Applications of Information Processing to Academic Learning

Over the past two decades, fundamental discoveries about the development of information processing have been applied to children's mastery of academic skills. In various subject matters, researchers are identifying the cognitive ingredients of skilled performance, tracing their development, and distinguishing good from poor learners by pinpointing differences in cognitive skills. They hope, as a result, to design teaching methods that will improve children's learning. In the following sections, we discuss a sampling of these efforts in reading, mathematics, and scientific reasoning.

Reading

When we read, we use many skills at once, taxing all aspects of our information-processing systems. We must perceive single letters and letter combinations, translate them into speech sounds, recognize the visual appearance of many common words, hold chunks of text in working memory while interpreting their meaning, and combine the meanings of various parts of a text passage into an understandable whole. In fact, reading is so demanding that most or all of these skills must be done automatically. If one or more are poorly developed, they will compete for space in our limited working memories, and reading performance will decline. Becoming a proficient reader is a complex process that begins in the preschool years.

- **EARLY CHILDHOOD** - Preschoolers understand a great deal about written language long before they begin to read and write in conventional ways. This is not surprising when we consider that children in industrialized nations live in a world filled with written symbols. Each day, they observe and participate in activities involving storybooks, calendars, lists, and signs. As part of these experiences, they try to figure out how written symbols convey meaning. Children’s active efforts to construct literacy knowledge through informal experiences are called emergent literacy.

  Young preschoolers search for units of written language as they “read” memorized versions of stories and recognize familiar signs, such as “PIZZA” at their favorite fast-food counter. But they do not yet understand the symbolic function of the elements of print (Bialystock & Martin, 2003). Many preschoolers think that a single letter stands for a whole word or that each letter in a person’s signature represents a separate name. In fact, initially preschoolers do not distinguish drawing from writing. Around age 4, their writing shows some distinctive features of print, such as separate forms arranged in a line. But they often include picturelike devices, such as writing “sun” by using a yellow marker or a circular shape (Levin & Bus, 2003). Using their understanding of the symbolic function of drawings, they make a “drawing of print.”

  Preschoolers revise these ideas as their cognitive capacities improve, as they encounter print in many contexts, and as adults help them with written communication. Gradually, they notice more features of written language and depict writing that varies in function, as in the “story” and “grocery list” in Figure 7.13. Eventually children figure out that letters are parts of words and are linked to sounds in systematic ways, as you can see in the invented spellings that are typical between ages 5 and 7. At first, children rely on sounds in the names of letters: “ADE LAFWTS KRMD NTU A LAVTR” (“eighty elephants cram one elevator”). Over time, they grasp sound-letter correspondences. They also learn that some letters have more than one common sound and that context affects their use (a is pronounced differently in cat than in table) (McGee & Richgels, 2004).

  Literacy development builds on a broad foundation of spoken language and knowledge about the world. Over time, children’s language and literacy progress facilitate one another (Dickinson et al., 2003). **Phonological awareness**—the ability to reflect on and manipulate the sound structure of spoken language, as indicated by sensitivity to changes in
sounds within words, to rhyming, and to incorrect pronunciation—is a strong predictor of emergent literacy knowledge (Foy & Mann, 2003). Vocabulary and grammatical development are also influential. And adult–child narrative conversations enhance diverse language skills essential for literacy progress.

The more informal literacy experiences preschoolers have, the better their language and emergent literacy development (Dickinson & McCabe, 2001). Pointing out letter–sound correspondences and playing language–sound games foster phonological awareness (Foy & Mann, 2003). Interactive storybook reading, in which adults discuss story content with preschoolers, promotes many aspects of language and literacy development. Adult–supported writing activities that focus on narrative, such as preparing a letter or a story, also have wide-ranging benefits (Purcell-Gates, 1996; Wasik & Bond, 2001). In longitudinal research, each of these literacy experiences predicted improved reading achievement in middle childhood (Senechal & LeFevre, 2002; Storch & Whitehurst, 2001).

Compared with their economically advantaged agemates, preschoolers from low-income families have fewer home and preschool language and literacy learning opportunities—a major reason that they are behind in reading achievement throughout the school years (Serpell et al., 2002). In a program that “flooded” child-care centers with children’s books and provided caregivers with training on how to get 3- and 4-year-olds to spend time with books, children showed much greater gains in emergent literacy knowledge than a control group not experiencing the intervention. These differences were still evident after the children entered kindergarten (Neuman, 1999). For ways to support early childhood literacy development, refer to Applying What We Know below.

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**Applying What We Know**

**Supporting Emergent Literacy in Early Childhood**

<table>
<thead>
<tr>
<th>Strategy</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide literacy–rich home and preschool environments</td>
<td>Homes and preschools with abundant reading and writing materials—including a wide variety of children’s storybooks, some relevant to children’s ethnic backgrounds—open the door to a wealth of language and literacy experiences.</td>
</tr>
<tr>
<td>Engage in interactive book reading</td>
<td>When adults discuss story content, ask open-ended questions about story events, explain the meaning of words, and point out features of print, they promote language development, comprehension of story content, knowledge of story structure, and awareness of units of written language.</td>
</tr>
<tr>
<td>Provide outings to libraries, museums, parks, zoos, and other community settings</td>
<td>Visits to child-oriented community settings enhance children’s general knowledge and offer many opportunities to see how written language is used in everyday life. They also provide personally meaningful topics for narrative conversation, which enhance many language skills essential for literacy development.</td>
</tr>
<tr>
<td>Point out letter–sound correspondences, play rhyming and other language–sound games, and read rhyming poems and stories</td>
<td>Experiences that help children isolate the sounds in words foster phonological awareness—a powerful predictor of early childhood literacy knowledge and later reading and spelling achievement.</td>
</tr>
<tr>
<td>Support children’s efforts at writing, especially narrative products</td>
<td>Assisting children in their efforts to write—especially letters, stories, and other narratives—fosters many language and literacy skills.</td>
</tr>
<tr>
<td>Model literacy activities</td>
<td>When children see adults engaged in reading and writing activities, they better understand the diverse, everyday functions of literacy skills and the knowledge and pleasure that literacy brings. As a result, children’s motivation to become literate is strengthened.</td>
</tr>
</tbody>
</table>

Sources: Dickinson & McCabe, 2001; McGee & Righels, 2004
As children make the transition from emergent to conventional literacy, phonological awareness continues to predict reading (and spelling) progress. It enables children to isolate speech segments and link them with their written symbols, in languages as different as English and Chinese. Other information-processing activities also contribute. Recall that processing speed increases dramatically during middle childhood. It fosters the ability to rapidly convert visual symbols into sounds, which also distinguishes good from poor readers (Kail, Hall, & Caskey, 1999; McBride-Chang & Kail, 2002). In addition, visual scanning and discrimination are important and improve with reading experience (Rayner, Pollatsek, & Starr, 2003). Performing all these skills efficiently releases working memory for higher-level activities involved in comprehending the text’s meaning.

Until recently, researchers were embroiled in an intense debate over how to teach children to read. On one side were those who took a whole-language approach. They argued that reading should be taught in a way that parallels natural language learning. From the very beginning, children should be exposed to text in its complete form—stories, poems, letters, posters, and lists—so that they can appreciates the communicative function of written language. According to these experts, as long as reading is kept meaningful, children will be motivated to discover the specific skills they need (Watson, 1989). On the other side were those who advocated a phonics approach. In their view, children should be given simplified reading materials and, at first, should be coached on phonics—the basic rules for translating written symbols into sounds. Only later, after they have mastered these skills, should they get complex reading material (Rayner & Pollatsek, 1989).

Many studies have resolved this debate by showing that children learn best with a mixture of both approaches. In kindergarten, first, and second grades, teaching that includes phonics boosts reading achievement scores, especially for children who are behind in reading progress (Berninger et al., 2003; Xue & Meisels, 2004). And when teachers combine real reading and writing with teaching of phonics and engage in other excellent teaching practices—encouraging children to tackle reading challenges and integrating reading into all school subjects—first graders show far greater literacy progress (Pressley et al., 2002).

Why might combining phonics with whole language work best? Learning relation between letters and sounds enables children to decode, or decipher, words they have never seen before. Yet, if practice in basic skills is overemphasized, children may lose sight of the goal of reading: understanding. Children who read aloud fluently without registering meaning know little about effective reading strategies—for example, that they must read more carefully if they will be tested than if they are reading for pleasure, or that explaining a passage in their own words is a good way to monitor comprehension. Providing instruction aimed at increasing children’s knowledge and use of reading strategies readily enhances reading performance of children from third grade on (Van Klee, 2004; Dickson et al., 1998).

Around age 7 to 8, a major shift occurs from “learning to read” to “reading to learn” (El2005). As decoding and comprehension skills reach a high level of efficiency, adolescent readers can become actively engaged with the text. They adjust the way they read to fit their current purpose—at times seeking new facts and ideas, at other times questioning or agreeing or disagreeing with the writer’s viewpoint.

**Mathematics**

Mathematical reasoning, like reading, builds on informally acquired knowledge. Recall from Chapter 6 that some evidence suggests that infants have basic numerical knowledge (see p. 255). Between 14 and 16 months, toddlers display a beginning grasp of ordinality, or order relationships between quantities—for example, that three is more than two and two is more than one—an attainment that serves as the basis for more complex understandings (Starkey, 1992).
EY早期 childhood • In the early preschool years, children start to attach verbal labels (such as \textit{lots, little, big, and small}) to amounts and sizes. And sometimes in the third year, they begin to count. At first, counting may be little more than a memorized routine—"One, two, three, four, five!"—But by the time preschoolers turn 3, most can count rows of about five objects, saying the correct number words, although they do not know exactly what the words mean. For example, when asked for one, they give 1 item, but when asked for \textit{two, three, four, or five}, they usually give a larger, but incorrect, amount. Nevertheless, 2$\frac{1}{2}$- to 3$\frac{1}{2}$-year-olds realize that when a number label changes—for example, from five to six—the number of items should change (Sarnecka & Gelman, 2004). They understand that a number word refers to a unique quantity.

By age 3$\frac{1}{2}$ to 4, most children have mastered the meaning of numbers up to \textit{ten}, count correctly, and grasp the vital principle of \textit{cardinality}—that the last word in a counting sequence indicates the quantity of items in a set (Bermúdez, 1996; Zur & Gelman, 2004). Mastery of cardinality increases the efficiency of children's counting. By age 4, children use counting to solve arithmetic problems. At first, their strategies are tied to the order of numbers as presented; when given 2 + 4, they count on from 2 (Bryant & Nunes, 2002). But soon they experiment with various other strategies. As a result, they master the \textit{min} strategy, a more efficient approach (refer back to Siegler's model of strategy choice, page 278). Around this time, children realize that subtraction cancels out addition. Knowing, for example, that 4 + 3 = 7, they infer without counting that $7 - 3 = 4$ (Rasmussen, Ho, & Bisanz, 2003). Grasping this principle, along with other basic rules of addition and subtraction, greatly facilitates rapid computation.

The arithmetic knowledge just described emerges universally around the world. But in homes and preschools where adults provide many occasions for counting, comparing quantities, and adding and subtracting in meaningful situations, children acquire these understandings sooner. In a math intervention program for low-income 4-year-olds, teachers included math activities in almost all classroom routines. For example, children counted the number of steps needed to get from various locations in the classroom to the play yard and identified a partner who held a card with a certain number of dots on it. Compared with children in other classrooms, children in the intervention program scored higher in math concepts and enjoyed math activities more (Arnold et al., 2002). Solid, secure early childhood math knowledge is essential for the wide variety of mathematical skills children will be taught once they enter school.

MIDDLE childhood • Mathematics teaching in elementary school builds on and greatly enriches children's informal knowledge of number concepts and counting. Written notation systems and formal computational techniques enhance children's ability to represent numbers and compute. Over the early elementary school years, children acquire basic math facts through a combination of frequent practice, reasoning about number concepts, and teaching that conveys effective strategies. (Return to page 276 for research supporting the importance of both extended practice and a grasp of concepts.) Eventually, children retrieve answers automatically and apply this knowledge to more complex problems.

Arguments about how to teach mathematics resemble those about reading. Extensive spaced practice is pitted against "number sense," or understanding. Again, a blend of these two approaches is most beneficial. In learning basic math, poorly performing students use cumbersome techniques (such as counting all items in an addition problem) or try to retrieve answers from memory too soon. Their responses are often sluggish and wrong because they have not sufficiently experimented with strategies to test which ones are most effective. And on tasks that reveal their understanding of math concepts, their performance is weak (Canobi, 2004; Canobi, Reeve, & Pattison, 2003). This suggests that encouraging students to apply strategies and making sure they understand why certain ones work well are vital for solid mastery of basic math.

A similar picture emerges for more complex skills, such as carrying in addition, borrowing in subtraction, and operating with decimals and fractions. When taught by rote, children cannot apply the procedure to new problems. Instead, they persistently make mistakes, using
a “math rule” that they recall incorrectly because they do not understand it (Carpenter et al., 1999). Look at the following subtraction errors:

\[
\begin{array}{c}
427 \\
-138 \\
311 \\
\hline
7,002 \\
-5,445 \\
1,447 \\
\end{array}
\]

In the first problem, the child consistently subtracts a smaller from a larger digit, regardless of which is on top. In the second, columns with zeros are skipped in a borrowing operation, and the bottom digit is written as the answer.

In contrast, when provided with rich opportunities to experiment with problem solving, to grasp the reasons behind strategies, and to evaluate solution techniques, children seldom make these errors. In one study, second graders who were taught in these ways not only mastered correct procedures but even invented their own successful strategies, some of which were superior to standard, school-taught methods! Consider this solution:

\[
\begin{array}{cccc}
3 & 15 & 14 & 12 \\
A & B & C & D \\
-1 & 9 & 6 & 8 \\
\hline
2 & 6 & 8 & 4 \\
\end{array}
\]

In subtracting, the child performed all trades first, flexibly moving either from right to left or from left to right, and then subtracted all four columns—a highly efficient, accurate approach (Fuson & Burghard, 2003). In a German study, the more teachers emphasized conceptual knowledge, by having children actively construct meanings in word problems before practicing computation and memorizing math facts, the more children gained in math achievement from second to third grade (Staub & Stern, 2002).

Current evidence suggests that many schools in the United States place too much emphasis on computational drill (Woodward, 2004). We will see in Chapter 15 that in cross-cultural comparisons of math achievement, students in Asian nations typically score at the top. Furthermore, in high school, Canadian students—and students in many other Western nations—outperform U.S. students. As the Cultural Influences box on the following page illustrates, Asian students receive a variety of supports for acquiring mathematical knowledge. The result is deeper processing—formation of secure numerical concepts that provide a firm foundation for mastery of new skills.

**Scientific Reasoning**

During a free moment in physical education class, 13-year-old Heidi wondered why more of her tennis serves and returns passed the net and dropped in her opponent’s court when she used a particular brand of balls. “Is it something about their color or size?” she asked herself. “Hmm . . . or could it be their surface texture—that might affect their bounce.”

The heart of scientific reasoning is coordinating theories with evidence. A scientist can clearly describe the theory he or she favors, knows what evidence is needed to support it and what would refute it, and can explain how pitting evidence against theories has led to the acceptance of one theory as opposed to others. What evidence would Heidi need to confirm her theory about the tennis balls?

Deanna Kuhn (2002) has conducted extensive research into the development of scientific reasoning, using problems that resemble Piaget’s tasks, in that several variables might affect an outcome. In one series of studies, third, sixth, and ninth graders and adults were provided with evidence, sometimes consistent and sometimes conflicting with theories. Then they were questioned about the accuracy of each theory.

For example, participants were given a problem much like the one Heidi posed. They were asked to theorize about which of several features of sports balls—size (large or small), color (light or dark), surface texture (rough or...
Asian Children's Understanding of Multidigit Addition and Subtraction

Many North American students have difficulty with multidigit addition and subtraction problems requiring trades between columns. Often they try to solve these problems by trial and error, without grasping crucial aspects of the procedure. They seem to have a single-digit conception of multidigit numbers. For example, they tend to view the 3 in 5,386 as just 3 rather than as 300. As a result, when they carry or borrow from this column, they are likely to compute the value incorrectly.

Chinese, Japanese, and Korean children, by contrast, are highly accurate at multidigit addition and subtraction. What accounts for their superior performance? To find out, Karen Fuson and Youngshim Kwon (1992) observed Korean second and third graders solving two- and three-digit problems and asked them to explain how they arrived at their answers. The children’s performance was excellent, even when they had not yet had formal instruction on the topic. An accurate understanding of multidigit numbers was clearly responsible. A Korean child viewed a “1” mark signaling trading to the tens column as one, as North American children often do. Instead, they clearly identified it as ten if it came from the ones column (addition) and as one hundred if it came from the hundreds column (subtraction).

Especially remarkable were third graders’ clear explanations of how to perform complex, multidigit trading operations that stump their North American agemates. In fact, most Korean third graders no longer wrote extra marks when solving these problems. They handled intricate trading procedures mentally.

Several language and cultural factors contribute to the sharp skill advantage of Asian over North American children. First, English words for two-digit numbers (such as twelve and thirteen) are irregular and do not convey the idea of tens and ones.

Asian-language number words (ten-two, ten-three) make this composition obvious. Chinese-, Japanese-, and Korean-speaking 5-year-olds know that numbers in the teens are composed of a tens-value and a ones-value, whereas their North American agemates show no evidence of this understanding (Miiura & Okamoto, 2003). Asian number words are also shorter and more quickly pronounced. This facilitates counting strategies and increases the speed with which children can retrieve math facts from long-term memory (Geary et al., 1996).

Finally, although use of the abacus is no longer regularly taught in Asian schools, many Chinese, Japanese, and Korean children take abacus lessons. Abacus operations chunk numbers into fives and tens, which fosters highly efficient multidigit calculation (Murata, 2004).

Asian teaching practices support rapid mastery of multidigit problems as well. For example, teachers frequently use phrases that explicitly describe the trading operation. Instead of carrying, they say “raise up”; instead of borrowing, “bring down.”

Finally, multidigit problems are introduced earlier in Asian schools. And teachers more often explain how and when to use effective strategies (Noito & Miura, 2001; Perry, 2000). Taken together, these findings highlight several ways in which North American adults might ease children’s mastery of fundamental numerical concepts.
Which features of these sports balls—size, color, surface texture, or presence or absence of ridges—influence the quality of a player’s serve? This set of evidence suggests that color might be important, since light-colored balls are largely in the good-serve basket and dark-colored balls in the bad-serve basket. But the same is true for texture! The good-serve basket has mostly smooth balls; the bad-serve basket, rough balls. Since all light-colored balls are smooth and all dark-colored balls are rough, we cannot tell whether color or texture makes a difference. But we can conclude that size and presence or absence of ridges are not important, since these features are equally represented in the good-serve and bad-serve baskets. (Adapted from Kuhn, Amsel, & O’Laughlin, 1988)

still insisted on the accuracy of Mr. S’s theory (which was also his own) asked to explain, he stated flatly, “Because this ball is big . . . the color doesn’t really matter” (Kuhn, 1989, p. 677).

These findings, and others like them, reveal that instead of viewing evidence as separate from and bearing on a theory, children often blend the two into a single representation of “the way things are.” The ability to distinguish theory from evidence and use logical rules to examine their relationship in complex, multivariable situations improves from childhood into adolescence and adulthood (Kuhn & Dean, 2004; Kuhn & Pearsall, 2000).

• HOW SCIENTIFIC REASONING DEVELOPS • What factors support skill at coordinating theory with evidence? Greater working-memory capacity, permitting a theory and the effects of several variables to be compared at once, is vital. In addition, adolescents benefit from exposure to increasingly complex problems and instruction that highlights critical features of tasks and effective strategies. Consequently, scientific reasoning is strongly influenced by years of schooling, whether individuals grapple with traditional scientific tasks (like the sports ball problem) or engage in informal reasoning—for example, justifying a theory about what causes children to fail in school (Kuhn, 1993).

Many researchers believe that sophisticated metacognitive understanding is at the heart of scientific reasoning (Kuhn, 1999; Moshman, 1999). Microgenetic research (see page 63 in Chapter 2) shows that when children regularly pit theory against evidence over many weeks, they experiment with various strategies, reflect on and revise them, and become aware of the nature of logic. Then they apply their abstract appreciation of logic to a wide variety of situations. The ability to think about theories, deliberately isolate variables, and actively seek disconfirming evidence is rarely present before adolescence (Kuhn, 2000; Moshman, 1998).

Although they are far more competent than children, adolescents and adults vary widely in scientific reasoning skills. Many continue to show a self-serving bias, in that they apply logic more effectively to ideas they doubt than to ideas they favor (Klaczynski, 1997; Klaczynski & Narasimham, 1998a). Reasoning scientifically requires the metacognitive capacity to evaluate one’s objectivity—a disposition to be fair-minded rather than self-serving (Moshman, 1999). As we will see in Chapter 11, this flexible, open-minded approach is not just a cognitive attainment but a personality trait—one that assists teenagers greatly in forming an identity and developing morally.

Adolescents develop scientific reasoning skills in a similar step-by-step fashion on different kinds of tasks. In a series of studies, 10- to 20-year-olds were given sets of problems graded in difficulty. For example, one set consisted of causal-experimental tasks like the sports ball problem in Figure 7.14. Another set contained quantitative-relational tasks like Piaget’s pendulum...
problem And still another set was made up of verbal propositional tasks (see page 247 in Chapter 6). In each type of task, adolescents mastered component skills in sequential order by expanding their metacognitive awareness (Demetriou et al., 1993, 1996, 2002). For example, on causal-experimental tasks, they first became aware of the many variables—separately and in combination—that could influence an outcome. This enabled them to formulate and test hypotheses. Over time, adolescents combined separate skills into a smoothly functioning system, constructing a general model that they could apply to many instances of a given type of problem.

Return to page 276 and review Robbie Case's information-processing view of Piaget's stages. Does Case's concept of central conceptual structures remind you of the metacognitive advances just described? Piaget also underscored the role of metacognition in formal operational thought when he spoke of "operating on operations" (see Chapter 6, page 246). However, information-processing findings reveal that scientific reasoning does not result from an abrupt, stagewise change, as Piaget believed. Instead, it develops gradually out of many specific experiences that require children and adolescents to match theory against evidence and reflect on their thinking.
Schooling

Unlike the informal world of peer relations, the school is a formal institution designed to transmit the knowledge and skills children need to become productive members of society. Children in the developed world spend many hours in school—on average, about 14,000 by high school graduation. In earlier chapters, we noted that schools are vital forces in children's development, affecting their motivation to learn and modes of remembering, reasoning, problem solving, and social and moral understanding. How do schools exert such a powerful impact? Research looking at schools as complex social systems—class and student body size, educational philosophies, transitions form one school level to the next, teacher–student relationships, and grouping practices—provides important insights.
Class and Student Body Size

The physical plants of all schools tend to be similar: Each has classrooms, hallways, a playground, and a lunchroom. But they also vary widely in the number of students they accommodate in each class and in the school as a whole.

Is there an optimal class size? In a large field experiment, more than 6,000 Tennessee kindergartners were randomly assigned to three class types: “small” (13 to 17 students), “regular” (22 to 25 students) with only a teacher to supervise, and regular with a teacher plus a full-time teacher’s aide. These arrangements continued into third grade. Small-class students—especially ethnic minority children—scored higher in reading and math achievement each year and continued to do so after they returned to regular-size classes (Mosteller, 1995). Placing teacher’s aides in regular-size classes had no consistent impact. Rather, being in small classes from kindergarten through third grade predicted substantially higher achievement from fourth through ninth grades (Nye, Hedges, & Konstantopoulos, 2001).

Why is small class size beneficial? With fewer children, teachers spend less time disciplining and more time getting to know students and giving individual attention. Also, children who learn in smaller groups show better concentration, higher-quality class participation, and more favorable attitudes toward school (Blatchford et al., 2002, 2003; Finn, Pannozzo, & Achilles, 2003). The impact of small class size on children’s social behavior, however, is inconsistent and may depend on the extent to which teachers include social goals in their daily plans (Blatchford, Edmonds, & Martin, 2003; NICHD Early Child Care Research Network, 2004a).

By the time students reach secondary school, they move from class to class and have access to many activities outside classroom instruction. As a result, the relevant physical context is the school as a whole. Student body size profoundly affects school life. Members of smaller schools consistently report more social support and caring. As one teacher at a large high school commented, “A huge problem here is our size. It breeds anonymity. It breeds disconnection…. There is no sense of identification” (Lee et al., 2000, p. 159).

Furthermore, schools with 500 to 700 students or less have fewer people to ensure that clubs, sports events, and social activities will function. As a result, young people enter a greater number and variety of activities and hold more positions of responsibility and leadership. In contrast, plenty of students are available to fill activity slots in large schools, so only an elite few are genuinely active (Barker & Gump, 1964).

In view of these findings, it is not surprising that adolescents in small schools report a greater sense of personal responsibility, competence, and challenge from their extracurricular experiences. This is true even for “marginal” students—those with low IQs, academic difficulties, and poverty-stricken backgrounds (Mahoney & Cairns, 1997). A special advantage of small schools is that potential dropouts are far more likely to join in activities, gain recognition, and remain until graduation. Reorganizations that create “schools within schools”—smaller units within large schools—can have the same effect. Consult the Social Issues box on page 628 for research indicating that extracurricular participation has a lasting, favorable impact on development.

Educational Philosophies

Each teacher brings to the classroom an educational philosophy that plays a major role in children’s learning experiences. Two philosophical approaches have received most research attention. They differ in what children are taught, in the way they are believed to learn, and in how their progress is evaluated.

• TRADITIONAL VERSUS CONSTRUCTIVIST CLASSROOMS • In a traditional classroom, the teacher is the sole authority for knowledge, rules, and decision making and does most of the talking. Students are relatively passive—listening, responding when called on, and completing teacher-assigned tasks. Their progress is evaluated by how well they keep pace with a uniform set of standards for their grade.

A constructivist classroom, in contrast, encourages students to construct their own knowledge. Although constructivist approaches vary, many are grounded in Piaget’s theory, which views children as active agents who reflect on and coordinate their own thoughts, rather than absorbing those of others. A glance inside a constructivist classroom reveals richly equipped learning centers, small groups and individuals solving problems they choose themselves, and a
Extracurricular Activities and Positive Youth Development

The weekend before graduation. Terrell—a senior at an inner-city high school—attended a cast party celebrating the drama club's final performance of the year. That evening, Terrell had played a leading role in a production written and directed by club members. When Mrs. Meyer, the club advisor, congratulated Terrell, he responded: I loved this club. When I joined, I wasn't good at English and math and all that stuff, and I thought I couldn't do anything. Working on the sets and acting was so great—finding out that I could do these things well. Before, I wasn't secure with myself. Now, I've got this boost of confidence.

Many studies show that high school extracurricular activities that focus on the arts, community service, and vocational development promote diverse academic and social skills and have a lasting positive impact on adjustment. Outcomes include improved academic performance, reduced antisocial behavior, more favorable self-esteem and initiative, greater peer acceptance, and increased concern for others (Mahoney, 2000; Sandstrom & Cole, 1999).

The benefits of extracurricular involvement extend into adult life. After many factors were controlled (including SES and academic performance), young people who were more involved in high school clubs and organizations achieved more in their occupations and engaged in more community service in their twenties and thirties (Berk, 1992).

How do extracurricular activities produce such wide-ranging benefits? Not just by giving young people something fun to do during leisure hours. In a Swedish study, adolescents who spent many afternoons and evenings in youth recreation centers that offered such unstructured pastimes as pool, Ping-Pong, video games, and TV showed repeated and persisting antisocial behavior (Mahoney, Stattin, & Magnusson, 2001). In contrast, highly structured, goal-oriented pursuits that require teenagers to take on challenging roles and responsibilities have a positive impact on development. Such activities also include caring and supportive interactions with peers and adults who impose high expectations, help with problems, and serve as mentors (Roth et al., 1998).

Youths with academic, emotional, and social problems are especially likely to benefit from extracurricular participation. In a study of teenagers experiencing uninvolved parenting, those who engaged in extracurricular pursuits showed lower levels of depressed mood. This outcome was strongest for adolescents who reported a trusting relationship with an activity adviser who validated their skills and strengthened their motivation to do their best (Mahoney, Schneider, & Stattin, 2002). Furthermore, activity participation sometimes strengthens connectedness between parent and teenager, as family members attend performances and exhibits or otherwise see the fruits of the young person's efforts (Mahoney & Magnusson, 2001).

Students seem to recognize the power of their extracurricular experiences to foster a smooth transition to adulthood. They report enjoyment, increased confidence, valuable relationships with adults, new friendships, and gains in setting goals, managing time, and working with others (Dworkin, Larson, & Hansen, 1993). Unfortunately, extracurricular activities are among the first aspects of school life to be eliminated when budgets are cut. Yet a wealth of evidence indicates that, instead, these pursuits should be expanded, with special attempts made to reach academically and socially marginal young people.

A group of high school students rehearses for a school play, one of many possible extracurricular activities that build competencies such as improved academic performance, self-esteem, peer acceptance, and concern for others (© Michael Newman/PhotoEdit).
The combined results of many studies reveal that older elementary school children in traditional classrooms have a slight edge in academic achievement. But constructivist settings are associated with other benefits—gains in critical thinking, greater valuing of individual differences in classmates, and more positive attitudes toward school (Walberg, 1986).

Despite grave concerns about its appropriateness, many preschool and kindergarten teachers have felt increased pressure to stress teacher-directed, academic training. Yet doing so undermines motivation and emotional well-being. When young children spend much time passively sitting and doing worksheets, as opposed to being actively engaged in learning centers, they display more stress behaviors (such as wiggling and rocking), have less confidence in their abilities, prefer less challenging tasks, and are less advanced in motor, academic, language, and social skills at the end of the school year (Marcon, 1999a; Stipek et al., 1995). Follow-ups reveal lasting effects through elementary school in poorer study habits and achievement (Burts et al., 1992; Hart et al., 1998, 2003). These outcomes are strongest for low-SES children. Yet teachers tend to prefer a traditional approach for economically disadvantaged children—a disturbing trend in view of its negative impact on motivation and learning (Stipek & Byler, 1997).

The heavy emphasis on knowledge absorption as early as kindergarten has contributed to a growing trend among parents to delay their child’s school entry. Traditional teaching may also increase the incidence of grade retention. See the From Research to Practice box on page 630 for research on these issues.

- **NEW PHILOSOPHICAL DIRECTIONS**—New approaches to education, grounded in Vygotsky’s sociocultural theory, capitalize on the rich social context of the classroom to spur children’s learning. In these social-constructivist classrooms, children participate in a wide range of challenging activities with teachers and peers, with whom they jointly construct understandings. As children appropriate (take for themselves) the knowledge and strategies generated from working together, they advance in cognitive and social development and become competent, contributing members of their cultural community (Palincsar, 2003). Vygotsky’s emphasis on the social origins of complex mental activities has inspired the following educational themes:

  - **Teachers and children as partners in learning.** A classroom rich in both teacher-child and child-child collaboration transfers culturally valued ways of thinking to children.
  
  - **Experience with many types of symbolic communication in meaningful activities.** As children master reading, writing, and mathematics, they become aware of their culture’s communication systems, reflect on their own thinking, and bring it under voluntary control.
  
  - **Teaching adapted to each child’s zone of proximal development.** Assistance that both responds to current understandings and encourages children to take the next step forward helps ensure that each student will make the best progress possible.

In Chapter 6, we considered two Vygotsky-inspired, collaborative practices: reciprocal teaching and cooperative learning (see pages 263–264). Recognizing that collaboration requires a supportive context to be most effective, another Vygotsky-based innovation makes it a school-wide value. Classrooms are transformed into communities of learners where teachers guide the overall process of learning, but otherwise, no distinction is made between adult and child contributors: All participate in joint endeavors and have the authority to define and resolve problems. This approach is based on the assumption that different people have different expertise that can benefit the community and that students may become experts to whom others may turn (Engle & Conant, 2002). Classroom activities often consist of long-term projects that address complex, real-world problems. In working toward project goals, children and teachers draw on one another’s expertise and those of others within and beyond the school (Strauss, 1998).
School Readiness and Grade Retention

While waiting to pick up their sons from preschool, Susan and Vicky struck up a conversation about kindergarten enrollment. "Freddy will be 5 in August," Susan announced. "He's a month older than the cutoff date."

"But he'll be one of the youngest in the class," Vicky countered. "Better check into what kids have to do in kindergarten these days. Have you asked his teacher what she thinks?"

"Well," Vicky admitted, "she did say Freddy was a bit young."

Since the 1980s, more parents have been delaying their child's kindergarten entry, a trend that has accelerated as academic expectations of kindergartners have increased. Aware that boys lag behind girls in development, parents must often hold out sons whose birth dates are close to the cutoff for kindergarten enrollment. Is delaying kindergarten entry beneficial? Although some teachers and principals recommend it, research has not revealed any advantages. Younger children make just as much academic progress as older children in the same grade (Cameron & Wilson, 1990; Graue & DiPerna, 2000). And younger first graders reap academic gains from on-time enrollment; they outperform same-age children a year behind them in school (Stipek & Byler, 2001). Furthermore, delaying kindergarten entry does not seem to prevent or solve emotional and social difficulties. To the contrary, students who are older than the typical age for their grade show high rates of behavior problems—considerably higher than students who are young for their grade (Stipek, 2002).

A related dilemma concerns whether to retain a student for a second year in kindergarten or in one of the primary grades. A wealth of research reveals no learning benefits but, instead, negative consequences for motivation, self-esteem, peer relations, and school attitudes (Carlton & Winstler, 1999). In a Canadian study, students retained between kindergarten and second grade—regardless of the academic and social characteristics they brought to the situation—showed worsening academic performance, anxiety, and (among boys) disruptiveness throughout elementary school. These unfavorable trends did not characterize nonretained students (Pogani et al., 2001).

As an alternative to kindergarten retention, some school districts place poorly performing children in a "transition" class—a way station between kindergarten and first grade. Transition classes, however, are a form of homogeneous grouping. As with other "low groups," teachers may lower their expectations and teach transition children in a less stimulating fashion than other children.

Each of the options just considered is based on the view that readiness for school largely results from biological maturation. An alternative perspective, based on Vygotsky's sociocultural theory, is that children acquire the knowledge, skills, and attitudes for school success through the assistance of parents and teachers. The U.S. National Association for the Education of Young Children recommends that all children of legal age start kindergarten and be provided with classroom experiences that foster their individual progress. Research confirms that school readiness is not something to wait for; it can be cultivated.

In one classroom, students studied animal–habitat relationships so they could design an animal of the future, suited to environmental changes. The class formed small research groups, each of which selected a subtopic—for example, defense against predators, protection from the elements, reproduction, or food getting. Each group member assumed responsibility for part of the subtopic, consulting diverse experts and preparing teaching materials. Then group members taught one another, assembled their contributions, and brought them to the community as a whole so the knowledge gathered could be used to solve the problem (Brown, 1997). The result was a deep, multifaceted understanding of the topic that would have been too difficult and time-consuming for any learner to accomplish alone.
School Transitions

Besides size and educational philosophy, an additional structural feature of schooling affects students' achievement and psychological adjustment: the timing of transitions from one school level to the next. Entering kindergarten is a major milestone. Children must accommodate to new physical settings, adult authorities, daily schedules, peer companions, and academic challenges.

• **EARLY ADJUSTMENT TO SCHOOL** • In a study of factors that predict effective transition to kindergarten, researchers observed children and interviewed their teachers at the end of preschool and again during their kindergarten year. Children who were cooperative and friendly when interacting with agemates in preschool seemed to transfer these skills to kindergarten. They were better liked by peers and more involved in classroom life. The presence of preschool friends in kindergarten also enhanced adaptation (Ladd & Price, 1987). The continuity of these ties may have provided children with a sense of stability in their otherwise changing school environments.

In further longitudinal research extending over the kindergarten year, children with more preschool experience scored higher on school readiness tests and showed increasingly positive school attitudes. Liking for school predicted greater classroom participation. And participation, in turn, predicted higher achievement. Furthermore, children with friendly, prosocial styles more easily made new friends, gained peer acceptance, and formed a warm bond with their teacher. These favorable relationships also predicted high achievement, perhaps by energizing cooperation and initiative in the classroom (Birch & Ladd, 1997; Ladd, Birch, & Buhs, 1999; Ladd, Buhs, & Seid, 2000; Ladd, Kochenderfer, & Coleman, 1997).

In contrast, kindergartners with antisocial styles (those who are argumentative and aggressive) tend to establish conflict-ridden relationships with teachers and peers, which impair their liking for school, classroom participation, and achievement. And peer-avoidant kindergartners often become overly dependent on teachers, clinging and asking for help when they do not really need it (Birch & Ladd, 1998). These early, poor-quality teacher–child relationships predict academic and behavior problems through elementary school (Hamre & Pianta, 2001).

Figure 15.9 summarizes factors linked to favorable adaptation to kindergarten. A look at these factors suggests that parents can foster good school adjustment by encouraging positive social skills and arranging for their child to attend preschool. In planning the composition of kindergarten classrooms, educators might consider grouping children with their friends. And positive teacher–child ties, while important for all children, are crucial for preventing lasting school difficulties in poorly adjusted kindergartners.

• **SCHOOL TRANSITIONS IN ADOLESCENCE** • Early adolescence is a second important period of school transition: Students typically move from an intimate, self-contained elementary school classroom to a much larger, impersonal secondary school where they must shift from one class to the next. With each school change—from elementary to middle or junior high school and then to high school—adolescents' grades decline. The drop is partly due to tighter academic standards. At the same time, the transition to secondary school often brings less personal attention, more whole-class...
instruction, and less chance to participate in classroom decision making (Seidman, Aber, & French, 2004).

In view of these changes, it is not surprising that students rate their middle or junior-high school learning experiences less favorably than their elementary school experiences (Wigfield & Eccles, 1994). They also report that their middle-school teachers care less about them, are less friendly, grade less fairly, and stress competition more and mastery and improvement less. Consequently, many young people feel less academically competent and experience a drop in motivation (Andelman & Midgley, 1997).

Inevitably, each of these transitions requires students to readjust their feelings of self-confidence and self-worth as academic expectations are revised and students enter a more complex social world. A comprehensive study revealed that the timing of school transition is important, especially for girls (Simmons & Blyth, 1987). More than 300 adolescents living in a large Midwestern city were followed from sixth to tenth grade. Some were enrolled in school districts with a 6–3–3 grade organization (a K–6 elementary school, a 3-year junior high, and a 3-year high school). These students made two school changes, one to junior high and one to high school. A comparison group attended schools with an 8–4 grade organization. They made only one school transition, from a K–8 elementary school to high school.

For the sample as a whole, grade point average dropped and feelings of anonymity increased after each transition. Participation in extracurricular activities declined more in the 6–3–3 than in the 8–4 arrangement, the drop being greater for girls. Furthermore, in 8–4 schools, school transition led to gains in self-esteem. In contrast, in 6–3–3 schools, sex differences in self-esteem were striking. Whereas boys remained stable, girls showed a drop with each school change (see Figure 15.10).

These findings show that any school transition is likely to depress adolescents' psychological well-being temporarily, but the earlier it occurs, the more dramatic and long lasting its impact. Girls in 6–3–3 schools fared poorest, the researchers argued, because movement to junior high tended to coincide with other life changes—namely, the onset of puberty and dating. Adolescents who face added strains, such as family disruption, poverty, low levels of involvement and support from parents, or learned helplessness on academic tasks, are at greatest risk for self-esteem and academic difficulties (Rudolph et al., 2001; Seidman et al., 2003).

Distressed young people whose school performance drops sharply often show a persisting pattern of poor self-esteem, motivation, and achievement. In another study, researchers compared “multiple-problem” youths (those having both academic and mental-health problems), youths having difficulties in just one area (either academic or mental health), and well-adjusted youths (those doing well in both areas) across the transition to high school. Although all groups declined in grade point average, well-adjusted students continued to get high marks and multiple-problem youths low marks, with the other groups falling in between. And as Figure 15.11 shows, the multiple-problem youths showed a far greater rise in truancy and out-of-school problem behaviors (Roeser, Eccles, & Freedman-Doan, 1999). For some, school transition initiates a downward spiral in academic performance and school involvement that leads to dropping out.

**HELPING ADOLESCENTS ADJUST TO SCHOOL TRANSITIONS** • As the findings just reviewed reveal, school transitions often lead to environmental changes that fit poorly with adolescents' developmental needs. They disrupt close relationships with teachers at a time when adolescents need adult support. They emphasize competition during a period of heightened self-focusing. They reduce decision making and choice as the desire for autonomy is increasing. And they interfere with peer networks as young people become more concerned with peer acceptance.

Enhanced support from parents, teachers, and peers eases the strain of school transition. Parental involvement, monitoring, and autonomy granting are associated with better adjustment after entering middle or junior high school (Grolnick et al., 2000). Because most students do better in an 8–4 school arrangement, school districts thinking about reorganization should
seriously consider this plan. Also, forming smaller units within large schools permits closer relations with teachers and peers and greater extracurricular involvement (Seidman, Aber, & French, 2004).

Other, less extensive changes are also effective. During the first year after a school transition, homerooms can be provided in which teachers offer academic and personal counseling and work closely with parents to promote favorable school adjustment. Students can also be assigned to classes with several familiar peers or a constant group of new peers—arrangements that promote emotional security and social support. In schools that intervened in these ways, students followed for 3 to 5 years were less likely to decline in academic performance and to display other adjustment problems, including low self-esteem, depression, substance abuse, delinquency, and dropping out of school (Felner et al., 2002).

Finally, teenagers' perceptions of the sensitivity and flexibility of their school learning environments contribute substantially to successful school transitions. When schools minimize competition and differential treatment by ability, middle- and junior-high school students are less likely to feel angry and depressed, to be truant, or to show declines in academic values, self-esteem, and achievement (Roese, Eccles, & Sameroff, 2000). School rules that strike young people as fair rather than punitive also foster satisfaction with school life (Eccles et al., 1993).

Teacher-Student Interaction

The classroom is a complex social system in which teachers engage in as many as 1,000 exchanges with students each day (Jackson, 1968). A vast amount of research exists on teacher-student interaction, most focusing on its significance for academic achievement.

Elementary and secondary school students describe good teachers as caring, helpful, and stimulating—behaviors associated with gains in students' motivation, achievement, and favorable peer relations (Daniels, Kalkman, & McCombs, 2001; Davis, 2003). But with respect to stimulation, a disappointing finding is that too many U.S. teachers emphasize repetitive drill over higher-level thinking, grappling with ideas, and applying knowledge to new situations (Campbell, Hombo, & Mazzeo, 2000). In a longitudinal investigation of more than 5,000 seventh graders, those in more stimulating, academically demanding classrooms showed better attendance and larger gains in math achievement over the following two years (Phillips, 1997).

As we have already seen, teachers do not interact in the same way with all children. Well-behaved, high-achieving students typically get more encouragement and praise, whereas unruly students have more conflicts with teachers and receive more criticism from them (Henricsson & Rydell, 2004). Caring teacher-student relationships have a stronger impact on the achievement and social behavior of low-SES minority young people (Crosno, Kirkpatrick, & Elder, 2004; Meehan, Hughes, & Cavell, 2003). But overall, higher-SES students—who tend to be higher achieving and to have fewer discipline problems—have closer, more sensitive and supportive relationships with teachers (Pianta, Hamre, & Stuhlman, 2003).

Unfortunately, once teachers' attitudes toward students are established, they can become more extreme than is warranted by students' behavior. A special concern is educational self-fulfilling prophecies: Children may adopt teachers' positive or negative views and start to live up to them. As early as first grade, teachers' beliefs in children's ability to learn predict students' year-end achievement progress after controlling for students' beginning-of-year performance. This effect is particularly strong when teachers emphasize competition and publicly compare children, regularly favoring the best students (Kuklinski & Weinstein, 2001; Weinstein, 2002).

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1 Most research on self-fulfilling prophecies focuses on teacher-student relationships, but the effect can occur in other social contexts, such as parent-child and peer relationships.
Teacher expectations have a greater impact on low achievers than high achievers (Maddox, Jussim, & Eccles, 1997). High-achieving students have less room to improve when teachers think well of them, and when a teacher is critical, they can fall back on their long history of success. Low-achieving students' sensitivity to self-fulfilling prophecies can be beneficial when teachers believe in them, but unfortunately, biased teacher judgments are usually slanted in a negative direction. In one study, African-American children were especially responsive to negative teacher expectations in reading, and girls were especially responsive to negative teacher expectations in math (McKown & Weinstein, 2002). Recall our discussion of stereotype threat in Chapter 8. A child in the position of confirming a negative stereotype may respond with anxiety and reduced motivation, increasing the likelihood of a negative self-fulfilling prophecy.

**Grouping Practices**

In many schools, students are grouped by ability or tracked into classes in which students of similar achievement levels are taught together. The practice is designed to reduce the need for teachers to meet a wide range of academic needs.

*GROUPING IN ELEMENTARY SCHOOL* Homogeneous groups or classes can be a potent source of self-fulfilling prophecies (Smith et al., 1998). Low-group students get more drill on basic facts and skills, engage in less discussion, and progress at a slower learning pace. Gradually, they show a drop in self-esteem and are viewed by themselves and others as “not smart.” Not surprisingly, homogeneous grouping widens the gap between high and low achievers (Dornbusch, Glasgow, & Lin, 1996).

Partly because of this finding, some schools have increased the heterogeneity of student groups by combining two or three adjacent grades. In multigrade classrooms, academic achievement, self-esteem, and attitudes toward school are usually more favorable than in the single-grade arrangement, perhaps because multigrade classrooms often decrease competition and increase harmony (Lloyd, 1999; Ong, Allison, & Haladyna, 2000). Multigrade grouping also affords opportunities for peer tutoring that may contribute to favorable outcomes.

When older or more expert students teach younger or less expert students, both tutors and tutees benefit in self-esteem and achievement (Renninger, 1998).

Finally, recall from our discussion of Vygotsky's theory in Chapter 6 that for expert children to promote learning in less expert children, participants must resolve conflicts, share responsibility, and consider one another's ideas. In North American classrooms, however, small heterogeneous groups of students working together often engage in poorer-quality interaction (less accurate explanations and answers) than homogeneous groups of above-average students (Webb, Nemer, & Chizhik, 1998). In Chapter 6, we noted that for collaboration between heterogeneous peers to succeed, children often need extensive guidance (see page 264). When teachers provide this assistance, heterogeneous classrooms are desirable into middle or junior high school, effectively supporting the motivation and achievement of students who vary widely in academic progress (Gilles, 2003; Gillies & Ashman, 1996).

*GROUPING IN HIGH SCHOOL* By high school, some homogeneous grouping is unavoidable because certain aspects of education must dovetail with the young person's educational and vocational plans. In the United States and Canada, high school students are counseled into college preparatory, vocational, or general education tracks. Unfortunately, this system perpetuates educational inequalities of earlier years.

Low-SES minority students are assigned in large numbers to noncollege tracks. Longitudinal research following thousands of U.S. students from eighth to twelfth grade reveals that assignment to a college track accelerates academic progress, whereas assignment to a vocational or general education track decelerates it (Hallinan & Kubitschek, 1999). Even in secondary schools that do not have an overarching tracking program, low-SES minority students tend to be assigned to lower course levels in most or all of their academic subjects,
resulting in de facto (unofficial) tracking that sorts students into classes on the basis of their SES and ethnicity (Lucas & Behrend, 2002).

Once a student is assigned to a low track or to lower-level courses, breaking out is difficult. Track or class enrollment is generally based on the student's past performance, which is limited by history of placement. Interviews with black students in one high school revealed that many thought their previous performance did not reflect their ability. Yet teachers and counselors, overburdened with other responsibilities, had little time to reconsider individual cases (Ogbu, 2003). When capable students (as indicated by their achievement test scores) end up in low tracks, they “sink” to the performance level of their trackmates. Furthermore, teachers of noncollege-track classes are less likely to communicate with parents about what they can do to support their adolescent's learning. Many minority parents, in turn, do not understand the tracking system, are unaware of their child's placement, and therefore do not intervene on behalf of their child (Dornbusch & Glasgow, 1997).

High school students are separated into academic and vocational tracks in virtually all industrialized nations. But in China, Japan, and most Western European countries, students take a national exam to determine their track placement in high school. The outcome usually fixes future possibilities for the young person. In North America, educational decisions are more fluid. Students who are not assigned to a college preparatory track or who do poorly in high school can still get a college education. But by the adolescent years, SES differences in quality of education and academic achievement have already sorted students more drastically than is the case in other countries. In the end, many young people do not benefit from this more open system. Compared with other Western nations, the United States and Canada have a higher percentage of young people who regard themselves as educational failures and drop out of high school—about 11 percent in both countries (Statistics Canada, 2004e; U.S. Department of Education, 2004b).