referred to Piaget's kind of constructivism as **first wave constructivism** or "solo" constructivism, with its emphasis on Central Idea 1, individual meaning making (DeCorte, Greer, and Verschaffel, 1996; Paris, Byrnes, & Paris, 2001).

First wave constructivism A focus on the individual and psychological sources of knowing, as in Piaget's theory.

At the extreme end of individual constructivism is the notion of **radical constructivism**. This perspective holds that there is no reality or truth "in the world," only the individual's perceptions and beliefs. Each of us constructs meaning from our own experiences, but we have no way of understanding or "knowing" the reality of others (Woods & Murphy, 2002). A difficulty with this position is that, when pushed to the extreme of relativism, all knowledge and all beliefs are equal because they are all valid individual perceptions. There are problems with this thinking for educators. First, teachers have a professional responsibility to emphasize some values, such as honesty or justice, over others, such as bigotry and deception. All perceptions and beliefs are not equal. As teachers, we ask students to work hard to learn. If learning cannot advance understanding because all understandings are equally good, then, as David Moshman (1997) notes, "we might just as well let students continue to believe whatever they believe" (p. 230). Also, it appears that some knowledge, such as counting and one-to-one correspondence, is not constructed, but universal. Knowing one-to-one correspondence is part of being human (Geary, 1995; Schunk, 2012).

VYGOTSKY'S SOCIAL CONSTRUCTIVISM. As you also saw in Chapter 2, Vygotsky emphasized Central Idea 2 above—social interaction, cultural tools, and activity shape individual development and learning. Ethan's interactions and activities in the grocery store with his mother shaped his learning about anticipating possible consequences (running out of space in the shopping cart and melted ice cream), the meaning of "produce" and "local," how to calculate price per pound, and geography (Martin, 2006). By participating in a broad range of activities with others, learners *appropriate* the outcomes produced by working together; these outcomes could include both new strategies and knowledge. **Appropriating** means being able to reason, act, and participate using cultural tools—for example, using conceptual tools such as "force" and "acceleration" to reason in physics (Mason, 2007). In psychological (cognitive) constructivism, learning means individually possessing knowledge. But in social constructivism, learning means belonging to a group and participating in the social construction of knowledge (Mason, 2007). Putting learning in social and cultural contexts, as Vygotsky did, is known as **second wave constructivism** (Paris, Byrnes, & Paris, 2001).

Because his theory relies heavily on social interactions and the cultural context to explain learning, most psychologists classify Vygotsky as a social constructivist (Palincsar, 1998; Prawat, 1996). However, some theorists categorize him as a psychological constructivist because he was primarily interested in development within the individual (Moshman, 1997; Phillips, 1997). In a sense, Vygotsky was both. One advantage of Vygotsky's theory of learning is that it gives us a way to consider both the psychological and the social: He bridges both camps. For example, Vygotsky's concept of the *zone of proximal development*—the area in which a child can solve a problem with the help (scaffolding) of an adult or more able peer—has been called a place where culture and cognition create each other (Cole, 1985). Culture creates cognition when the adult uses tools and practices from the culture (language, maps, computers, looms, music) to steer the child toward goals the culture values (reading, writing, weaving, dance). Cognition creates culture as the adult and child together generate new practices and problem solutions to add to the cultural group's repertoire (Serpell, 1993). So people are both products and producers of their societies and cultures (Bandura, 2001). One way of integrating individual and social constructivism is to think of knowledge as both *individually constructed* and *socially mediated* (Windschitl, 2002).

The term **constructionism** is sometimes used to describe how public knowledge in math, science, history, and other subjects is created. Although this is not our main concern in educational psychology, it is worth a quick look.

CONSTRUCTIONISM. Social constructionists do not focus on individual learning. Their concern is how public knowledge is constructed in the disciplines such as economics and even educational psychology. Beyond this kind of academic knowledge, constructionists also are interested in how common-sense ideas, everyday beliefs, and commonly held understandings about people and the world are communicated to new members of a

Radical constructivism Knowledge is assumed to be the individual's construction; it cannot be judged right or wrong.

Appropriating Being able to internalize or take for yourself knowledge and skills developed in interaction with others or with cultural tools.

Second wave constructivism A focus on the social and cultural sources of knowing, as in Vygotsky's theory.

Constructionism How public knowledge in disciplines such as science, math, economics, or history is constructed.

sociocultural group (Gergen, 1997; Phillips, 1997). Questions raised might include who determines what constitutes history, what is the proper way to behave in public, or how to get elected class president. Social constructionists believe all knowledge is socially constructed, and, more important, some people have more power than others to define what constitutes such knowledge. Relationships between and among teachers, students, families, and the community are the important issues. Collaboration to understand diverse viewpoints is encouraged, and traditional bodies of knowledge often are challenged (Gergen, 1997). The philosophies of Jacques Dierrida and Michel Foucault are important sources for constructionists. Vygotsky's theory, with its attention to the way cognition creates culture, has some elements in common with constructionism.

These different perspectives on constructivism raise some general questions, and they disagree on the answers. These questions can never be fully resolved, but different theories tend to favour different positions. Let's consider the questions.

How Is Knowledge Constructed?

One tension among different approaches to constructivism is based on how knowledge is constructed. Moshman (1982) describes three explanations.

1. *The realities and truths of the external world direct knowledge construction*. Individuals reconstruct outside reality by building accurate mental representations such as propositional networks, concepts, cause-and-effect patterns, and condition-action production rules that reflect "the way things really are." The more the person learns, the deeper and broader his or her experience is, the closer that person's knowledge is to objective reality. Information processing holds this view of knowledge (Cobb & Bowers, 1999).
2. *Internal processes such as Piaget's organization, assimilation, and accommodation direct knowledge construction*. New knowledge is abstracted from old knowledge. Knowledge is not a mirror of reality, but rather an abstraction that grows and develops with cognitive activity. Knowledge is not true or false; it just grows more internally consistent and organized with development.
3. *Both external and internal factors direct knowledge construction*. Knowledge grows through the interactions of internal (cognitive) and external (environmental and social) factors. Vygotsky's description of cognitive development through the appropriation and use of cultural tools such as language is consistent with this view (Bruning, Schraw, & Norby, 2011). Another example is Bandura's theory of reciprocal interactions among people, behaviours, and environments described in Chapter 11 (Schunk, 2012). Table 10.2 summarizes the three general explanations about how knowledge is constructed.

Knowledge: Situated or General?

A second question that cuts across many constructivist perspectives is whether knowledge is internal, general, and transferable, or bound to the time and place in which it is constructed—situated. Psychologists who emphasize the social construction of knowledge and situated learning affirm Vygotsky's notion that learning is inherently social and embedded in a particular cultural setting (Cobb & Bowers, 1999). What is true in one time and place—such as the "fact" before Columbus's time that the earth was flat—becomes false in another time and place. Particular ideas may be useful within a specific **community of practice**—a social situation or context in which ideas are judged useful or true—such as fifteenth-century navigation, but useless outside that community. What counts as new knowledge is determined in part by how well the new idea fits with current accepted practice. Over time, the current practice may be questioned and even overthrown, but until such major shifts occur, current practice will shape what is considered valuable.

Situated learning emphasizes that learning in the real world is not like studying in school. It is more like an apprenticeship where novices, with the support of an expert guide and model, take on more and more responsibility until they are able to function independently. Proponents of this view believe situated learning explains learning in

Community of practice Social situation or context in which ideas are judged useful or true.

Situated learning The idea that skills and knowledge are tied to the situation in which they were learned and that they are difficult to apply in new settings.

TABLE 10.2 • **How Knowledge Is Constructed**

TYPE	ASSUMPTIONS ABOUT LEARNING AND KNOWLEDGE	EXAMPLE THEORIES
External Direction	Knowledge is acquired by constructing a representation of the outside world. Direct teaching, feedback, and explanation affect learning. Knowledge is accurate to the extent that it reflects the "way things really are" in the outside world.	Information processing
Internal Direction	Knowledge is constructed by transforming, organizing, and reorganizing previous knowledge. Knowledge is not a mirror of the external world, even though experience influences thinking and thinking influences knowledge. Exploration and discovery are more important than teaching.	Piaget
Both External and Internal Direction	Knowledge is constructed based on social interactions and experience. Knowledge reflects the outside world as filtered through and influenced by culture, language, beliefs, interactions with others, direct teaching, and modelling. Guided discovery, teaching, models, and coaching as well as the individual's prior knowledge, beliefs, and thinking affect learning.	Vygotsky

factories, around the dinner table, in high school halls, in street gangs, in the business office, and on the playground. The ideas, skills, and knowledge a person learns are tied to the situation in which they were learned and may be difficult to apply in new settings.

Situated learning is sometimes described as "enculturation," or adopting the norms, behaviours, skills, beliefs, language, and attitudes of a particular community. The community might be mathematicians or gang members or writers or students in your grade 8 class or soccer players—any group that has particular ways of thinking and doing. Knowledge is viewed not as an individual's cognitive structures, but rather as a creation of the community over time. The practices of the community—the ways of interacting and getting things done, as well as the tools the community has created—constitute the knowledge of that community. Learning means becoming more able to participate in those practices and use the tools (Greeno, Collins, & Resnick, 1996; Mason, 2007; Rogoff, 1998).

At the most basic level, "situated learning emphasizes the idea that much of what is learned is specific to the situation in which it is learned" (Anderson, Reder, & Simon, 1996, p. 5). Thus, some would argue, learning to do calculations in school may help students do more school calculations, but it may not help them balance a chequebook, because the skills can be applied only in the context in which they were learned—namely school (Lave, 1997; Lave & Wenger, 1991). But it also appears that knowledge and skills can be applied across contexts that were not part of the initial learning situation, as when you use your ability to read and calculate to do your income taxes, even though income tax forms were not part of your high school curriculum (Anderson, Reder, & Simon, 1996).

Learning that is situated in school does not have to be doomed or irrelevant (Bereiter, 1997). As you saw in Chapter 9, a major question in educational psychology—and education in general—concerns the transfer of knowledge from one situation to another. How can you encourage this transfer from one situation to another? Help is on the way in the next section.

Common Elements of Constructivist Student-Centred Teaching

STOP & THINK What makes a lesson student-centred? List the characteristics and features that put the student in the centre of learning. •

We have looked at some areas of disagreement among the constructivist perspectives, but what about areas of agreement? All constructivist theories assume that knowing develops as learners, like Chelsea and Ethan, try to make sense of their experiences. "Learners, therefore, are not empty vessels waiting to be filled, but rather active organisms seeking meaning" (Driscoll, 2005, p. 487). Humans construct mental models or schemas and continue to revise them to make better sense of their experiences. Again, we are knowledge inventors, not filing cabinets. Our constructions do not necessarily resemble external reality; rather, they are our unique interpretations, like Chelsea's friendly, persistent wall. This doesn't mean that all constructions are equally useful or viable. Learners test their understandings against experience and the understandings of other people—they negotiate and co-construct meanings like Ethan did with his mother.

Constructivists share similar goals for learning. They emphasize knowledge *in use* rather than *storing* inert facts, concepts, and skills. Learning goals include developing abilities to find and solve ill-structured problems, critical thinking, inquiry, self-determination, and openness to multiple perspectives (Driscoll, 2005). Even though there is no single constructivist theory, many constructivist approaches recommend five conditions for learning:

1. Embed learning in complex, realistic, and relevant learning environments.
2. Provide for social negotiation and shared responsibility as a part of learning.
3. Support multiple perspectives and use multiple representations of content.
4. Nurture self-awareness and an understanding that knowledge is constructed.
5. Encourage ownership in learning. (Driscoll, 2005; Marshall, 1992)

Before we discuss particular teaching approaches, let's look more closely at these dimensions of constructivist teaching.

COMPLEX LEARNING ENVIRONMENTS AND AUTHENTIC TASKS. Constructivists believe that students should not be given stripped-down, simplified problems and basic skills drills. Instead, students should encounter **complex learning environments** that present "fuzzy," ill-structured problems. The world beyond school presents few simple problems or step-by-step directions, so schools should be sure that every student has experience solving complex problems. Complex problems are not just difficult ones; rather, they have many parts. There are multiple, interacting elements in complex problems and multiple possible solutions. There is no one right way to reach a conclusion, and each solution may bring a new set of problems.

These complex problems should be embedded in authentic tasks and activities, the kinds of situations that students would face as they apply what they are learning in the real world (Needles & Knapp, 1994). Students may need support (*scaffolding*) as they work on these complex problems, with teachers helping them find resources, keeping track of their progress, breaking larger problems down into smaller ones, and so on. This aspect of constructivist approaches is consistent with situated learning in emphasizing learning in situations where the knowledge will be applied.

SOCIAL NEGOTIATION. Many constructivists share Vygotsky's belief that higher mental processes develop through **social negotiation**—an aspect of the learning process that relies on collaboration with others and respect for different perspectives—and interaction. So, collaboration in learning is valued. A major goal of teaching is to develop students' abilities to establish and defend their own positions while respecting the positions of others and working together to negotiate or co-construct meaning. To accomplish this exchange, students must talk and listen to each other. It is a challenge for children in cultures that are individualistic and competitive to adopt what has been called an **intersubjective attitude**—a commitment to build shared meaning by finding common ground and exchanging interpretations.

MULTIPLE PERSPECTIVES AND REPRESENTATIONS OF CONTENT. When students encounter only one model, one analogy, one way of understanding complex content, they often oversimplify as they try to apply that one approach to every situation. Anita saw this

Complex learning environments Problems and learning situations that mimic the ill-structured nature of real life.

Social negotiation Aspect of learning process that relies on collaboration with others and respect for different perspectives.

Intersubjective attitude A commitment to build shared meaning with others by finding common ground and exchanging interpretations.

AUTHENTIC TASKS AND SOCIAL INTERACTIONS Constructivist approaches recommend that educators emphasize complex, realistic, and relevant learning environments, as well as the importance of social interactions in the learning process. For example, the students here are collaborating to create a household budget.

happen in her educational psychology class when six students were presenting an example of guided discovery learning. The students' presentation was a near copy of a guided discovery demonstration earlier in the semester, but with some major misconceptions. Anita's students knew only one way to represent discovery learning. Resources for the class should have provided **multiple representations of content** using different analogies, examples, and metaphors. This idea is consistent with Jerome Bruner's (1966) **spiral curriculum**, a structure for teaching that introduces the fundamental structure of all subjects—the "big ideas"—at a basic level early in the school years, then successively revisits those ideas in more and more complex forms over time.

UNDERSTANDING THE KNOWLEDGE CONSTRUCTION PROCESS. Constructivist approaches emphasize making students aware of their role in constructing knowledge. The assumptions we make, our beliefs, and our experiences shape what each of us comes to "know" about the world. Different assumptions and different experiences lead to different knowledge, as we saw in Chapter 6 when we explored the role of cultural differences in shaping knowledge. If students are aware of the influences that shape their thinking, they will be more able to choose, develop, and defend positions in a self-critical way while respecting the positions of others.

STUDENT OWNERSHIP OF LEARNING. "While there are several interpretations of what [constructivist] theory means, most agree that it involves a dramatic change in the focus of teaching, putting the students' own efforts to understand at the center of the educational enterprise" (Prawat, 1992, p. 357). Student ownership does not mean that the teacher abandons responsibility for instruction. Because the design of teaching is a central issue in our text, we will spend the rest of this chapter discussing examples of *ownership of learning* and *student-centred instruction*.

Applying Constructivist Perspectives

Even though there are many applications of constructivist views of learning, we can recognize constructivist approaches by the activities of the teacher and the students. Mark Windschitl (2002) suggests that the following activities encourage meaningful learning:

- Teachers elicit students' ideas and experiences in relation to key topics, then fashion learning situations that help students elaborate on or restructure their current knowledge.
- Students are given frequent opportunities to engage in complex, meaningful, problem-based activities.
- Teachers provide students with a variety of information resources as well as the tools (technological and conceptual) necessary to mediate learning.
- Students work collaboratively and are given support to engage in task-oriented dialogue with one another.
- Teachers make their own thinking processes explicit to learners and encourage students to do the same through dialogue, writing, drawings, or other representations.
- Students are routinely asked to apply knowledge in diverse and authentic contexts, explain ideas, interpret texts, predict phenomena, and construct arguments based on evidence, rather than focus exclusively on the acquisition of predetermined "right answers."

Multiple representations of content Considering problems using various analogies, examples, and metaphors.

Spiral curriculum Bruner's design for teaching that introduces the fundamental structure of all subjects early in the school years, then revisits the subjects in more and more complex forms over time.

- Teachers encourage students' reflective and autonomous thinking in conjunction with the conditions in this list.
- Teachers employ a variety of assessment strategies to understand how students' ideas are evolving and to give feedback on the processes as well as the products of their thinking. (p. 137)

In addition, constructivist approaches include **scaffolding**, providing supports students need to develop expertise and, as they succeed, gradually withdrawing those supports. One implication of Vygotsky's theory of cognitive development is that deep understanding requires that students grapple with problems in their zone of proximal development; they need scaffolding to work productively in that zone that stretches just beyond their current level of competence. Here is a good description of scaffolding that emphasizes the dynamic interactive nature of scaffolding as well as the knowledge that both teacher and student bring—both are experts on something: "Scaffolding is a powerful conception of teaching and learning in which teachers and students create meaningful connections between teachers' cultural knowledge and the everyday experience and knowledge of the student" (McCaslin & Hickey, 2001, p. 137). Look back at the grocery store conversation between Ethan and his mother at the beginning of the previous section. Notice how the mother used the melted ice cream on the kitchen counter and the scale in the doctor's office—connections to Ethan's experience and knowledge—to scaffold Ethan's understanding.

Even though there are different views of scaffolding, most educational psychologists agree on three characteristics (van de Pol, Volman, & Beishuizen, 2010):

1. **Contingency Support**: The teacher is constantly adjusting, differentiating, and tailoring responses to the student.
2. **Fading**: The teacher gradually withdraws support as the student's understanding and skills deepen.
3. **Transferring Responsibility**: Students assume more and more responsibility for their own learning.

In the next sections, we will examine three specific teaching approaches that put the student at the centre and provide scaffolding: inquiry and problem-based learning, cognitive apprenticeships, and cooperative learning.

Inquiry and Problem-Based Learning

John Dewey described the basic **inquiry learning** format in 1910 as an approach in which the teacher presents a puzzling situation and students solve the problem by gathering data and testing their conclusions. There have been many adaptations of this strategy, but the form usually includes the following student activities (Echevarria, 2003; Lashley, Matczynski, & Rowley, 2002) after the teacher presents a puzzling event, question, or problem:

- Formulate hypotheses to explain the event or solve the problem;
- collect data to test the hypotheses;
- draw conclusions; and
- reflect on the original problem and the thinking processes needed to solve it.

EXAMPLES OF INQUIRY. Shirley Magnusson and Annemarie Palincsar have developed a teachers' guide for planning, implementing, and assessing different phases of inquiry science units, called *Guided Inquiry Supporting Multiple Literacies or GisML* (Hapgood, Magnusson, & Palincsar, 2004; Palincsar, Magnusson, Collins, & Cutter, 2001; Palincsar, Magnusson, Marano, Ford, & Brown, 1998). The teacher first identifies a curriculum area and some general guiding questions, puzzles, or problems. For example, the teacher chooses *communication* as the area and asks this general question: "How and why do humans and animals communicate?" Next, several specific focus questions are posed. "How do whales communicate?" "How do gorillas communicate?" The focus questions have to be carefully chosen to guide students toward important understandings. One

Scaffolding Teachers and students make meaningful connections between what the teacher knows and what the students know and need in order to help the students learn more.

Inquiry learning Approach in which the teacher presents a puzzling situation and students solve the problem by gathering data and testing their conclusions.

Watch
Examples of Inquiry

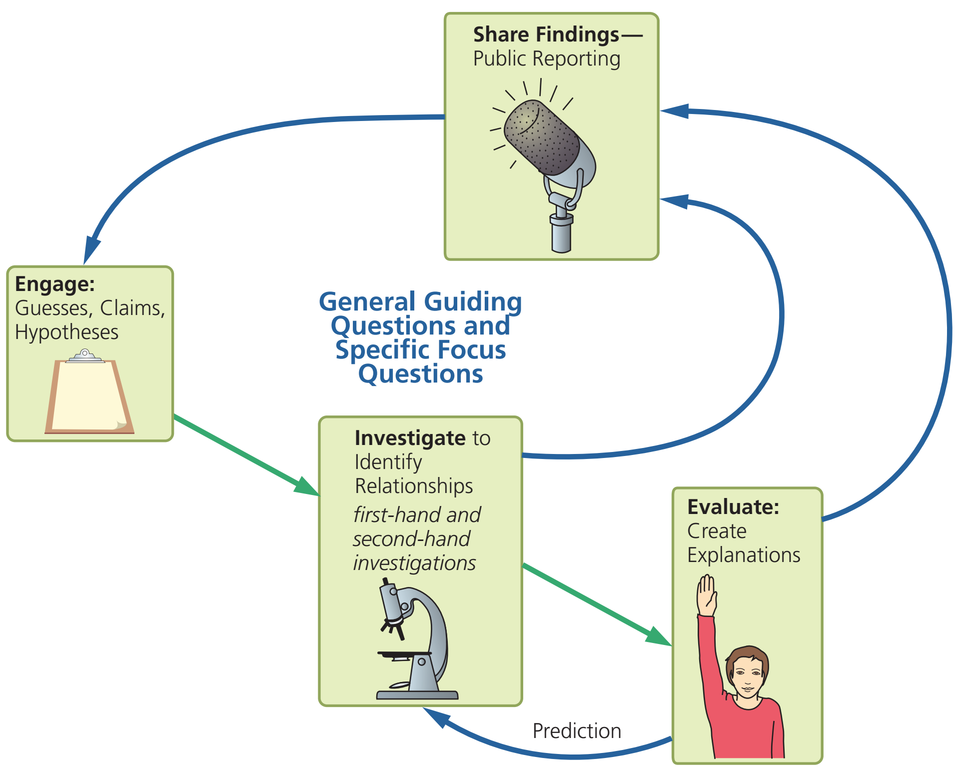
key idea in understanding animal communication is the relationship among the animal's structures, survival functions, and habitat. Animals have specific *structures* such as large ears or echo-locators, which function to find food, attract mates, or identify predators, and these structures and functions are related to the animals' *habitats*—large ears for navigating in the dark, for example. Thus, focus questions must ask about animals with different structures for communication, different functional needs for survival, and different habitats. Questions about animals with the same kinds of structures or the same habitats would not be good focus points for inquiry (Magnusson & Palincsar, 1995).

The next phase is to engage students in the inquiry, perhaps by playing an audio recording of different animal sounds, having students make guesses and claims about communication, and asking the students questions about their guesses and claims. Then, the students conduct both first-hand and second-hand investigations. First-hand investigations are direct experiences and experiments—for example, measuring the size of bats' eyes and ears in relation to their bodies (using pictures or videos—not real bats!). In second-hand investigations, students consult books, the internet, interviews with experts, and other resources to find specific information or get new ideas. As part of their investigating, the students begin to identify patterns. The curved line in Figure 10.1 shows that cycles can be repeated. In fact, students might go through several cycles of investigating, identifying patterns, and reporting results before moving on to constructing explanations and making final reports. Another possible cycle is to evaluate explanations before reporting by making and then checking predictions, applying the explanation to new situations.

FIGURE 10.1

A MODEL TO GUIDE TEACHER THINKING ABOUT INQUIRY-BASED SCIENCE INSTRUCTION

The straight lines show the sequence of phases in instruction, and the curved lines show cycles that might be repeated during instruction.



Source: Based on Palinscar, A. S., Magnusson, S. J., Marano, D., Ford, D., & Brown, N. (1988). Designing a Community of Practice: Principles and Practices of the GisML Community. Teaching and Teacher Education, 14, *p. 12. Adapted with permission from Elsevier.*

Inquiry teaching allows students to learn content and process at the same time. In the examples just discussed, students learned about how animals communicate and how structures are related to habitats. In addition, they learned the inquiry process itself—how to solve problems, evaluate solutions, and think critically.

PROBLEM-BASED LEARNING. Whereas inquiry learning grew out of practices in science, problem-based learning grew out of research on expert knowledge in medicine (Schmidt, van der Molen, te Winkel, & Wijnen, 2009). The goals of **problem-based learning** are to help students develop knowledge that is useful and flexible, not inert, by providing realistic problems that don't necessarily have "right" answers. *Inert knowledge* is information that is memorized but seldom applied (Cognition and Technology Group at Vanderbilt [CTGV], 1996; Whitehead, 1929). Other goals of problem-based learning are to enhance intrinsic motivation and skills in problem solving, collaboration, evidence-based decision making, and self-directed lifelong learning.

In problem-based learning, students are confronted with a problem that launches their inquiry as they collaborate to find solutions. The students identify and analyze the problem based on the facts from the scenario; and then they begin to generate hypotheses about solutions. As they suggest hypotheses, they identify missing information—what do they need to know to test their solutions? This launches a phase of research. Then, students apply their new knowledge, evaluate their problem solutions, recycle to research again if necessary, and finally reflect on the knowledge and skills they have gained. Throughout the entire process, students are not alone or unguided. Their thinking and problem solving is scaffolded by the teacher, computer software supports, models, coaching, expert hints, guides and organizational aids, or other students in the collaborative groups—so working memory is not overloaded. For example, as students work, they may have to fill in a diagram that helps them distinguish between "claims" and "reasons" in a scientific argument (Derry, Hmelo-Silver, Nagarajan, Chernobilsky, & Beitzel, 2006; Hmelo-Silver, Ravit, & Chinn, 2007).

In true problem-based learning, the problem is real and the students' actions matter. For example, during the 2010 Deepwater oil spill in the Gulf of Mexico, many teachers used the problem as a springboard for learning. Their students researched how this spill compared to others in size, location, costliness, causes, and attempted solutions. What could be done? How do currents and tides play a role? What locations, businesses, and wildlife are in the greatest danger? What will the short-term and long-term financial and environmental impacts be? What actions can students take to play a positive role? A number of teachers blogged about using the oil spill in problem-based learning and collected resources for other teachers (see www.edutopia.org/blog/oil-spill-project-based-learning-resources).

Some problems are not authentic because they do not directly affect the students' lives, but they are engaging. For example, in a computer simulation called the *River of Life Challenge* (Sherwood, 2002), students meet Billy and his lab partner, Suzie, who are analyzing the quality of water from a local river. Suzie is concerned that Billy's conclusions are careless and incomplete. Billy is challenged to research the issue in more depth by the Legacy League, a multi-ethnic group of characters who raise questions and direct Billy and Suzie to helpful resources so they can research the answers. The format for the challenge in the STAR Legacy Cycle includes six phases: Encounter the challenge, generate ideas, consider multiple perspectives, research and revise your ideas, test your mettle (check your understanding), and go public about your conclusions. Undergraduate science education students who used this simulation improved their graph-reading skills as well as their conceptual understanding of several topics such as the composition of air and classes of organisms in a river ecosystem (Kumar & Sherwood, 2007).

Let's look at these phases more closely as they might take place in an upper-level science class (Klein & Harris, 2007).

1. The cycle begins with an *intriguing challenge* to the whole class. For example, in biomechanics it might be "Assume you are a living cell in a bioreactor. What things will influence how long you live?" or "Your grandmother is recovering from a broken hip. In which hand should she hold the cane to help her balance?" The question

Problem-based learning Methods that provide students with realistic problems that don't necessarily have "right" answers.

POINT/COUNTERPOINT Are Inquiry and Problem-Based Learning Effective Teaching Approaches?

Inquiry, discovery learning, and problem-based learning are very appealing, but are they effective? Specifically, does problem-based learning lead to deep understanding for most students?

POINT

Problem-based learning is overrated. Paul Kirschner and his colleagues were clear and critical in their article in the *Educational Psychologist*. Even the title of the article was blunt: "Why minimal guidance during instruction does not work: An analysis of the failure of constructivist, discovery, problem-based, experiential, and inquiry-based teaching." They argued:

> *Although unguided or minimally guided instructional approaches are very popular and intuitively appealing, the point is made that these approaches ignore both the structures that constitute human cognitive architecture and evidence from empirical studies over the past half-century that consistently indicate that minimally guided instruction is less effective and less efficient than instructional approaches that place a strong emphasis on guidance of the student learning process. (Kirschner, Sweller, & Clark, 2006, p. 75)*

These respected researchers (and others more recently) cited decades of research demonstrating that unguided discovery/inquiry and problem-based learning are ineffective, especially for students with limited prior knowledge (Kalyuga, 2011; Klahr & Nigam, 2004; Tobias, 2010). Louis Alfieri and his colleagues (2011) examined the results from 108 studies going back over 50 years and found that explicit teaching was more beneficial than unassisted discovery, especially for studies published in the most well-rated journals. Their conclusion: "unassisted discovery generally does not benefit learning" (p. 12).

But what about problem-based learning in particular? Much of the research on problem-based learning has taken place in medical schools, and results have been mixed. In one study, students learning through problem-based instruction were better at clinical skills such as problem formation and reasoning, but they were worse in their basic knowledge of science and felt less prepared in science (Albanese & Mitchell, 1993). A review of problem-based learning curricula in medical schools concluded that this approach was not effective in promoting higher levels of student knowledge (Colliver, 2000).

COUNTERPOINT

Problem-based learning is a powerful teaching approach. Problem-based learning has some advantages. In one study, medical students who learned with problem-based approaches created more accurate and coherent solutions to medical problems (Hmelo, 1998). In an extensive study of a problem-based medical program in the Netherlands, Schmidt and his colleagues (2009) concluded that, compared to graduates of conventional programs, graduates of the problem-based learning program performed better in practical medical and interpersonal skills, took less time to graduate, and had small positive differences in their medical knowledge and diagnostic reasoning. MBA students who learned a concept using problem-based methods were better at explaining the concept than students who had learned the concept from lecture and discussion (Capon & Kuhn, 2004). Students who are better at self-regulation may benefit more from problem-based

is framed in a way that makes students bring to bear their current knowledge and preconceptions.

2. Next, students *generate ideas* to compile what they currently know and believe using individual, small-group, or whole-group brainstorming or other activities.
3. *Multiple perspectives* are added to the process in the form of outside experts (live, on video, or from texts), websites, magazine or journal articles, or a CD on the subject. In the river challenge, the Legacy League guided Billy and Suzie to explore multiple perspectives.
4. Students go deeper to *research and revise*. They consult more sources or hear class lectures, all the while revising ideas and perhaps journaling about their thinking.
5. Students *test their mettle* by getting feedback from other students or the teacher about their tentative conclusions. Some formative (ungraded) tests might check their understanding at this point.
6. Students *go public* with their final conclusions and solutions in the form of an oral presentation, poster/project, or final exam.

Project-based science is a multimedia learning environment similar to problem-based learning that focuses on grades K-12 (Krajcik & Czerniak, 2007). MyProject is a web-based science learning environment used in college (Papanikolaou & Boubouka, 2011). The teacher's role in problem-based learning is to identify engaging problems and methods (Evensen, Salisbury-Glennon, & Glenn, 2001), but using problem-based methods over time can help all students to develop self-directed learning skills.

Cindy Hmelo-Silver (2004; Hmelo-Sliver, Ravit, & Chinn, 2007) reviewed the research and found good evidence that problem-based learning supports the construction of flexible knowledge and the development of problem-solving and self-directed learning skills. But there is less evidence that participating in problem-based learning is intrinsically motivating or that it teaches students to collaborate. In studies of high school economics and mathematics, recent research favours problem-based approaches for learning more complex concepts and solving multistep word problems.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Beware of Either/Or. You don't have to choose between inquiry and content-focused methods. The best approach in elementary and secondary schools may be a balance of content-focused and inquiry or problem-based methods. For example, Eva Toth, David Klahr, and Zhe Chen (2000) tested a balanced approach for teaching grade 4 students how to use the controlled variable strategy in science to design good experiments. The method had three phases: (1) In small groups, students conducted exploratory experiments to identify variables that made a ball roll farther down a ramp; (2) the teacher led a discussion, explained the controlled variable strategy, and modelled good thinking about experiment design; and (3) the students designed and conducted application experiments to isolate which variables caused the ball to roll farther. The combination of inquiry, discussion, explanation, and modelling was successful in helping the students understand the concepts. Clearly scaffolding supports are key factors in successful inquiry and problem-based learning.

The difference seems to come down to completely unguided discovery versus guided, supported, and well-scaffolded inquiry. Alfieri and his colleagues (2011) concluded:

> *Overall, the effects of unassisted-discovery tasks seem limited, whereas enhanced-discovery tasks requiring learners to be actively engaged and constructive seem optimal. On the basis of the current analyses, optimal approaches should include at least one of the following: (a) guided tasks that have scaffolding in place to assist learners, (b) tasks requiring learners to explain their own ideas and ensuring that these ideas are accurate by providing timely feedback, or (c) tasks that provide worked examples of how to succeed in the task. (p. 13)*

appropriate resources; orient students to the problem by describing objectives and rationales; organize the students by helping them set goals and define tasks; support, coach, and mentor students as they gather information, craft solutions, and prepare artifacts (models, reports, videos, PowerPoints, portfolios, etc.); and support student reflection on their own learning outcomes and processes (Arends & Kilcher, 2010).

RESEARCH ON INQUIRY AND PROBLEM-BASED LEARNING. Does using inquiry or problem-based learning activities lead to greater achievement? The debate has waged for years. Some research results say, "Yes." For example, using an open-ended and software-supported inquiry science approach called GenScope that explores genetics, students in high school science classrooms learned significantly more compared to students in traditional classrooms (Hickey, Kindfield, Horwitz, & Christie, 1999, Hickey, Wolfe, & Kindfield, 2000). In a study of almost 20 000 middle-school students in a large urban district who used inquiry-based materials, those who participated in inquiry learning had significantly higher passing rates on standardized tests. African American males especially benefited from these methods (Geier et al., 2008). Several other studies point to increases in student engagement and motivation with inquiry learning (Hmelo-Silver, Ravit, & Chinn, 2007), as long as the learning is supported and students have adequate background knowledge. But not every educational psychologist agrees that problem-based learning is valuable, at least for all students, as you can see in the *Point/Counterpoint*.

Another constructivist approach that relies heavily on scaffolding is cognitive apprenticeships.

Cognitive Apprenticeships and Reciprocal Teaching

Over the centuries, apprenticeships have proved to be an effective form of education. By working alongside a master and perhaps other apprentices, young people have learned many skills, trades, and crafts. Knowledgeable guides provide models, demonstrations, and corrections, as well as a personal bond that is motivating. The performances required of the learner are real and important and grow more complex as the learner becomes more competent (Collins, 2006; Linn & Eylon, 2006; Hung, 1999). With *guided participation* in real tasks comes *participatory appropriation*—students appropriate the knowledge, skills, and values involved in doing the tasks (Rogoff, 1995, 1998). In addition, both the newcomers to learning and the old-timers contribute to the community of practice by mastering and remastering skills—and sometimes improving these skills in the process (Lave & Wenger, 1991).

Allan Collins (2006) suggests that knowledge and skills learned in school have become too separated from their use in the world beyond school. To correct this imbalance, some educators recommend that schools adopt many of the features of apprenticeships. But rather than learning to sculpt or dance or build a cabinet, apprenticeships in school would focus on cognitive objectives such as reading comprehension, writing, or mathematical problem solving. There are many **cognitive apprenticeship** models in which a less experienced learner acquires knowledge and skills under the guidance of an expert, but most share six features:

- Students observe an expert (usually the teacher) *model* the performance.
- Students get external support through *coaching* or tutoring (including hints, tailored feedback, models, and reminders).
- Students receive conceptual *scaffolding*, which is then gradually faded as the student becomes more competent and proficient.
- Students continually *articulate* their knowledge—putting into words their understanding of the processes and content being learned.
- Students *reflect* on their progress, comparing their problem solving to an expert's performance and to their own earlier performances.
- Students are required to *explore* new ways to apply what they are learning—ways that they have not practised at the master's side.

As students learn, they are challenged to master more complex concepts and skills and to perform them in many different settings.

How can teaching provide cognitive apprenticeships? Mentoring in teaching is one example. Another is cross-age grouping. In some schools, students of different ages work side by side for part of every day on a "pod" designed to have many of the qualities of an apprenticeship. The pods might focus on a craft or a discipline. Examples include gardening, architecture, and "making money." Many levels of expertise are evident in the students of different ages, so students can move at a comfortable pace, but still have the model of a master available. Community volunteers, including many parents, visit to demonstrate a skill that is related to the pod topic.

Alan Schoenfeld's (1989, 1994) teaching of mathematical problem solving is another example of the cognitive apprenticeship instructional model.

COGNITIVE APPRENTICESHIPS IN READING: RECIPROCAL TEACHING. The goal of **reciprocal teaching** is to help students understand and think deeply about what they read (Palincsar, 1986; Palincsar & Brown, 1984, 1989). To accomplish this goal, students in small reading groups learn four strategies: *summarizing* the content of a passage, *asking a question* about the central point, *clarifying* the difficult parts of the material, and *predicting* what will come next. These are strategies skilled readers apply almost automatically, but poor readers seldom do—or they don't know how. To use the strategies effectively, poorer readers need direct instruction, modelling, and practice in actual reading situations.

Cognitive apprenticeship A relationship in which a less experienced learner acquires knowledge and skills under the guidance of an expert.

Reciprocal teaching Designed to help students understand and think deeply about what they read.

First, the teacher introduces these strategies, perhaps focusing on one strategy each day. As the expert, the teacher explains and models each strategy and encourages student apprentices to practise. Next, the teacher and the students read a short passage silently. Then, the teacher again provides a model by summarizing, questioning, clarifying, or predicting based on the reading. Everyone reads another passage, and the students gradually begin to assume the teacher's role. The teacher becomes a member of the group, and may finally leave, as the students take over the teaching. Often, the students' first attempts are halting and incorrect. But the teacher gives clues, guidance, encouragement, support doing parts of the task (such as providing question stems), modelling, and other forms of scaffolding to help the students master these strategies. The goal is for students to learn to apply these strategies independently as they read so they can make sense of text.

APPLYING RECIPROCAL TEACHING. Although reciprocal teaching seems to work with almost any age student, most of the research has been done with younger adolescents who can read aloud fairly accurately, but who are far below average in reading comprehension. After 20 hours of practice with this approach, many students who were in the bottom quarter of their class moved up to the average level or above on tests of reading comprehension. Palincsar has identified three guidelines for effective reciprocal teaching ("When Student Becomes Teacher," 1986):

1. *Shift gradually*. The shift from teacher to student responsibility must be gradual.
2. *Match demands to abilities*. The difficulty of the task and the responsibility must match the abilities of each student and grow as these abilities develop.
3. *Diagnose thinking*. Teachers should carefully observe the "teaching" of each student for clues about how the student is thinking and what kind of instruction he or she needs.

In contrast to some approaches that try to teach 40 or more strategies, an advantage of reciprocal teaching is that it focuses attention on four powerful strategies. But these strategies must be taught—not all students develop them on their own. One study of reciprocal teaching spanning over three years found that questioning was the strategy used most often, but that students had to be taught how to ask higher-level questions because most student questions were literal or superficial (Hacker & Tenent, 2002). Another advantage of reciprocal teaching is that it emphasizes practising these four strategies in the context of actual reading—reading literature and reading texts. Finally, the idea of scaffolding and gradually moving the student toward independent and fluid reading comprehension is a critical component in reciprocal teaching and cognitive apprenticeships in general (Rosenshine & Meister, 1994).


NURTURING INDEPENDENT READERS The concept of scaffolding and gradually moving the student toward independent and fluid reading comprehension is a critical component in reciprocal teaching and cognitive apprenticeships.

Patrick White/Merrill

Collaboration and Cooperation

Even with all the concern today about academic standards, performance on proficiency tests, and international comparisons of student achievement, schooling has always been about more than academic learning. Of course, academics are the prime directive, but an education also prepares students to live and work cooperatively with all kinds of people:

> Most corporations are looking for employees who are not only good at the mastery of a particular set of academic skills but who also have the ability to work harmoniously with a wide variety of coworkers as a cooperative team, to demonstrate initiative and responsibility, and to communicate effectively. (Aronson, 2000, p. 91)

For the past four decades, researchers have examined collaboration and cooperation in schools. Although there are some inconsistencies, the majority of the studies indicate that truly cooperative groups have positive effects—from preschool to college—on students' empathy, tolerance for differences, feelings of acceptance, friendships, self-confidence, awareness of the perspectives of others, higher-level reasoning, problem solving, and even school attendance (Galton, Hargreaves, & Pell, 2009; Gillies & Boyle, 2011; Solomon, Watson, & Battistich, 2001). It is even argued that cooperative learning experiences are crucial in preventing many of the social problems that plague children and adolescents (Gillies, 2003, 2004).

Listen
Collaboration and Cooperation

COLLABORATION, GROUP WORK, AND COOPERATIVE LEARNING. The terms *collaboration, group work*, and *cooperative learning* often are used as if they mean the same thing. Certainly there is some overlap, but there are differences as well. The distinctions between collaboration and cooperation are not always clear. Ted Panitz (1996) suggests **collaboration** is a philosophy about how to relate to others—how to learn and work. Collaboration is a way of dealing with people that respects differences, shares authority, and builds on the knowledge that is distributed among other people. **Cooperation**, on the other hand, is a way of working with others to attain a shared goal (Gillies, 2003). Collaborative learning has roots in the work of British teachers who wanted their students to respond to literature in more active ways as they learned. Cooperative learning has North American roots in the work of psychologists John Dewey and Kurt Lewin. You could say that *cooperative* learning is one way to *collaborate* in schools.

Group work, on the other hand, is simply several students working together—they may or may not be cooperating. Many activities can be completed in groups. For example, students can work together to conduct a local survey. How do people feel about the plan to build a new mall that will bring more shopping and more traffic? Would the community support or oppose the building of a nuclear power plant? If students must learn 10 new definitions in a biology class, why not let them divide up the terms and definitions and teach one another? Be sure, however, that everyone in the group can handle the task. Sometimes, one or two students end up doing the work of the entire group.

Group work can be useful, but true cooperative learning requires much more than simply putting students in groups and dividing up the work. Angela O'Donnell and Jim O'Kelly describe a teacher who claimed to be using "cooperative learning" by asking students to work in pairs on a paper, each writing one part. Unfortunately, the teacher allowed no time to work together and provided no guidance or preparation in cooperative social skills. Students got a grade for their individual part and a group grade for the whole project. One student received an A for his part, but a C for the group project because his partner earned an F—he never turned in any work. So one student was punished with a C for a situation he could not control while the other was rewarded with a C for doing no work at all. This was not cooperative learning—it wasn't even group work (O'Donnell & O'Kelly, 1994).

BEYOND GROUPS TO COOPERATION. David and Roger Johnson (2009a), two of the founders of cooperative learning in North America, define formal **cooperative learning** as "students working together, for one class period to several weeks, to achieve shared learning goals and complete jointly specific tasks and assignments" (p. 373). Cooperative learning has a long history in education, moving in and out of favour over the years. Today, evolving constructivist perspectives have fuelled a growing commitment to learning situations that rely on elaboration, interpretation, explanation, and argumentation—that is, cooperative learning (Webb & Palincsar, 1996, p. 844). David and Roger Johnson (2009a) note:

> From being discounted and ignored, cooperative learning has steadily progressed to being one of the dominant instructional practices throughout the world. Cooperative learning is now utilized in schools and universities throughout most of the world in every subject area and from preschool through graduate school and adult training programs. (p. 365)

Collaboration A philosophy about how to relate to others—how to learn and work.

Cooperation Way of working with others to attain a shared goal.

Cooperative learning Situations in which elaboration, interpretation, explanation, and argumentation are integral to the activity of the group and where learning is supported by other individuals.

Different learning theory approaches favour cooperative learning for different reasons (O'Donnell, 2002, 2006). Information processing theorists point to the value of group discussion in helping participants rehearse, elaborate, and expand their knowledge. As group members question and explain, they have to organize their knowledge, make connections, and review—all processes that support information processing and memory. Advocates of a Piagetian perspective suggest the interactions in groups can create the cognitive conflict and disequilibrium that lead an individual to question his or her understanding and try out new ideas—or, as Piaget (1985) said, "to go beyond his current state and strike out in new directions" (p. 10). Those who favour Vygotsky's theory suggest that social interaction is important for learning because higher mental functions such as reasoning, comprehension, and critical thinking originate in social interactions and are then appropriated and internalized by individuals. Students can accomplish mental tasks with social support before they can do them alone. Thus, cooperative learning provides the social support and scaffolding students need to move learning forward. To benefit from these dimensions of cooperative learning, groups must be cooperative—all members must participate. But, as any teacher or parent knows, cooperation is not automatic when students are put into groups.

COOPERATION: A WORTHY GOAL While academics are the key goal, education also prepares students to live and work cooperatively with all kinds of people. Studies of cooperative learning indicate its positive influence on students' empathy, tolerance, friendships, self-confidence, and even school attendance.

Patrick White/Merrill

WHAT CAN GO WRONG: MISUSES OF GROUP LEARNING. Without careful planning and monitoring by the teacher, group interactions can hinder learning and reduce rather than improve social relations in classes (Gillies & Boyle, 2011). For example, if there is pressure in a group for conformity—perhaps because rewards are being misused or one student dominates the others—interactions can be unproductive and unreflective. Misconceptions might be reinforced, or the worst, not the best, ideas may be combined to construct a superficial or even incorrect understanding (Battistich, Solomon, & Delucci, 1993). Students who work in groups but arrive at wrong answers may be more confident that they are right—a case of "two heads are worse than one" (Puncochar & Fox, 2004). Also, the ideas of low-status students may be ignored or even ridiculed while the contributions of high-status students are accepted and reinforced, regardless of the merit of either set of ideas (Anderson, Holland, & Palincsar, 1997; Cohen, 1986). Mary McCaslin and Tom Good (1996) list several other disadvantages of group learning:

- Students often value the process or procedures over the learning. Speed and finishing early take precedence over thoughtfulness and learning.
- Rather than challenging and correcting misconceptions, students support and reinforce misunderstandings.
- Socializing and interpersonal relationships may take precedence over learning.
- Students may simply shift dependency from the teacher to the "expert" in the group—learning is still passive and what is learned can be wrong.
- Status differences may be increased rather than decreased. Some students learn to "loaf" because the group progresses with or without their contributions. Others become even more convinced that they are unable to understand without the support of the group.

The next sections examine how teachers can avoid these problems and encourage true cooperation.

Tasks for Cooperative Learning

Like other decisions in teaching, plans for using cooperative groups begin with a goal. What are students supposed to accomplish? Successful teachers interviewed in one study emphasized that group activities must be well planned, students need to be prepared to work in groups, and teachers' expectations for the task have to be explicitly stated (Gillies & Boyle, 2011). What is the task? Is it a true group task—one that builds on the knowledge and skills of several students—or is the task more appropriate for individuals (Cohen, 1994; O'Donnell, 2006)?

Tasks for cooperative groups may be more or less structured. Highly structured tasks include work that has specific answers—drill and practice, applying routines or procedures, answering questions from readings, computations in mathematics, and so on. Ill-structured complex tasks have multiple answers and unclear procedures, requiring problem finding and higher-order thinking. These ill-structured problems are true group tasks; that is, they are likely to require the resources (knowledge, skills, problem-solving strategies, creativity) of all the group members to accomplish, whereas individuals often can accomplish highly structured tasks just as effectively as groups. These distinctions are important because ill-structured, complex, true group tasks appear to require more and higher-quality interactions than routine tasks if learning and problem solving are to occur (Cohen, 1994; Gillies, 2004; Gillies & Boyle, 2011).

Watch
Highly Structured, Review, and Skill-Building Tasks

HIGHLY STRUCTURED, REVIEW, AND SKILL-BUILDING TASKS. A relatively structured task such as reviewing previously learned material for an exam might be well served by a structured technique such as STAD (Student Teams Achievement Divisions), in which teams of four students compete to determine which team's members can amass the greatest improvement over previous achievement levels (Slavin, 1995). Praise, recognition, or extrinsic rewards can enhance motivation, effort, and persistence under these conditions, and thus increase learning. Focusing the dialogue by assigning narrow roles also may help students stay engaged when the tasks involve practice or review.

ILL-STRUCTURED, CONCEPTUAL, AND PROBLEM-SOLVING TASKS. If the task is ill structured and more cognitive in nature, then an open exchange and elaborated discussion will be more helpful (Cohen, 1994; Ross & Raphael, 1990). Thus, strategies that encourage extended and productive interactions are appropriate when the goal is to develop higher-order thinking and problem solving. In these situations, a tightly structured process, competition among groups for rewards, and rigid assignment of roles are likely to inhibit the richness of the students' interactions and to interfere with progress toward the goal. Open-ended techniques such as reciprocal questioning (King, 1994), reciprocal teaching (Palincsar & Brown, 1984; Rosenshine & Meister, 1994), pair-share (Kagan, 1994), or Jigsaw (Aronson, 2000) should be more productive because, when used appropriately, they encourage more extensive interaction and elaborative thought in situations where students are being exposed to complex materials. In these instances, the use of rewards may well divert the group away from the goal of in-depth cognitive processing. When rewards are offered, the goal often becomes achieving the reward as efficiently as possible, which could mean having the highest-achieving students do all the work (Webb & Palincsar, 1996).

SOCIAL SKILLS AND COMMUNICATION TASKS. When the goal of peer learning is enhanced social skills or increased intergroup understanding and appreciation of diversity, the assignment of specific roles and functions within the group might support communication (Cohen, 1994; Kagan, 1994). In these situations, it can be helpful to rotate leadership roles so that minority group students and females have the opportunity to demonstrate and develop leadership skills; in addition, all group members can experience the leadership capabilities of each individual (Miller & Harrington, 1993). Rewards probably are not necessary, and they may actually get in the way because the goal is to build community, a sense of respect, and responsibility for all team members.

Preparing Students for Cooperative Learning

David and Roger Johnson (2009a) explain five elements that define true cooperative learning groups:

- Positive interdependence
- Promotive interaction
- Individual accountability
- Collaborative and social skills
- Group processing

Group members experience *positive interdependence*. The members believe they can attain their goals only if the others in the group attain their goals as well, so they need each other for support, explanations, and guidance. *Promotive interaction* means that group members encourage and facilitate each other's efforts. They usually interact face to face and close together, not across the room, but they also could interact via digital media around the world. Even though they feel a responsibility to the group to work together and help each other, students must ultimately demonstrate learning on their own; they are held *individually accountable* for learning, often through individual tests or other assessments. *Collaborative and social skills* are necessary for effective group functioning. Often, these skills, such as giving constructive feedback, reaching consensus, and involving every member, must be taught and practised before the groups tackle a learning task. Finally, members monitor *group processes* and relationships to make sure the group is working effectively and to learn about the dynamics of groups. They take time to ask, "How are we doing as a group? Is everyone working together? What should we do more or less of next time?"

Research in grades 8 through 12 in Australia found that students in cooperative groups that were structured to require positive interdependence and mutual helping learned more in math, science, and English than students in unstructured learning groups (Gillies, 2003). In addition, compared to students in the unstructured groups, students in the structured groups also said learning was more fun.

SETTING UP COOPERATIVE GROUPS. How large should a cooperative group be? Again, the answer depends on your learning goals. If the purpose is for the group members to review, rehearse information, or practise, four to six students is about the right size. But if the goal is to encourage each student to participate in discussions, problem solving, or computer learning, then groups of two to four members work best. Also, when setting up cooperative groups, it often makes sense to balance the number of boys and girls. Some research indicates that when there are just a few girls in a group, they tend to be left out of the discussions unless they are the most able or assertive members. By contrast, when there are only one or two boys in the group, they tend to dominate and be "interviewed" by the girls unless these boys are less able than the girls or are very shy. In some studies, but not all, of mixed-gender groups, girls avoided conflict and boys dominated discussion (O'Donnell & O'Kelly, 1994; Webb & Palincsar, 1996). Whatever the case, teachers must monitor groups to make sure everyone is contributing and learning.

If a group includes some students who are perceived as different or who are often rejected, then it makes sense to be sure that there are group members who are tolerant and kind. One successful teacher interviewed by Gillies and Boyle (2011) put it this way:

> I also try to make sure that there are one or two people in the group who have the ability to be tolerant. At least the kid in question will know that, while the other group members may not be his best friends, they won't give him a hard time. I try to put the least reactive kids in the group with the child in question. This year I've had a couple of girls who have been very good with difficult kids. They don't put up with nonsense but they don't over-react and are prepared to demonstrate some good social skills. (p. 72)

GIVING AND RECEIVING EXPLANATIONS. In practice, the effects of learning in a group vary, depending on what actually happens in the group and who is in it. If only a few people take responsibility for the work, these people will learn, but the nonparticipating members probably will not. Students who ask questions, get answers, and attempt explanations are more likely to learn than students whose questions go unasked or unanswered. In fact, there is evidence that the more a student provides elaborated, thoughtful explanations to other students in a group, the more the *explainer* learns. Giving good explanations appears to be even more important for learning than receiving explanations (O'Donnell, 2006; Webb, Farivar, & Mastergeorge, 2002). In order to explain, you have to organize the information, put it into your own words, think of examples and analogies (which connect the information to things you already know), and test your understanding by answering questions. These are excellent learning strategies (King, 1990, 2002; O'Donnell & O'Kelly, 1994).

Good explanations are relevant, timely, correct, and elaborated enough to help the listener correct misunderstandings; the best explanations tell why (Webb, Farivar, & Mastergeorge, 2002; Webb & Mastergeorge, 2003). For example, in a middle-school mathematics class, students worked in groups on the following problem:

> Find the cost of a 30-minute telephone call to the prefix 604 where the first minute costs $0.22 and each additional minute costs $0.13.

The level of explanation and help students received was significantly related to learning; the higher the level of explanation, the more learning took place. Table 10.3 shows the different levels of help. Of course, the students must pay attention to and use the help in order to learn. And the help-receiver also has responsibilities if learning is to go well. For example, if a helper says, "13 times 29," then the receiver should say, "Why is it 29?" Asking good questions and giving clear explanations are critical, and usually these skills must be taught.

ASSIGNING ROLES. Some teachers assign roles to students to encourage cooperation and full participation. Several roles are described in Table 10.4. If you use roles, be sure that they support learning. In groups that focus on social skills, roles should support listening, encouragement, and respect for differences. In groups that focus on practice, review, or mastery of basic skills, roles should support persistence, encouragement, and participation. In groups that focus on higher-order problem solving or complex learning, roles should encourage thoughtful discussion, sharing of explanations and insights, probing, brainstorming, and creativity. Make sure that you don't communicate to students that the major purpose of the groups is simply to do the procedures—the roles. Roles are supports for learning, not ends in themselves (Woolfolk Hoy & Tschannen-Moran, 1999).

TABLE 10.3 • **Levels of Help in Cooperative Groups**

Students are more likely to learn if they give and get higher-level help.

LEVEL	DESCRIPTION AND EXAMPLE
Highest	
6	Verbally labelled explanation of how to solve part or all of the problem ("Multiply 13 cents by 29, because 29 minutes are left after the first minute.")
5	Numerical rule with no verbal labels for the numbers ("This is 30, so you minus 1.")
4	Numerical expression or equation ("13 times 29.")
3	Numbers to write or copy ("Put 13 on top, 29 on the bottom. Then you times it.")
2	Answer to part or all of the problem ("I got $3.77.")
1	Non-content or non-informational response ("Just do it the way she said.")
0	No response
Lowest	

Source: Adapted from Webb, N. M., Troper, J. D., & Fall, R. (1995). Constructive activity and learning in collaborative small groups. Journal of Educational Psychology, 87, *p. 411.*

TABLE 10.4 • Possible Student Roles in Cooperative Learning Groups

Depending on the purpose of the group and the age of the participants, having these assigned roles might help students cooperate and learn. Of course, students may have to be taught how to enact each role effectively, and roles should be rotated so students can participate in different aspects of group learning.

ROLE	DESCRIPTION
Encourager	Encourages reluctant or shy students to participate
Praiser/Cheerleader	Shows appreciation of others' contributions and recognizes accomplishments
Gate Keeper	Equalizes participation and makes sure no one dominates
Coach	Helps with the academic content, explains concepts
Question Commander	Makes sure all students' questions are asked and answered
Checker	Checks the group's understanding
Taskmaster	Keeps the group on task
Recorder	Writes down ideas, decisions, and plans
Reflector	Keeps group aware of progress (or lack of progress)
Quiet Captain	Monitors noise level
Materials Monitor	Picks up and returns materials

Source: Based Kagan, S. (1994). Cooperative Learning. *San Clemente: Kagan Publishing.*

Often, cooperative learning strategies include group reports to the entire class. If you have been on the receiving end of these class reports, you know that they can be deadly dull. To make the process more useful for the audience as well as the reporters, Annemarie Palincsar and Leslie Herrenkohl (2002) taught the class members to use *intellectual roles* as they listened to reports. These roles were based on the scientific strategies of predicting and theorizing, summarizing results, and relating predictions and theories to results. Some audience members were assigned the role of checking the reports for clear relationships between predictions and theories. Other students in the audience listened for clarity in the findings. And the rest of the students were responsible for evaluating how well the group reports linked prediction, theories, and findings. Research shows that using these roles promotes class dialogue, thinking and problem solving, and conceptual understanding (Palincsar & Herrenkohl, 2002).

Designs for Cooperation

Developing deep understandings in cooperative groups requires that all the group members *participate* in *high-quality discussions*. Discussions that support learning include talk that interprets, connects, explains, and uses evidence to support arguments. We now turn to different strategies that build in structures to support both participation and high-quality discussions.

RECIPROCAL QUESTIONING. **Reciprocal questioning** is where students work on realistic problems that don't necessarily have "right" answers. It requires no special materials or testing procedures and can be used with a wide range of ages. After a lesson or presentation by the teacher, students work in pairs or triads to ask and answer questions about the material (King, 1990, 1994, 2002). The teacher provides question stems (see Table 10.5), and then students are taught how to develop specific questions on the lesson material using the generic question stems. The students create questions, and then take turns asking and answering. This process has proved more effective than traditional discussion groups because it seems to encourage deeper thinking about the material.

Reciprocal questioning Students work in pairs or triads to ask and answer questions about lesson material.

TABLE 10.5 • Question Stems to Encourage Dialogue in Reciprocal Questioning

After participating in a lesson or studying an assignment on their own, students use these stems to develop questions, create and compare answers, and collaborate to create the best response.

What is an everyday application of . . . ?
How would you define . . . in your own words?
What are the advantages and disadvantages of . . . ?
What do you already know about . . . ?
Explain why . . . applies to . . . ?
How does . . . influence . . . ?
What is the value of . . . ?
What are the reasons for . . . ?
What are some arguments for and against . . . ?
What is the your first choice about . . . ? Your second choice? Why?
What is the best . . . and why?
Compare . . . and . . . based only on . . .
How would . . . be different if . . . ?
Do you agree or disagree with this claim? What is your evidence?

Questions such as those in Table 10.5, which encourage students to make connections between the lesson and previous knowledge or experience, seem to be the most helpful.

For example, using question stems like those in Table 10.5, a small group in Mr. Garcia's grade 9 world cultures class had the following discussion about the concept of culture:

> **Sally**: In your own words, what does culture mean?
>
> **Jim**: Well, Mr. Singh said in the lesson that a culture is the knowledge and understandings shared by the members of a society. I guess it's all the things and beliefs and activities that people in a society have in common. It includes things like religion, laws, music, medical practices, stuff like that.
>
> **Sally**: And dance, art, family roles.
>
> **Barry**: Knowledge includes language. So, I guess cultures include language, too.
>
> **Jim**: I guess so. Actually, I have a question about that: How does a culture influence the language of a society?
>
> **Barry**: Well, for one thing, the language is made up of words that are important to the people of that culture. Like, the words name things that the people care about, or need, or use. And so, different cultures would have different vocabularies. Some cultures may not even have a word for *telephone,* because they don't have any. But, phones are important in our culture, so we have lots of different words for phones, like *cell phone, digital phone, desk phone, cordless phone, phone machine,* and . . .
>
> **Jim** (laughing): I'll bet desert cultures don't have any words for *snow* or *skiing.*
>
> **Sally** (turning to Barry): What's your question?
>
> **Barry**: I've got a great question! You'll never be able to answer it. What would happen if there were a group somewhere without any spoken language? Maybe they were all born not being able to speak, or something like that. How would that affect their culture, or could there even be a culture?
>
> **Sally**: Well, it would mean they couldn't communicate with each other.
>
> **Jim**: And they wouldn't have any music! Because they wouldn't be able to sing.
>
> **Barry**: But wait! Why couldn't they communicate? Maybe they would develop a nonverbal language system, you know, the way people use hand signals, or the way deaf people use sign language. (King, 2002, pp. 34–35)

Jigsaw Classroom A learning process in which each student is part of a group and each group member is given part of the material to be learned by the whole group. Students become "expert" on their piece and then teach it to the others in their group.

JIGSAW. Elliot Aronson and his graduate students invented the **Jigsaw Classroom** when Aronson was a professor of social psychology (and Anita was a student) at the University of Texas at Austin. Some of her friends worked on his research team. Aronson developed the approach "as a matter of absolute necessity to help defuse a highly explosive situation" (Aronson, 2000, p. 137). The Austin schools had just been desegregated by court order. White, African American, and Hispanic students were together in classrooms for the first time. Hostility and turmoil ensued, with fistfights in corridors and classrooms. Aronson's answer was the Jigsaw Classroom, a learning process in which each student is part of a group and each group member is given part of the material to be learned by the whole group. Students become "expert" on their piece and then teach it to the others in their group.

Because students have to learn and be tested on every piece of the larger "puzzle," everyone's contribution is important—the students truly are interdependent. A more recent version, Jigsaw II, adds expert groups in which the students who are responsible for the same material from each learning group confer to make sure they understand their assigned part and then plan ways to teach the information to their learning group members. Next, students return to their learning groups, bringing their expertise to the sessions. In the end, students take an individual test covering all the material and earn points for their learning team score. Teams can work for rewards or simply for recognition (1995).

STRUCTURED CONTROVERSIES. Constructive conflict resolution is essential in classrooms because conflicts are inevitable and even necessary for learning. Piaget's theory tells us that developing knowledge requires cognitive conflict. David and Roger Johnson (2009b) make a powerful case for constructive intellectual conflict:

> Conflict is to student learning what the internal combustion engine is to the automobile. The internal combustion engine ignites the fuel and the air with a spark to create the energy for movement and acceleration. Just as the fuel and the air are inert without the spark, so, ideas in the classroom are inert without the spark of intellectual conflict. (p. 37)

One study of grade 10 students found that students who were wrong, but for different reasons, were sometimes able to correct their misunderstandings if they argued together about their conflicting wrong answers (Schwarz, Neuman, & Biezuner, 2000). Individuals trying to exist in groups will have interpersonal conflicts, too, which also can lead to learning. In fact, research over the past 40 years demonstrates that constructive controversy in classrooms can lead to greater learning, open-mindedness, seeing the perspectives of others, creativity, motivation, engagement, and self-esteem (2009b). Table 10.6 shows how academic and interpersonal conflicts can be positive forces in a learning community.

As you can see in Table 10.6, the structured part of **structured controversies** is that students work in pairs within their four-person cooperative groups to research a particular

Structured controversy Students work in pairs within their four-person cooperative groups to research a particular controversy.

TABLE 10.6 • **Structured Controversies: Learning From Academic and Interpersonal Conflicts**

Conflict, if handled well, can support learning. Academic conflicts can lead to critical thinking and conceptual change. Conflicts of interest are unavoidable, but can be handled so no one is the loser.

ACADEMIC CONTROVERSY	CONFLICTS OF INTEREST
One person's ideas, information, theories, conclusions, and opinions are incompatible with those of another, and the two seek to reach an agreement.	The actions of one person attempting to maximize benefits prevents, blocks, or interferes with another person maximizing her or his benefits.
Controversy Procedure	*Integrative (Problem-Solving) Negotiations*
Research and prepare positions	Describe wants
Present and advocate positions	Describe feelings
Refute opposing position and refute attacks on own position	Describe reasons for wants and feelings
Reverse perspectives	Take other's perspective
Synthesize and integrate best evidence and reasoning from all sides	Invent three optional agreements that maximize joint outcomes. Choose one and formalize agreement

Source: From Johnson, D., & Johnson, R. (1999). The Three Cs of School and Classroom Management. In H. J. Freiberg (Ed.), Beyond Behaviourism: Changing the Classroom Management Paradigm. *Boston: Allyn and Bacon. Adapted with permission.*

GUIDELINES

Using Cooperative Learning

Fit group size and composition to your learning goals.
Examples
1. For social skills and team-building goals, use groups of two to five, common interest groups, mixed groups, or random groups.
2. For structured fact and skill-based practice and review tasks, use groups of two to four, mixed ability such as high-middle and middle-low or high-low and middle-middle group compositions.
3. For higher-level conceptual and thinking tasks, use groups of two to four; select members to encourage interaction.

Assign appropriate roles.
Examples
1. For social skills and team-building goals, assign roles to monitor participation and conflict; rotate leadership of the group.
2. For structured fact and skill-based practice and review tasks, assign roles to monitor engagement and insure low-status students have resources to offer, as in Jigsaw.
3. For higher-level conceptual and thinking tasks, assign roles only to encourage interaction, divergent thinking, and extended, connected discourse, as in debate teams or group facilitator. Don't let roles get in the way of learning.

Make sure you assume a supporting role as the teacher.
Examples
1. For social skills and team-building goals, be a model and encourager.
2. For structured fact and skill-based practice and review tasks, be a model, director, or coach.
3. For higher-level conceptual and thinking tasks, be a model and facilitator.

Move around the room and monitor the groups.
Examples
1. For social skills and team-building goals, watch for listening, turn-taking, encouraging, and managing conflict.
2. For structured fact and skill-based practice and review tasks, watch for questioning, giving multiple elaborated explanations, attention, and practice.
3. For higher-level conceptual and thinking tasks, watch for questioning, explaining, elaborating, probing, divergent thinking, providing rationales, synthesizing, using and connecting knowledge sources.

Start small and simple until you and the students know how to use cooperative methods.
Examples
1. For social skills and team-building goals, try one or two skills, such as listening and paraphrasing.
2. For structured fact and skill-based practice and review tasks, try pairs of students quizzing each other.
3. For higher-level conceptual and thinking tasks, try reciprocal questioning using pairs and just a few question stems.

For more information on cooperative learning, see www.co-operation.org.

Source: Based on Woolfolk Hoy, A., & Tschannen-Moran, M. (1999). Implications of Cognitive Approaches to Peer Learning for Teacher Education. In A. O'Donnell and A. King (Eds.), Cognitive Perspectives on Peer Learning *(pp. 257–284). Mahwah, NJ: Lawrence Erlbaum.*

controversy, such as whether lumber companies should be allowed to cut down trees in national forests. Each pair of students researches the issue, develops a pro or con position, presents their position and evidence to the other pair, discusses the issue, and then reverses positions and argues for the other perspective. Then, the group develops a final report that summarizes the best arguments for each position and reaches a consensus (Johnson & Johnson, 2009b; O'Donnell, 2006).

In addition to these approaches, Spencer Kagan (1994) has developed many cooperative learning structures designed to accomplish different kinds of academic and social tasks. The *Guidelines* give you ideas for incorporating cooperative learning in to your classes.

Reaching Every Student: Using Cooperative Learning Wisely

Cooperative learning always benefits from careful planning, but sometimes including students with special needs requires extra attention to planning and preparation. For example, cooperative structures such as scripted questioning and peer tutoring depend on a balanced interaction between the person taking the role of questioner or explainer and the student who is answering or being taught. In these interactions, you want to see and hear explaining and teaching, not just telling or giving right answers. But many students with learning disabilities have difficulties understanding new concepts, so both the explainer and the student can get frustrated, and social rejection for the student with learning disabilities might follow. Because students with learning disabilities often have problems with social relations, it is not a good idea to put them in situations where more rejection is likely. So, when you are teaching new or difficult-to-grasp concepts, cooperative learning might not be the best choice for students with learning disabilities (Kirk, Gallagher, Anastasiow, & Coleman, 2006). In fact, research has found that cooperative learning in general is not always effective for students with learning disabilities (Smith, 2006).

Gifted students also may not benefit from cooperative learning when groups are mixed in ability. The pace often is too slow, the tasks too simple, and there is just too much repetition. In addition, gifted students often fall into the role of teacher or end up just doing the work quickly for the whole group. If you use mixed-ability groups and include gifted students, the challenges are to use complex tasks that allow work at different levels and keep gifted students engaged without losing the rest of the class (Smith, 2006).

Cooperative learning may be an excellent choice for learners developing skills in English as an additional language (EALs), however. The Jigsaw cooperative structure is especially helpful because all students in the group, including the EAL students, have information that the group needs, so they also must talk, explain, and interact. In fact, the Jigsaw approach was developed in response to the need to create high interdependence in diverse groups. In many classrooms today, there are four, five, six, or more languages represented. Teachers can't be expected to master every heritage language spoken by all of their students every year. In these classrooms, cooperative groups can help as students work together on academic tasks. Students who speak two languages can help translate and explain lessons to others in the group. Speaking in a smaller group may be less anxiety provoking for students who are learning another language; thus, EAL students may get more language practice with feedback in these groups (Smith, 2006).

Cooperative learning is only as good as its design and implementation. Cooperative methods probably are both misused and underused in schools, in part because using cooperative learning well requires time and investment in teaching students how to learn in groups (Blatchford, Baines, Rubie-Davis, Bassett, & Chowne, 2006).

Dilemmas of Constructivist Practice

Years ago, Larry Cremin (1961) observed that progressive, innovative pedagogies require exceptionally skilled teachers. Today, the same could be said about constructivist teaching. We have already seen that there are many varieties of constructivism and many practices that flow from these different conceptions. We also know that all teaching today happens in a context of high-stakes testing and accountability. In these situations, constructivist teachers face many challenges. Mark Windschitl (2002) identified four teacher dilemmas of constructivism in practice, summarized in Table 10.7. The first is conceptual: How do I make sense of cognitive versus social conceptions of constructivism and reconcile these different perspectives with my practice? The second dilemma is pedagogical: How do I teach in truly constructivist ways that both honour my students' attempts to think for themselves, but still insure that they learn the academic material? Third are cultural dilemmas: What activities, cultural knowledge, and ways of talking will build a community in a diverse classroom? Finally, there are political dilemmas: How can I teach for deep understanding and critical thinking, but still satisfy the accountability demands of parents?

TABLE 10.7 • **Teachers' Dilemmas of Constructivism in Practice**

Teachers face conceptual, pedagogical, cultural, and political dilemmas as they implement constructivist practices. Here are explanations of these dilemmas and some representative questions that teachers face as they confront them.

TEACHERS' DILEMMA CATEGORY	REPRESENTATIVE QUESTIONS OF CONCERN
I. *Conceptual dilemmas*: Grasping the underpinnings of cognitive and social constructivism; reconciling current beliefs about pedagogy with the beliefs necessary to support a constructivist learning environment.	Which version of constructivism is suitable as a basis for my teaching? Is my classroom supposed to be a collection of individuals working toward conceptual change or a community of learners whose development is measured by participation in authentic disciplinary practices? If certain ideas are considered correct by experts, should students internalize those ideas instead of constructing their own?
II. *Pedagogical dilemmas*: Honouring students' attempts to think for themselves while remaining faithful to accepted disciplinary ideas; developing deeper knowledge of subject matter; mastering the art of facilitation; managing new kinds of discourse and collaborative work in the classroom.	Do I base my teaching on students' existing ideas rather than on learning objectives? What skills and strategies are necessary for me to become a facilitator? How do I manage a classroom where students are talking to one another rather than to me? Should I place limits on students' construction of their own ideas? What types of assessments will capture the learning I want to foster?
III. *Cultural dilemmas*: Becoming conscious of the culture of your classroom; questioning assumptions about what kinds of activities should be valued; taking advantage of experiences, discourse patterns, and local knowledge of students with varied cultural backgrounds.	How can we contradict traditional, efficient classroom routines and generate new agreements with students about what is valued and rewarded? How do my own past images of what is proper and possible in a classroom prevent me from seeing the potential for a different kind of learning environment? How can I accommodate the worldviews of students from diverse backgrounds while at the same time transforming my own classroom culture? Can I trust students to accept responsibility for their own learning?
IV. *Political dilemmas*: Confronting issues of accountability with various stakeholders in the school community; negotiating with key others the authority and support to teach for understanding.	How can I gain the support of administrators and parents for teaching in such a radically different and unfamiliar way? Should I make use of approved curriculums that are not sensitive enough to my students' needs, or should I create my own? How can diverse problem-based experiences help students meet specific state and local standards? Will constructivist approaches adequately prepare my students for high-stakes testing for college admissions?

Source: Adapted from Windschitl, M. (2002). Framing constructivism in practice as the negotiation of dilemmas: An analysis of the conceptual, pedagogical, cultural, and political challenges facing teachers. Review of Educational Research, 72, *p. 133. Reproduced with permission of the publisher.*

SERVICE LEARNING

Service learning combines academic learning with personal and social development for secondary and college students (Woolfolk Hoy, Demerath, & Pape, 2002). A more formal definition of **service learning** is "a teaching and learning strategy that integrates meaningful community service with instruction and reflection to enrich the learning experience, teach civic responsibility, and strengthen communities" (National Service Learning Clearing House, n.d.). Common characteristics of service learning strategies in Canada include:

- are organized and meet actual community needs
- are integrated into the student's curriculum
- provide time to reflect and write about the service experience
- provide opportunities to apply newly learned academic skills and knowledge
- enhance both academic learning and a sense of caring for others

Service learning activities may involve direct service (tutoring, serving meals at homeless shelters), indirect service (collecting food for shelters, raising money), or advocacy (designing and distributing posters about a food drive, writing newspaper articles) (Johnson & Notah, 1999). Service learning also could be a form of problem-based learning.

Service learning Combines academic learning with personal and social development for secondary and college students.

Participation in service learning can promote political and moral development for adolescents. Through service learning projects, adolescents experience their own competence and agency by working with others in need. Students see themselves as political and moral agents, rather than as merely good citizens (Youniss & Yates, 1997). In addition, service learning can help adolescents think in new ways about their relationships with people who are unlike them, and thus can lead them to become more tolerant of differences (Tierney, 1993). Finally, service learning experiences foster an "ethic of care" that can result in a growing commitment to confront difficult social problems (Rhodes, 1997). In this sense, student involvement in service learning can motivate and empower adolescents to critically reflect on their role in society (Woolfolk Hoy, Demerath, & Pape, 2002). A number of schools now have participation in service learning as a graduation requirement, but some educators question if "required" service is fair or appropriate. At least three of the school requirements have been challenged in court, but, so far, the requirements have been upheld (Johnson & Notah, 1999).

SERVICE LEARNING Community service projects can promote adolescents' moral development, feelings of competence and agency, and tolerance of differences, and encourage them to reflect critically on their roles in society.

Studies of service learning have produced mixed results. Some studies have found modest gains on measures of social responsibility, tolerance for others, empathy, attitude toward adults, and self-esteem (Solomon, Watson, & Battistich, 2001). A case study at an urban parochial high school describes a successful service learning experience program that was required for juniors and was part of a year-long course on social justice (Youniss & Yates, 1999). In the class, students examined the moral implications of current social issues such as homelessness, poverty, exploitation of immigrant labourers, and urban violence. Students also were required to serve four times (approximately 20 hours) at an inner-city soup kitchen. The researchers concluded that students emerged from the course with "a deeper awareness of social injustice, a greater sense of commitment to confront these injustices, and heightened confidence in their abilities overall" (Yates & Youniss, 1999, p. 64).

Your students may be involved in service learning both inside and outside the school. You might share the *Family and Community Partnership Guidelines* with families and use them yourself. Many are taken from Richard Sagor (2003) and Elias and Schwab (2006).

Learning in a Digital World

Watch
Learning in a Digital World

It seems that computers, smartphones, iPods, iPads, iTouches, tablets, digital readers, and interactive video games, along with iCloud, Facebook, Twitter, Google, Yahoo!, and other digital tools and media have changed life for everyone. Homes and schools are filled with media. For students, doing homework often involves exchanging messages with friends via email, texting, or cell phones; searching the web; and downloading resources—all the time listening to music via an iPod or watching television (Roberts, Foehr, & Rideout, 2005). A recent Ipsos-Reid poll found that, in early 2010, Canadians were spending slightly more than 18 hours per week online, while they watched television for just under 17 hours per week (Ipsos, 2010).

Learning Environments and Technology

With all the technology available today, there is growing interest in *technology-rich learning environments*, or TREs. These environments include virtual worlds, computer

GUIDELINES FAMILY AND COMMUNITY PARTNERSHIPS

Service Learning

The service should be ongoing, not just a brief project.

Examples

1. Instead of having a two-week food drive with a party for the class that collected the most, encourage a longer commitment to cook or serve food at shelters for homeless families.
2. Contact local agencies to identify real needs that your students could address or search online by postal code: www.volunteermatch.org.

Consider virtual volunteering. See www.serviceleader.org/virtual.

Examples

1. Translate a document into another language.
2. Provide multimedia expertise, such as preparing a PowerPoint, QuickTime, or other computer-based presentation.
3. Design an agency's newsletter or brochure, or copy edit an agency's publication or proposal.
4. Proofread drafts of papers and online publications.
5. Research and write articles for brochures, newsletters, websites.
6. Design a logo for an agency or program, or fill other illustration needs.

Be aware of service learning projects in school. Make sure learning is at the centre.

Examples

1. Have clear learning objectives for the projects.
2. Examine grade-level standards in science, history, health, literature, and other areas to see how some might be met through service projects—for example, how might concepts in biology be learned through designing a nutrition education project for senior citizens or preschool students?
3. Do students reflect over time about their experiences, keep journals, write or draw what they have learned, and include these reflections in class discussions?

Make sure the service draws on your child's talents and skills so that it is actually valuable to the recipients and he or she gains a sense of accomplishment and usefulness from applying skills to help others.

Examples

1. Youth who have artistic talents might help redecorate a game room at a senior citizens' centre.
2. Individuals who are good storytellers could work with children at a day care centre or in a children's clinic.
3. Students who are bilingual might help teachers translate school newsletters into the languages of fellow students' families or serve as translators at local clinics.

Design service learning opportunities so they are inclusive (Dymond, Renzaglia, & Chun, 2007).

Examples

1. Consider transportation needs for children with disabilities.
2. Link service learning projects to life skills such as social skills on the job, safety, and punctuality.
3. Encourage teachers to monitor interactions in groups for all students; be aware of how students with special needs are included.

For more ideas, see www.communityservicelearning.ca/en/resources.htm.

simulations that support problem-based learning such as the *River of Life Challenge* described earlier, intelligent tutoring systems, educational games, audio recordings, handheld wireless devices, and multimedia environments—to name just a few.

There are three kinds of uses for technology in schools. First, teachers can design technology-based activities for their classrooms, for virtual learning environments, or for blended models using both in-class and virtual environments. Second, students can interact with technologies in a variety of ways, such as by using a computer or tablet to complete assignments, or by collaborating in a virtual environment with other students or teachers using interactive **cloud computing** applications. Cloud computing allows computer users online access to applications such as a Google documents or Microsoft Web Mail along with computing assets such as network-accessible data storage and processing. Finally, administrators use technology to track teacher, class, and student information in school, district, or provincial systems. You could be involved with any or all three uses of technology in your teaching.

Cloud computing Allows computer users to access applications such as a Google document or Microsoft Web Mail, as well as computing assets such as network-accessible data storage and processing to use online applications.

The primary goal for integrating technology into a classroom is to support student learning. The process may seem difficult and troublesome at first, especially for teachers with few technological skills. Starting points include researching your school or district technology policies and procedures, identifying internal resources such as technology integration teams, seeking out training resources, and working with teachers who already use technology in their classes. Becoming familiar with available technological resources will help you to identify and include new technologies that will enhance your teaching. A golden rule for technology integration in any classroom is that you do not need to reinvent the wheel. Focus on identifying centres of expertise where existing resources are available to adapt and build on.

Virtual Learning Environments

Virtual Learning Environment (VLE) is a broad term that describes many ways of learning in virtual systems. The most traditional VLE is referred to as a **Learning Management System (LMS)**. LMSs deliver e-learning using applications such as Moodle, BlackBoard, RCampus, and Desire2Learn. Learning management systems are large, complex, and costly—Phil's university uses a system called Canvas to support every course on all three of the university's campuses. Canvas sites have readings, discussion groups, a calendar, and many other resources. Professors taught classes without these assets for decades, but the learning management system has expanded their teaching and learning options. To deal with costs, some institutions use free *open-source software* to construct virtual learning environments. Tools that support open-source software include Moodle, Google Apps, Microsoft SharePoint, and PBWorks.

There are different kinds of virtual learning environments. A **Personal Learning Environment (PLE)** framework provides tools that support individualized learning in a variety of contexts and situations; the learners assume control of how and when their learning occurs. Students working in personal learning environments can download an assignment at Panera, read the material on the bus, and then post an analysis on the discussion board at 4:00 a.m. from their room—learning is asynchronous, it takes place anytime and anywhere. Complex personal learning environments include tools that assess learners' knowledge and then adapt the next content to fit their needs. Tools that support PLEs include computer-based training modules, ebooks, cognitive tutors, quizzes, and self-assessment tools.

A **Personal Learning Network (PLN)** is a framework in which knowledge is constructed through online peer interactions. PLNs consist of both synchronous (real time) and asynchronous technologies using interactive web conferencing, hybrid classes, or online discussions. A PLN can be used for K–12 instructional purposes and also as a resource for professional development. Social networking tools such as Facebook, Twitter, Edutopia, and EdWeb allow the instruction to move outside the school, city, and even country to include learners with similar interests around the globe. Tools that support personal learning networks include web conferencing tools such as Adobe Connect and Elluminate, instant messaging, interactive video and audio messaging, social networking, discussion boards, and blogs.

The most complex VLE is an **Immersive Virtual Learning Environment (IVLE)**. The IVLE is a simulation of a real-world environment that immerses students in tasks like those required in a professional practicum. The purpose is to learn through enculturation, for example by being eco explorers in the rainforest or reporters covering a story about an outbreak of food poisoning in a local school (Gee, 2003; Gibson, Aldrich, & Prensky, 2006; Hamilton, 2011; Shaffer et al., 2009). Immersive Virtual Learning Environments are designed to be domain specific using realistic scenarios (Bagley & Shaffer, 2009; Shaffer et al., 2009). IVLE experiences mimic tasks required in a professional practicum, such as interviewing sources for a news story about food poisoning, following leads to identify the source of a problem, and crafting an accurate engaging article, thus blending real-world engagement in a virtual scenario. These immersive environments often include *cognitive tutors*—the technology is programmed to interact as a tutor by providing prompts after analyzing the student's response.

Massive Multi-player Online Games (MMOGs) are interactive gaming environments constructed in virtual worlds in which the learner assumes a character role of avatar. Virtual world simulations incorporating MMOGs have been used for experiential and didactic learning in the medical field for several years and quickly are gaining attention

Virtual Learning Environment (VLE) A broad term that describes many ways of learning in virtual or online systems.

Learning Management System (LMS) System that delivers e-learning, provides tools and learning materials, keeps records, administers assessments, and manages learning.

Personal Learning Environment (PLE) Provides tools that support individualized learning in a variety of contexts and situations.

Personal Learning Network (PLN) Framework in which knowledge is constructed through online peer interactions.

Immersive Virtual Learning Environment (IVLE) A simulation of a real-world environment that immerses students in tasks like those required in a professional practicum.

Massive Multi-player Online Games (MMOGs) Interactive gaming environments constructed in virtual worlds where the learner assumes a character role of avatar.

in PK–12 classrooms. The pedagogic value in good gaming design is the ability to create complex scenarios by developing lessons using modelling and problem-based learning scenarios as alternative methods of instruction (Gee, 2008). For example, Project Evoke is a game developed by the World Bank (www.urgentevoke.com). As they play the game, adolescents from around the world work collectively to solve major world problems such as hunger. Stay tuned for more exciting learning worlds.

Developmentally Appropriate Computer Activities for Young Children

Digital media are appealing, but are they appropriate for preschool children? This is hotly debated. Computers should not be used to do solitary drill-and-practice activities. Developmentally appropriate ways to use computers with 3- and 4-year-olds are different from the ways we use computers in kindergarten and the primary grades (www.kidsource.com/education/computers.children.html). With developmentally appropriate computer activities, young children can benefit cognitively without sustaining losses in creativity (Haugland & Wright, 1997). Software for children should include simple spoken directions; the activities should be open-ended and encourage discovery, exploration, problem solving, and understanding of cause and effect. Children should be able to remain in control of the activities through a variety of responses. Finally, the content should be appropriate for and respectful of diverse cultures, ages, and abilities (Fischer & Gillespie, 2003; Frost, Wortham, & Reifel, 2005). Linda Tsantis and her colleagues suggest that you ask this question about any program you are considering: "Does this software program help create learning opportunities that did not exist without it?" (Tsantis, Berwick, & Thouvebelle, 2003).

There is another important consideration—does the program's multimedia features (e.g., embedded videos, zoom-ins, music, added sounds, images) add to learning or take away from it? One danger is that programs will include attractive visuals or sound effects that actually interrupt and interfere with the development of important concepts. For example, do the sounds of a buzz saw and the thud of a falling tree in a Peter Rabbit storytelling program foster distractibility and interfere with understanding the story, plot, and characters? Maybe (Tsantis, Bewick, & Thouvenelle, 2003).

Dealing with all of this stimulation might make children better at multitasking, but also worse at deeper thought processes such as developing perspective-taking skills and understanding the plot, theme, and sequence of the story. So children learn to do several things at once, but have a superficial understanding of what they are doing (Carpenter, 2000).

Research in the Netherlands, however, demonstrated that multimedia storybooks can provide support for understanding stories and remembering linguistic information for kindergarten students from families with low educational levels who are behind in language and literacy skills (Verhallen, Bus, & de Jong, 2006). The difference in this study seemed to be that the multimedia features of the story supported understanding and memory by providing multiple pathways to meaning, giving visual and verbal representations of key story elements, focusing attention on important information, and reinforcing key ideas. This extra scaffolding may be especially important for students with limited language and literacy skills. So the bottom line is that multimedia elements should focus on meaning and not just provide attractive "bells and whistles."

Computers and Older Students

There is evidence that using computers—especially games that require multiple activities, visual attention, imagery, and fast action—supports the development of visual skills, as long as the tasks fit the student's level of ability (Subrahmanyam, Greenfield, Kraut, & Gross, 2001). But does computer use support academic learning? The answer is complex and even surprising. After reviewing hundreds of studies, including five other research reviews, Roschelle, Pea, Hoadley, Gordon, and Means (2000) concluded that there were no strong conclusions. Using computer tutorial programs appeared to improve achievement

GUIDELINES

Using Computers

IF YOU HAVE ONLY ONE COMPUTER IN YOUR CLASSROOM

Provide convenient access.
Examples
1. Find a central location if the computer is used to display material for the class.
2. Find a spot on the side of the room that allows seating and view of the screen, but does not crowd or disturb other students if the computer is used as a workstation for individuals or small groups.

Be prepared.
Examples
1. Check to be sure software needed for a lesson or assignment is installed and working.
2. Make sure instructions for using the software or doing the assignment are in an obvious place and clear.
3. Provide a checklist for completing assignments.

Create "trained experts" to help with computers.
Examples
1. Train student experts, and rotate experts.
2. Use adult volunteers—parents, grandparents, aunts and uncles, older siblings—anyone who cares about the students.

Develop systems for using the computer.
Examples
1. Make up a schedule to insure that all students have access to the computer and no students monopolize the time.
2. Create standard ways of saving student work.

IF YOU HAVE MORE THAN ONE COMPUTER IN YOUR CLASSROOM

Plan the arrangement of the computers to fit your instructional goals.
Examples
1. For cooperative groups, arrange so students can cluster around their group's computer.
2. For different projects at different computer stations, allow for easy rotation from station to station.

Experiment with other models for using computers.
Examples
1. Navigator Model—four students per computer: One student is the (mouse and keyboard) driver, another is the "navigator." "Back-seat driver 1" manages the group's progress and "back-seat driver 2" serves as the timekeeper. The navigator attends a 10-minute to 20-minute training session in which the facilitator provides an overview of the basics of particular software. Navigators cannot touch the mouse. Driver roles are rotated.
2. Facilitator Model—six students per computer: the facilitator has more experience, expertise, or training—serves as the guide or teacher.
3. Collaborative Group Model—seven students per computer: Each small group is responsible for creating some component of the whole group's final product. For example, one part of the group writes a report, another creates a map, and a third uses the computer to gather and graph census data.

NO MATTER HOW MANY COMPUTERS YOU HAVE IN YOUR CLASSROOM

Select developmentally appropriate programs that encourage learning, creativity, and social interaction.
Examples
1. Encourage two children to work together rather than having children work alone.
2. Check the implicit messages in programs. For example, some drawing programs allow children to "blow up" their projects if they don't like them, so instead of solving a problem they just destroy it. Tsantis and colleagues (2003) recommend a recycle metaphor instead of a "blow it up" option.
3. Look for programs that encourage discovery, exploration, problem solving, and multiple responses.

Monitor children as they work at computers.
Examples
1. Make sure computers are in areas where adults can observe them.
2. Discuss with children why some programs or websites are off limits.
3. Balance computer time with active play such as hands-on projects, blocks, sand, water, and art.

Keep children safe as they work at computers.
Examples
1. Teach children to shield their identity on the internet and monitor any "friends" they may be communicating with.
2. Install filtering software to protect children from inappropriate content.

Sources: Suggestions are taken from Frost, J. L., Wortham, S. C., & Reifel, S. (2005). Play and child development *(2nd ed.). Upper Saddle River, NJ: Prentice-Hall, pp. 76–80; Tsantis, L. A., Bewick, C. J., & Thouvenelle, S. (2003, November). Examining some common myths about computer use in the early years.* Beyond the Journal: Young Children on the Web *(pp. 1–9).*

Anthony Magnacca/Merrill

DIGITALLY DISADVANTAGED? Many students have limited access to technology at home or in their communities. This split in access to technology has been called the digital divide.

test scores for K–12 students, but simulations and enrichment programs had few effects—perhaps another example that when you teach and test specific skills, children learn the skills. More recent research reports similar results. Computers may be more useful in improving mathematics and science skills than other subjects and not very successful in improving reading (Slavin, Lake, Chambers Cheung, & Davis, 2009). Like any teaching tool, computers can be effective if used well, but just being on a computer will not automatically increase academic achievement, especially achievement as measured by standardized tests (Richtell, 2011). Roschelle and colleagues concluded that computers are more likely to increase achievement if they support the basic processes that lead to learning: active engagement, frequent interaction with feedback, authenticity and real-world connection, and productive group work (Jackson et al., 2006). See the *Guidelines* for more ideas.

Media/Digital Literacy

With the advent of digital media comes a new concern with literacy—media or digital literacy. Today, to be literate—that is to be able to read, write, and communicate—children have to read and write in many media, not just printed words. Films, videos, DVDs, computers, photographs, artwork, magazines, music, television, billboards, and more communicate through images and sounds. How do children read these messages? This is a new area of research and application in educational and developmental psychology (Hobbs, 2004).

As an example of practice, consider Project Look Sharp, directed by Cynthia Scheibe, a developmental psychologist (www.ithaca.edu/looksharp). The goal of the project is to provide materials, training, and support as teachers integrate media literacy and critical thinking about media into their class lessons. Teachers participating in the project help their students become critical readers of media. One group of elementary school students studied ants in science, and then viewed the animated film *Antz*. In the discussion after the movie, students were challenged to describe what was accurate and inaccurate in the film's portrayal of ants. What were the messages of the film? How was product placement (e.g., an ant drinking a bottle of Pepsi) used? Tests immediately and six months later indicated that the children performed best on the questions related to the discussion about the accuracy of the film (Scheibe, 2005). Project Look Sharp suggests these questions to guide discussion of media:

1. Who made—and who sponsored—this message, and what is their purpose?
2. Who is the target audience, and how is the message specifically tailored to that audience?
3. What are the different techniques used to inform, persuade, entertain, and attract attention?
4. What messages are communicated (and/or implied) about certain people, places, events, behaviours, lifestyles, and so forth?
5. How current, accurate, and credible is the information in this message?
6. What is left out of the message that might be good to know? (p. 63)

The *Guidelines* give more ideas from Scheibe and Rogow (2004) for supporting the development of media literacy in your students.

GUIDELINES

Supporting the Development of Media Literacy

Use media to practise general observation, critical thinking, analysis, perspective-taking, and production skills.
Examples
1. Ask students to think critically about the information presented in advertising, "news" programs, and textbooks—would different people interpret the messages in differing ways?
2. Foster creativity by having students produce their own media on a topic you are studying.
3. Ask students to compare ways information might be presented in a documentary, TV news report, advertisement, public service announcement, etc.
4. Give examples of how word selection, background music, camera angles, colour, etc. can be used to set a mood or bias a message.

Use media to stimulate interest in a new topic.
Examples
1. Analyze a magazine article about the topic.
2. Read sections from a novel or view film clips on the topic.

Help students identify what they already know or believe about a topic based on popular media content. Help them identify erroneous beliefs.
Examples
1. What do students "know" about space travel?
2. What have they learned about biology from advertisements?

Use media as a standard pedagogical tool.
Examples
1. Provide information about a topic through many different media sources—internet, books, DVDs, audio recordings, online newspapers, etc.
2. Assign homework that makes use of different media.
3. Have students express opinions or attempt to persuade using different media—photographs, collages, videos, poems, songs, animated films, etc.

Analyze the effects that media had on historical events.
Examples
1. How were First Nations Canadians portrayed in art and in films?
2. What sources of information were available 50 years ago? 100 years ago?

For more ideas, see www.ithaca.edu/looksharp.

▼ SUMMARY

The Learning Sciences (pp. 329–331)

What are some basic assumptions of the learning sciences? Key assumptions in the learning sciences are that experts develop deep conceptual knowledge, learning comes from the learner, creating learning environments is the responsibility of the school, students' prior knowledge is key, and reflection is a critical component of learning. These common assumptions enable researchers from various disciplines to address the same issues of learning from a variety of perspectives.

Cognitive and Social Constructivism (pp. 331–338)

Describe two kinds of constructivism, and distinguish these from constructionism. *Psychological* constructivists such as Piaget are concerned with how individuals make sense of their world, based on individual knowledge, beliefs, self-concept, or identity—also called *first wave constructivism*. *Social* constructivists such as Vygotsky believe that social interaction, cultural tools, and activity shape individual development and learning—also called *second wave constructivism*. By participating in a broad range of activities with others, learners appropriate the outcomes produced by working together; they acquire new strategies and knowledge of their world. Finally, constructionists are interested in how public knowledge in academic disciplines is constructed as well as how everyday beliefs about the world are communicated to new members of a sociocultural group.

Kelia Neokow/ Shutterstock.com

In what ways do constructivist views differ about knowledge sources, accuracy, and generality? Constructivists debate whether knowledge is constructed by mapping external reality, by adapting and changing internal understandings, or by an interaction of external forces and internal understandings. Most psychologists believe there is a role for both internal and external factors, but differ in how much they emphasize one or the other. Also, there is discussion about whether knowledge can be constructed in one situation and applied to another or whether knowledge is situated—that is, specific and tied to the context in which it was learned.

What is meant by thinking as enculturation? Enculturation is a broad and complex process of acquiring knowledge and understanding consistent with Vygotsky's theory of mediated learning. Just as our home culture taught us lessons about the use of language, the culture of a classroom can teach lessons about thinking by giving us models of good thinking; providing direct instruction in thinking processes; and encouraging practice of those thinking processes through interactions with others.

What are some common elements in most constructivist views of learning? Even though there is no single constructivist theory, many constructivist approaches recommend complex, challenging learning environments and authentic tasks; social negotiation and co-construction; multiple representations of content; understanding that knowledge is constructed; and student ownership of learning.

Applying Constructivist Perspectives (pp. 338–356)

Distinguish between inquiry methods and problem-based learning. The inquiry strategy begins when the teacher presents a puzzling event, question, or problem. The students ask questions (only yes/no questions in some kinds of inquiry) and then formulate hypotheses to explain the event or solve the problem; collect data to test the hypotheses about casual relationships; form conclusions and generalizations; and reflect on the original problem and the thinking processes needed to solve it. Problem-based learning may follow a similar path, but the learning begins with an authentic problem—one that matters to the students. The goal is to learn math or science or history or some other important subject while seeking a real solution to a real problem.

Describe six features that most cognitive apprenticeship approaches share. Students observe an expert (usually the teacher) model the performance; get external support through coaching or tutoring; and receive conceptual scaffolding, which is then gradually faded as the student becomes more competent and proficient. Students continually articulate their knowledge—putting into words their understanding of the processes and content being learned. They reflect on their progress, comparing their problem solving to an expert's performance and to their own earlier performances. Finally, students explore new ways to apply what they are learning—ways that they have not practised at the master's side.

Describe the use of dialogue in reciprocal teaching. The goal of reciprocal teaching is to help students understand and think deeply about what they read. To accomplish this goal, students in small reading groups learn four strategies: summarizing the content of a passage, asking a question about the central point, clarifying the difficult parts of the material, and predicting what will come next. These strategies are practised in a classroom dialogue about the readings. Teachers first take a central role, but as the discussion progresses, the students take more and more control.

What are the differences between collaboration and cooperation? One view is that collaboration is a philosophy about how to relate to others—how to learn and work. Collaboration is a way of dealing with people that respects differences, shares authority, and builds on the knowledge that is distributed among other people. Cooperation, on the other hand, is a way of working together with others to attain a shared goal.

What are the learning theory underpinnings of cooperative learning? Learning can be enhanced in cooperative groups through rehearsal and elaboration (information processing theories), creation and resolution of disequilibrium (Piaget's theory), or scaffolding of higher mental processes (Vygotsky's theory).

Describe five elements that define true cooperative learning. Students interact face to face and close together, not across the room. Group members experience positive interdependence—they need each other for support, explanations, and guidance. Even though they work together and help each other, members of the group must ultimately demonstrate learning on their own—they are held individually accountable for learning, often through individual tests or other assessments. If necessary, the collaborative skills important for effective group functioning, such as giving constructive feedback, reaching consensus, and involving every member, are taught and practised before the groups tackle a learning task. Finally, members monitor group processes and relationships to make sure the group is working effectively and to learn about the dynamics of groups.

How should tasks match design in cooperative learning? A relatively structured task works well with a structured technique; extrinsic rewards can enhance motivation, effort, and persistence under these conditions; roles, especially those that focus attention on the work to be accomplished, also may be productive. On the other hand, strategies that encourage extended and productive interactions are appropriate when the goal is to develop higher-order thinking and problem solving. The use of rewards may well divert the group away from the goal of in-depth cognitive processing. When the goal of peer learning is enhanced social skills or increased intergroup understanding and appreciation of diversity, the assignment of specific roles and functions within the group might support communication. Rewards probably are not necessary and may actually get in the way because the goal is to build community, a sense of respect, and responsibility for team members.

What are some possible strategies for cooperative learning? Strategies include reciprocal questioning, Jigsaw, structured controversy, and many cooperative structures described by Spencer Kagan.

Service Learning (pp. 356–357)

What are some key characteristics of service learning? Service learning activities should be organized around and designed to meet actual community needs, and integrated into the student's curriculum. Teachers should provide time for students to reflect on and write about their service experience, offer opportunities to apply newly learned academic skills and knowledge, and strive to enhance both academic learning and a sense of caring for others. Service learning activities ought not be supplementary to students' regular activities, but instead should be an integral part of their learning.

Learning in a Digital World (pp. 357–363)

What are some possible uses of technology in education? Technology such as computers, iPods, smartphones, digital readers, and interactive gaming systems are extremely popular among young people. In fact, the many ways of communicating and interacting with others through technology may even shape the way students think about what it means to socialize. These technologies can be useful teaching tools, but they do have limitations. First, technology cannot necessarily replace the teacher when it comes to direct instruction (and not all programs are able to bring about learning). Classrooms of the future may take greater advantage of learning environments that immerse students in virtual worlds where they work alone or with others to solve problems, create projects, simulate the skills of experts, visit historical sites, tour world-class museums, or play games that teach and apply academic skills. The results of research on technology-enhanced learning emphasize that technology by itself will not guarantee improvement in academic achievement—like any tool, technology must be used well by confident, competent teachers.

▼ WHAT WOULD YOU DO?

TEACHERS' CASEBOOK: Dilemma on Day 1

Here is how some practising teachers responded to the situation described at the beginning of the chapter.

ELAINE TAN COMEAU

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As a new teacher myself, I understand the initial excitement this teacher was feeling. Rather than feel helpless at this point, remember that these book reviews reflect only one type of assessment—the written form. Today's multi-ability-level classrooms require a variety of assessment methods to address diverse backgrounds and learning styles and to give students more opportunities to demonstrate progress. The key here is to focus less on what needs to be covered and more on how it will be covered—process over content!

The first assignment might have caused some students to feel incapable because they lacked English grammar and writing skills and used an underdeveloped vocabulary. The key for English language learners is to provide lower-language and higher-interest visuals; for example, to use key words that connect ideas, sentence frames, or line maps. All students will benefit from vocabulary building. Select key vocabulary in each lesson and ask students to discuss, use, and apply those words.

The teacher should also adapt various instructional methods. For example, supplement long novels with videos or short stories written at appropriate levels to access students' different learning styles and means of understanding; integrate fine art to appeal to another type of learning style. Try the same activity again by grouping students in twos and threes, providing each with an interesting article she or he can relate to and write about. Prepare in advance a set of sentence frames to be completed for the students' articles.

Make use of the capable students, since all students benefit from shared learning experiences. Ask these three students to function as peer tutors in small groups. Cooperative learning groups assist with the inherent behavioural management challenge and help to reduce the isolation, boredom, and fear of sharing some students feel. Small groups also give the English language learner access to a fluent English speaker while simultaneously building the confidence and self-esteem of the peer tutor.

Where possible, assign world literature selections based on students' countries of origin to heighten interest and attention span. English language learners may want to write responses in their first languages. Ask peer tutors to assist these students in translating their ideas into English. This provides major language and interpersonal benefits for both groups of students, along with challenges for the advanced students.

LESLEY PETERSON

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The first thing to determine is whether this writing task was a reasonably reliable diagnostic tool. Did you check that the students were familiar with the conventions of the review form and/or ensure that your expectations were clearly articulated to students? It might be worth assigning another writing task before deciding that the students whose papers were lacking in coherence were, in fact, unable to write coherent papers. However, in my experience, weak students tend to interpret every writing task as an invitation to retell the story. If these students have failed to do even that coherently, the problem is probably a real one.

Determining how to proceed with the very weak students, then, assuming that their weaknesses are validated, requires reference to the program policy and course outline. Also, if the course is required for university entrance or is a prerequisite for such a course, you cannot solely grade on effort and improvement. There must be standards. You should be prepared to differentiate your teaching in terms of the material that students read, the assignments they may choose, and the criteria by which they are evaluated. Differentiating instruction is still a good strategy for the standards-driven curriculum while retaining the same evaluation criteria for all students.

Central to the design of courses like this is a strong emphasis on the writing process. You should plan to teach writing, reading, and revision strategies that will be helpful to all or most students. If this is your goal, however, I strongly suggest changing this first assignment. Instead, ask the students to write reviews of the "best" book they have ever read. Knowing what they consider to be the "best" books is invaluable for planning a wide range of readings that engage students' interest. If you're well and widely read in world literature, you'll be able to find novels, short stories, and poems that intersect with what engages students. It's that basic old principle of teaching that needs to be put into action here: Find out where they are, then meet them, and take them forward from there.

If this is a university-entrance course, you should gather more data about the students who appear weak. Check their final marks in the prerequisite course and talk to previous English teachers. If you still feel a student does not have the reading, writing, and thinking skills necessary for success in this course, consider requesting conferences with the student's parents. Advise parents that this course will be a struggle for their child. An early recommendation to see a guidance counsellor or to change a timetable can turn into a real favour to the student. Better that the student enroll in an appropriate course now than sit in the wrong one, have her or his self-esteem battered for months, and then drop the course.

As for the really advanced writers, they need to be recognized, supported, and challenged. Nurture and challenge their love of literature and writing. Assigning advanced students assignments that are too easy can hurt students' self-esteem and lead to underachievement (not to mention boredom). Encourage these students to get involved in whatever writing communities are available. If a school magazine doesn't exist, encourage them to start one. Many cities have organizations similar to the Manitoba Writers' Guild, which sponsors readings and open-microphone sessions, organizes workshops, and so on that can be very helpful to advanced writers.

Teaching a separate, gifted program to three students is more work than most English teachers have time for. But there are community resources you can access. Does your town library, university, or college have a "writer in residence?" If your school has a work experience coordinator, can he or she hook up these students with a professional journalist? Our local theatre gave one of my students a volunteer position reading and making recommendations on scripts. It changed her life.

Find out what kind of writing these students are most interested in and introduce them to other people who care about it as much as they do. You definitely shouldn't "punish" these students for their ability by giving them extra work. It might be possible for them to earn a separate credit for their extra involvement—talk to a guidance counsellor, work experience coordinator, or administrator to find out what's available. And have the grace to admit that these students might learn more if you let them spend part of your class time in the library. They'll respect you more for it, not less.