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ABSTRACT

This manual identifies characteristics of instructional tools that are effective and efficient in promoting cognitive access for a broad diversity of students, especially those with learning disabilities. An introductory chapter defines "instructional tools" and considers the importance of their design, their use in addressing student performance diversity, characteristics of students with learning difficulties, and relation of each difficulty to specific instructional implications. The next six chapters each address one broad instructional principle and its application to instructional tools. Each chapter explains the instructional principle and applies it with examples to specific content areas and to the characteristics of students with learning difficulties. These chapters cover: (1) an emphasis on big ideas (to provide the most mileage out of the least instruction); (2) use of explicit instructional and learning strategies (seen as more efficient than discovery learning for students with learning difficulties); (3) use of instructional scaffolding (students with learning disabilities are seen as likely to benefit from more scaffolding than nondisabled peers); (4) integration of interrelated knowledge areas; (5) provision of necessary background knowledge; and (6) provision of adequate, distributed, cumulative, and varied review. (Contains 44 references.) (DB)

Access to Curriculum

6

Instructional Tools for Students with Learning Difficulties

Robert Dixon

Douglas Carnine

Edward Kameenui

THE COUNCIL FOR EXCEPTIONAL CHILDREN

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NOTE FOR SYMPOSIUM PARTICIPANTS

This limited edition of *Access to Curriculum: Six Instructional Tools for Students with Learning Disabilities* has been prepared for use at the CEC Symposium on Achieving Curriculum Mastery: Creating Academic Success for All, June 6 and 7, 1996, in Dallas, Texas. CEC plans to publish and market this book beginning September 1996. We have the unique opportunity and luxury of "testing" this resource before its final printing. Any suggestions you might have for improving the book would be welcome. Please send your suggestions to Jean Boston, Director of Publications, The Council for Exceptional Children, 1920 Association Drive, Reston, VA 22091-1589. All recommendations must be received by June 30, 1996.

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Introduction

PURPOSE OF THIS MANUAL

Our purpose is to outline the characteristics of *instructional tools* that effectively promote *cognitive access* for a broad diversity of students, especially those with learning disabilities. These characteristics are of importance for the design, evaluation, selection, or adoption of instructional tools. The viewpoint presented herein is that effective instructional tools facilitate cognitive access for students with learning difficulties, similar to the way that a scanning device provides physical access to computers for students with certain physical disabilities.

WHAT ARE INSTRUCTIONAL TOOLS?

Reading researchers have pointed out that reading comprehension, for example, is facilitated or hindered according to a student's prior knowledge of the material being read. Students with some prior knowledge of sailing, for instance, are likely to better comprehend a reading passage about sailing. It can be argued, then, that students with a dearth of prior knowledge lack the access to reading comprehension enjoyed by other students.

Instructional tools may promote or deny cognitive access in a number of ways. Our focus here is upon some important means by which such tools can effectively promote cognitive access.

We define *instructional tools* as any identifiable component of instruction used to accomplish a set of identifiable student-performance outcomes. Textbooks, media, software, and teacher/student activities can all be instructional tools and can be created by publishers or teachers. By implication, however, instructional tools are used by instructional craftspersons, namely, teachers. The greater the challenges that learners present to teachers, the greater the need for precise, highly useful instructional tools. All evidence points to ever increasing challenges for teachers.

DO TOOLS REALLY MATTER?

Two factors may lead some to believe that instructional tool design is *not* of critical importance. First, during much of the history of American education, instructional tools probably had limited impact on overall school effectiveness. When schooling prepared mostly White, relatively affluent, college-bound students, educators might have been hard pressed to demonstrate that one tool served significantly better than others. It may still be the case today that among more affluent students with abundant family support and with no discernible cognitive disability, one tool may be as good as the next. Many such students seem to "get it" one way or another, regardless of the instructional tools their teachers use.

Second, schools periodically shift from highly structured instruction directed by teachers to unstructured, child-centered instruction. Child-centered education once again has been popular in recent years, but signs indicate that the pendulum may swing back (again) to a more teacher-directed orientation, with a balanced emphasis upon skills and problem solving. Because child-centered instruction originates from interests children express, tools are often considered directive and, therefore, inappropriate.

An increasing performance diversity of students implies a far more crucial role for instructional tools than in the past. Teachers cannot realistically accommodate performance diversity by teaching three groups in each subject area: low, average, and high. Often, teachers are hard pressed to teach each subject once per day. The applicability of that one lesson to students of widely diverse performance levels will quite likely be influenced by the quality of the instructional tool employed. One tool might work very well for the highest third for students and moderately well for the middle third but poorly for the bottom third. Another tool might be most effective with the bottom third only. Rather than putting teachers in the unenviable position of deciding which students get the effective instruction, there is a tremendous need for tools designed specifically to assist teachers in achieving performance goals with the vast majority of—if not all—students in a classroom.

Neither swing in educational fads, from teacher-directed basics to child-centered problem solving, effectively addresses the reality of modern classrooms. An inherent danger in teacher-directed instruction is that it can become *learner-dependent* instruction, wherein the learner appears to be successful but only in the context of direct teacher support. An inherent danger in basics-oriented instruction is that learners receive inadequate opportunities to apply their basic knowledge to higher order thinking, including challenging, realistic problems.

On the other hand, reliance upon child-centered approaches to problem solving has rarely been shown to be effective for low-performing students, whether used with basic learning or more complex problem solving, and the success of these approaches with higher performing students varies. However, someone always benefits from child-centered instruction, and every child probably benefits from it *at some time*.

Instructional tools can be designed to help synthesize these apparently disparate approaches by incorporating empirically validated characteristics that accommodate the natural progression of learning. For example, a teacher can initially teach a strategy explicitly and with substantial support, then gradually reduce the support while giving students more discovery-oriented activities in which to apply the strategy. This circumvents the problem of students becoming dependent upon teachers and allows students to reliably acquire knowledge, then use it across a broad range of interests. Similarly, basics and higher order thinking can be taught hand-in-hand (to the benefit of both). Features to accomplish these goals can be built in to instructional tools, and probably should be, because teachers are unlikely to have the time to create them fully on their own.

Precise, highly useful instructional tools are those that most effectively serve teachers in their quest for helping all learners achieve at their highest potential levels of performance. The design of tools can substantially influence the extent to which they meet this criterion for effectiveness. An impressive base of empirical research on instructional design over the past 30 years is the foundation upon which effective, durable tools can be built—durable because they are not spawned by fleeting fits of faddism but instead by solid instructional design research.

WHY START WHERE ALL STUDENTS CAN PLUG INTO THE PROCESS?

Diversity in modern American classrooms is an undisputed reality. The continuing trend toward including special education students in general education classrooms contributes to that diversity, but many other factors contribute as well. Even if inclusion students are not counted in the mix, today's general education students display greater cultural and performance diversity than ever before.

The diversity principally addressed in this book is *performance diversity*: the broad range of performance displayed across all the students in a classroom, regardless of a variety of possible causes. A girl who is gifted and Black, for instance, contributes to the overall diversity of a classroom in two dimensions: racial culture and exceptional performance. Of those two, her status as a gifted student contributes to the *performance* diversity of the classroom. Similarly, a middle-class, White child with learning difficulties contributes to the cultural diversity of a classroom and contributes to the performance diversity by virtue of learning difficulties.

It is tempting to attribute *low* performance—including learning disabilities—to numerous possible factors: cognitive difficulties, poverty, racism, behavioral or emotional disorders, and social factors, such as single parenthood or two working parents. The probability that a given student, influenced by one or more of these factors, will perform poorly in school varies considerably. Poverty correlates highly with poor performance, but no such high correlation has been shown for children of two working parents.

Our approach to performance diversity is pragmatic: It puts emphasis on the factor over which teachers have the most control—the instruction they deliver—and less on factors beyond their control—social and cognitive factors. This approach, however, is also realistic in that effective instruction is counted as a crucial element in student development but not a cure-all. Effective instruction, in this view, is the primary, fundamental responsibility of schooling.

Our approach is pragmatic in another respect. It is unrealistic to think that any single tool is *optimal* for every student in a performance-diverse classroom, including tools designed around well-established empirical principles of instructional design. Studies of instructional design variables always report findings that benefit some children more than others. This fact implies that teachers have to *adapt* even the most judiciously designed tools.

The question, then, is: In which *direction* should teachers adapt? That is, should teachers aim to accommodate the highest students and adapt the tools to lower performing students or vice versa? We suggest herein that tools should most directly accommodate the students with learning difficulties, such as students with learning disabilities, and appropriate adaptations should be made for higher performers. This view is not based upon moral imperative nor an inherent prejudice in favor of students with learning difficulties but rather upon the realities of classrooms. Clearly, the needs of both students who excel and those with learning difficulties *must* be accommodated. However, it is usually *easier* to modify instructional tools to accommodate higher performing students.

Consider **review**, for example. (See Chapter 6 for details on **review.**) If the amount, type, and location of **review** in an instructional program is appropriate for higher performing students, then the adaptation teachers would have to make for students with learning difficulties is to *develop and design additional review on the teachers' time.* In reality, teacher preparation time is already at a premium.

On the other hand, an instructional tool that provides appropriate amounts, types, and locations of **review** for students with learning difficulties is a relatively easy tool for teachers to modify for higher performing students: Almost no preparation is required for a teacher to *not assign* **review** that is unnecessary for such students. Modifying instruction to provide less support for students who do not need it is a far more practical approach to adaptation than the opposite.

All of the instructional design principles discussed in the following pages can be readily modified, with a minimum of preparation time, to accommodate the needs of higher performing students. Throughout, we will provide some examples of tool features that are helpful for students with learning difficulties yet are easily modified for higher performing students.

CHARACTERISTICS OF STUDENTS WITH LEARNING DIFFICULTIES

Obviously, students with learning difficulties differ from one another in terms of individual characteristics. Nevertheless, some general characteristics recur and provide a dependable if incomplete basis for the development of instructional guidelines.

A brief overview of these characteristics is presented next, with reference to instructional implications. Following chapters deal specifically with the instructional implications.

Students Who Learn Slowly

In general, students with learning difficulties learn at a slower rate than other students. The fundamental implication of this widely acknowledged characteristic is that instruction needs to be more *efficient* for those students. Such efficiency, however, cannot be achieved at a cost of depreciated effectiveness and, therefore, cannot be achieved easily.

One implication of slow learning rate is that instruction should focus on teaching the most important aspects of a content area, as opposed to "covering" a great deal of material. (See **Big Ideas** chapter.) Another instructional implication is that strategies, concepts, principles, and the like be introduced explicitly, which is more efficient than discovery-oriented introductions to new material. (See **Explicit Strategies** chapter.)

The following paragraphs attempt to link the remaining characteristics of children with learning disabilities and other children at risk for learning difficulties to the reasons *why* the learning rate of such children is relatively slow.

Students Whose Language Skills Are Delayed

Several investigations by Vellutino (1987) suggest that students with learning disabilities experience difficulties processing linguistic information. He contends that many of these students' characteristics that are often cited as examples of visual-coding difficulties are in reality manifestations of linguistic-processing difficulties. Donahue (1987) has reviewed substantial research strongly suggesting that students with learning disabilities perform below their normally achieving peers in a variety of language-related skills, including phonological, semantic, and syntactic tasks.

Language delays among children with learning disabilities are usually investigated in relation to reading. However, they may also contribute to social-cognitive deficits and, indirectly, to difficulties in solving verbal mathematics problems, although research on this relationship is equivocal.

Regardless of the exact nature of language problems, a fairly straightforward instructional implication is that new concepts and strategies must be explained in clear, concise, accurate, and comprehensible language that builds on the students' prior knowledge to make the learning meaningful. (See **Explicit Strategies** and **Background Knowledge** chapters.)

Students Who Cannot Remember

Students with learning difficulties demonstrate deficiencies in remembering material covered in instruction. Even when memory is categorized into subtypes, students with learning difficulties display deficiencies across subtypes. Research also indicates that not remembering material is not the same as having poor memory. Rather, many students with learning difficulties may lack strategies for activating memory. They appear to not classify or organize new material as effectively as students who learn normally.

Two general instructional considerations are implied by the descriptive research on retention for students with learning disabilities. First, memory is enhanced when material is meaningful and is presented in a prearranged, structured manner. Of course, there are other advantages, besides enhanced memory, to presenting new material in a way that facilitates meaningfulness. (See **Big Ideas** and **Explicit Strategies** chapters.)

Second, given that initial learning is meaningful and well-organized, the number of opportunities students have for applying new material and the distribution of those opportunities has an impact upon how well that material is remembered. (See **Review** chapter.)

Students Who Lack Fluency

Samuels (1987) has been influential in describing the relationships between basic and higher order cognition. Although basic cognition does not necessarily build hierarchically to higher cognition in many domains, it facilitates higher order cognition in nearly all domains—if students can apply their basic knowledge automatically, or fluently. For example, a student who decodes fluently is in a much better position to comprehend challenging reading material than one who does not decode fluently.

Fluency is closely related to memory: Material is learned to high automaticity if there are sufficient opportunities to use it frequently in a variety of applications, including those that build fluency. (See **Review** chapter.)

Students Whose Attention Wanders

Much of the research on learning disabilities and other learning difficulties addresses various manifestations of attention: selective attention, meta-attention, and meta-cognition. Although some studies have failed to discriminate students with learning disabilities from other students on the basis of attention, most such studies have identified some form of attention as a psychological processing deficit in students with learning disabilities. Moreover, attention problems appear to play a major role in the referral of students for special education services and in identifying students at risk of such referral.

1. Selective Attention. Students with learning disabilities in general have problems differentiating pertinent or important information from irrelevant or insignificant information.

Because knowledge discrimination—knowing when to use knowledge—impacts so strongly on transference of learning, an inability among students with learning disabilities to make such discriminations independently is likely to impact significantly upon learning in general and transference in particular. Effective instruction for these students, therefore, should explicitly assist them in attending to cues of when to use knowledge. (See **Explicit Strategies** chapter.)

2. Meta-attention. Related to selective attention, meta-attention refers to the extent to which a student possesses knowledge about attention and its importance and has control over that knowledge. Students with learning disabilities appear to do a poor job of allocating their attention to critical aspects of new or difficult tasks. These students may not necessarily *be* inattentive but may *become* inattentive when tasks demand too much of them.

Thus, students with learning disabilities or other learning difficulties may be as attentive as their peers without disabilities in some contexts: those in which the tasks are not overdemanding. Unfortunately, many desired educational outcomes are demanding by nature. The solution for students with learning difficulties is not to restrict them to simple tasks but to develop instructional means for (a) making the instruction clear (possibly by temporarily simplifying complex tasks); (b) relating the complex tasks to prior knowledge; and (c) providing **scaffolded** instruction through the initial, difficult phases of performing complex tasks. (See **Explicit Strategies, Scaffolding,** and **Background Knowledge** chapters.)

3. Meta-cognition. Meta-cognition refers both to students' knowledge of their cognitive ability and their ability to self-regulate cognitive abilities. In some cases, specific manifestations of meta-cognition appear to relate to knowledge and control of study skills, such as the kind of knowledge required for appropriately studying for different types of exams. In other cases, the particulars of meta-cognition appear to be domain specific. For example, Smiley, Oaken, Worthen, Campione, and Brown (1977) identify the ability to recall critical-idea units in a story as meta-cognitive knowledge while Englert, Raphael, Fear, and Anderson (1988) label as meta-cognitive knowledge about text structure and the writing process.

The keys to improving the meta-cognitive ability of students appear to be twofold: First, strategic cognitive knowledge should be made conditional, meaning that students know *when* to apply it. Depending upon the nature of the strategic knowledge, students should be able to generalize this knowledge, within or across domains. (See **Integrate Information** chapter.) Second, students do not appear to truly learn such knowledge unless they receive repeated application opportunities. (See **Review** chapter.)

Students Who Have a Poor Attitude or Lack Motivation

A consistent study finding is that the relatively poor academic performance of students with learning disabilities or other learning problems correlates with poor attitudes toward school, a sense of failure, and inappropriate classroom behavior. Whether other characteristics of these students cause their maladaptive behavior or vice versa, improvements in academic performance correspond to improvements in behavior.

In any case, interventions designed specifically for students with learning disabilities must create a range of successful experiences for these students. All the instructional guidelines discussed in this book have been identified as contributors to successful experiences.

Students Who Have Poor Background Knowledge in Content Areas

Students with learning difficulties frequently enter new instructional situations with a dearth of relevant **background knowledge**. Instruction should first determine whether students possess the relevant knowledge prerequisite to acquiring new knowledge and then provide such knowledge when it is not present.

EFFECTIVE INSTRUCTIONAL TOOLS AND HOW THEY WORK

Table 1 summarizes this chapter's description of learner characteristics and instructional implications. The implications marked with » (such as **Big Ideas**) are discussed fully in the remaining chapters of this book. Six features of instructional tools that have shown themselves to be particularly effective in efficiently teaching students with learning difficulties are each explored in these six chapters. Ideally, instructional tools—texts, computer programs, and the like—should incorporate these features as a means of allowing teachers the greatest flexibility in accommodating the needs of students whose performance levels are widely diverse.

The first of the six features—**Big Ideas**—focuses upon what to teach. The remaining five focus upon the "how" of instruction.

Table 1
Summary of Student Characteristics and Instructional Implications

Characteristic (Research Support)	Instructional Implications
Slow Learning Rate Students with learning disabilities generally learn at a slower rate than other students (Marston & Magnusson, 1985; O'Shea & Vacante, 1986).	» **Big Ideas:** Less should be taught for exposure; more emphasis on central understandings. » **Explicit strategies**: More efficient than discovery-oriented instruction. Also, the time allocated to instruction should be used efficiently. First and most obviously, time should not be wasted.
Language Deficits Students with learning difficulties perform below other students in a variety of language-related skills, including phonological, semantic, and syntactic tasks (Donahue, 1987; Dunlap & Strope, 1982; Levy & Schenck, 1981; Stanovich, 1988; Vellutino, 1987; Wagner & Torgensen, 1987).	» **Explicit strategies**: Should be explained in clear, concise language that is comprehensible to the learner. » **Background knowledge**: Student knowledge of language prerequisite to such explanations should be established (assessed and taught if necessary).
Memory Deficits Students with learning disabilities demonstrate deficiencies in remembering material covered in instruction (Bauer, 1987; Swanson, 1988; Torgeson & Goldman, 1977; Torgeson & Kail, 1980; Torgeson, Murphy, & Ivey, 1979; Wong, 1978, 1985).	» **Big Ideas, Explicit strategies**: Memory is enhanced when material is meaningful and is presented in a prearranged, structured manner (Bransford, Sherwood, Vye, & Rieser; 1986; Dwyer, 1985; Phillips, 1986; Swing & Peterson, 1988; Torgeson, Rashotte, Greenstein, & Portes, 1988). » **Review**: Students should have ample cumulatively distributed opportunities to apply new meaningful material, in order to retain that material (Dempster, 1991: Mulligan, Lacey, & Guess, 1982; Pelligrino & Goldman, 1987; Resnick, 1989; Swing & Peterson, 1988; Trafton, 1984).
Automaticity Because students with learning disabilities often lack automaticity with lower level cognition, they are often preempted from acquisition of higher level cognition (Ashcraft, 1985; Cawley, 1985; Pelligrino & Goldman, 1987).	» **Review**: Automaticity is closely related to memory. Ample, cumulatively distributed application opportunities contribute to automaticity as well as memory.

Continued on next page.

Table 1, *Continued*

Characteristic (Research Support)	Instructional Implications
Attention Various manifestations of attention difficulties (selective attention, meta-attention, meta-cognition) play a major role in the referral of students for special education services and in identifying students at risk of such referral. *Referral:* Bryan, Bay, Shelden, & Simon, 1990; Cooper & Farran, 1988. *Selective attention:* Hallahan & Reeve, 1980; Koppitz, 1971; Krupski, 1985; Samuels & Miller, 1985; Snef, 1971; Tarver, Hallahan, Kaufman, & Ball, 1976. *Meta-attention:* Loper, Hallahan, & Ianna, 1982; Krupsky, 1985; Miller, 1985. *Meta-cognition:* Deschler & Schumaker, 1986; Englert, Raphael, Fear, & Anderson, 1988; Palinscar & Brown, 1987; Schumaker, Deschler, Alley, Warner, & Denton, 1984; Smiley, Oaken, Worthen, Campione, & Brown, 1977.	» **Integrated Information:** Strategic knowledge should be made conditional, ensuring that students know when to apply it appropriately. » **Explicit strategies**: The characteristics of new knowledge that promote transference (Gick & Holyoak, 1987) should be made explicit for students, in order to lessen inattention (Gersten, Woodward, & Darch, 1986). » **Scaffolding**: Students need assistance in making the transition from the initial introduction of potentially confusing new strategies to self-regulated application, in the form of **scaffolding**, temporarily simplified instruction, and explicitness. » **Review**: Repeated opportunities to apply new strategies result in better understanding (Wong, 1988). » **Background knowledge**: Relating new, complex knowledge to prior knowledge can help simplify the new knowledge, thus making attention easier.
Attitudes and Motivation The relatively poor academic performance of students with learning difficulties correlates with poor attitudes toward school, a sense of failure, and inappropriate classroom behavior (McKinney, 1989).	Although a cause-and-effect relationship between academic performance and attitudes has not been convincingly shown, an emphasis on all instructional factors that contribute to student success is presumed to have potential for improving students' attitudes and motivation.
Prior Knowledge Students with learning disabilities frequently enter new instructional situations with a dearth of relevant **background knowledge** (Kolligian & Sternberg, 1987; Synder & Tarver, 1988).	» **Background knowledge**: Instruction should first determine whether students possess the relevant knowledge prerequisite to acquiring new knowledge and then provide such prerequisite knowledge when it is not present.

1

Big Ideas

Are Roman numerals as important to understanding mathematics as estimation? Are semicolons as important to the mechanics of writing as commas? These questions illustrate that, within any content area, certain ideas—concepts, principles, even facts—can be identified as crucial to understanding while other ideas are of lesser importance. The *most* crucial ideas within a content area can be referred to as **Big Ideas**.

Crucial in what sense? Who determines just which aspects of a given content area are the most crucial to understanding? Obviously, the collective view of content-area experts plays a major role in determining **Big Ideas**. For example, the Standards of the National Council of Teachers of Mathematics (NCTM Commission on Standards for School Mathematics, 1989) give some indication of the most important aspects of mathematics (e.g., estimation, graphing).

The criterion used in this book is that a ***Big Idea** gets the most mileage out of the least instruction*. Mathematics educators, for example, believe estimation is important in mathematics because of its broad application: Many real-world problems can be solved sufficiently through estimation. Plus, estimation is a widely applicable way of "double checking" one's mathematical thinking when solving problems that require precise answers, regardless of the particular mathematical operation involved. For example, if a student commits a procedural error and determines that a 30% discount on a $29.95 item is $.89 (for a cost of $29.06), estimation knowledge should alert the student to the error, while simultaneously helping to enhance understanding of both money and percentages.

WRITING: AN EXTENDED EXAMPLE

Of all the guidelines outlined in this book, **Big Ideas** may be the most difficult to grasp because it has only recently been discussed in educational literature. The following example, therefore, illustrates the **Big Ideas** concept in relation to three research areas on effective writing instruction for students with learning difficulties as well as for general education students: (a) writing processes, (b) text structures, and (c) collaborative learning.

Writing Processes

Anyone familiar with trends in writing instruction over the past several years is aware of the prominence of writing processes in such trends. To review briefly, the processes of writing are usually listed as some variation on these five steps:

1. Planning
2. Drafting
3. Revising
4. Editing
5. Publishing

These phases of writing are reiterative. While editing, for example, authors might decide to make a major change in their compositions, a change that would constitute further planning. Similarly, an accomplished writer might "edit ahead" during the drafting phase of writing by correcting minor errors, misspellings, and the like.

Writing processes are a **Big Idea**, according to the "most mileage/least instruction" criterion because, theoretically, students can learn to use these processes once, then apply them to unlimited types of writing such as fictional stories, book reports, research papers, essays, descriptive narratives, and arguments.

Text Structures

Perhaps less familiar than writing processes are text structures. Each *type* of text—story, explanation, and so forth—has its own unique structure. Stories, for example, almost always have the same basic elements arranged in the same basic structure: a protagonist with a problem to solve; an antagonist who thwarts the protagonist's efforts; a series of unsuccessful attempts by the protagonist to solve the problem; and eventually, a climax and resolution during which the protagonist does in fact solve the problem. This structure has been identified in reading comprehension research as "story grammar," where it has proven to be a **Big Idea** for effectively comprehending stories.

It is reasonable to assume that a student, faced with writing a particular type of text (such as an explanation), would benefit from knowing the structural elements common to most examples of that type of text. Once students have mastered the structure of an explanation, for example, they are prepared to write many more explanations, on widely varying topics, with confidence. Text structures, therefore, are a **Big Idea** for writing instruction: A lot of mileage can be had for relatively little instruction on a handful of the most common structures.

Collaborative Learning

Normally, collaborative learning (cooperative learning, peer tutoring) is not considered as specific to *content* areas. Rather, it is assumed that the *instructional* approaches collectively known as collaborative learning can be applied to any content area. (See **scaffolding** chapter.) However, there is a unique application of collaboration with respect to writing: Writers almost always have a readership or audience, and collaborative writing experiences help aspiring writers get a sense of their audience and its expectations.

Taken together, explicit instruction on writing processes, text structures, and collaborative learning have proven themselves a powerful combination for teaching writing to students of widely diverse performance levels. In some cases, students with learning disabilities have achieved competence in writing equal to that of their general education peers. A crucial element in studies achieving that kind of success, however, has been that the **Big Ideas** were taught *thoroughly*. In one major study (Englert & Raphael, 1991), for example, students were explicitly taught *only two text structures in a single school year.* They not only mastered the two targeted text structures (explanations and arguments), but the knowledge they acquired made for relatively quick and easy transfer to entirely new text structures: Lots of mileage, relatively little instruction.

OTHER CONTENT AREAS

Here, we briefly outline the potential applicability of **Big Ideas** to content areas other than writing.

Mathematics

A full understanding of a measurement concept such as volume is dependent upon the realization that volume is fundamentally a function of the base of a three-dimensional object times its height ($B \cdot h$). This fundamental relationship is frequently, if unintentionally, muddled for students through instruction on seven different traditional formulas for computing the volumes of seven types of three-dimensional objects. Once students understand the **Big Idea** or fundamental concept of volume as a function of base times height, they can "figure out" slight variations for different figures ($B \cdot \frac{1}{3}h$ for figures that come to a point and $B \cdot \frac{2}{3}h$ for spheres) by observing the relationships among figures.

Beginning Reading

Research overwhelmingly supports phonemic awareness as a crucial **Big Idea** of beginning reading. Such "awareness" manifests itself in students' ability to perform various sound-related tasks, including but not limited to the ability to blend isolated phonemes into complete words (such as blending /s/, /a/, and /t/ to form "sat") and the ability to segment a verbal word into its component sounds (identifying the sounds in "sat" as /s/, /a/, and /t/). Another **Big Idea** of beginning reading, related to phonemic segmentation, is the alphabetic principle: the fact that sounds in verbal words are represented by letters in written words.

Science

Convection is an important **Big Idea** in science with many applications including familiar phenomena such as water boiling or air moving around in a room. However, convection applies beyond the movement of gases and liquids, as demonstrated by the role of convection in the earth's mantle.

Social Studies

One or more of four factors usually determines the extent to which a group successfully achieves a goal: (a) motivation, (b) leadership, (c) resources, and (d) capability. These factors largely explain, for example, the success of the Federalists in establishing the U.S. Constitution. As wealthy landowners, the Federalists were highly motivated to protect the new nation as well as their economic interests. They had excellent leadership (as did the anti-Federalists with Jefferson and others). However, as landowners, they had superior resources and strong capabilities so they could carefully organize plans for accomplishing their goal of achieving a central, federal Constitution.

There is tremendous potential for "mileage" in this analysis of success factors, in that it can be applied to nearly any historical group effort: wars, colonization, an expedition (such as Lewis and Clark's), and so on. Moreover, this **Big Idea** might be considered unusually "huge" in that it provides students with a relatively simple way to connect important historical events to their own lives. The potential or past success of an athletic team or a student council, for example, can be analyzed in terms of the four success factors just described.

BIG IDEAS AND STUDENTS WITH LEARNING DIFFICULTIES

An antiquated, discredited idea in special education is to give students with learning difficulties easier work to do, covering more basic material that general education students already know or learn more easily. That approach essentially denies cognitive access to student with learning difficulties. **Big Ideas** suggest a promising alternative for differentiating curricula based upon performance: All students can benefit from instruction focusing on **Big Ideas**, with higher performing students receiving opportunities to move beyond **Big Ideas** to a fuller range of content that can include areas of low utility but high interest to them.

For example, every student learning to write is likely to benefit from instruction on common text structures, particularly those demanded by continued schooling. Higher performing students, however, might well take an interest in more esoteric text structures, such as the structure for poetic forms like haiku or sonnets. Students with learning difficulties need not be denied access to instruction on more "esoteric ideas," but their participation should be contingent upon mastery of more essential, core ideas.

For students with learning difficulties, **Big Ideas** particularly help to provide cognitive access often preempted by slow learning rate and memory deficits.

2

Explicit Strategies

As mentioned previously, **Big Ideas** relate particularly to *content*. The remaining instructional guidelines outlined here are content independent; that is, they appear to apply about equally to effective instruction across content areas. The specific **Big Ideas** identified for a given content area could be characterized as *what* to teach most thoroughly. **Explicit strategies**—the subject of this chapter—and other guidelines relate to the *how* of communicating **Big Ideas** most effectively (and efficiently).

A clarification is in order: This guideline will strike some readers as an affront to some currently popular instructional approaches. As noted in the Introduction, based upon empirical research results we recommend that *initial* instruction on **Big Ideas** be *explicit*. This is not an anti-discovery or anti-constructivist position because explicit initial instruction actually facilitates students' ability to benefit from discovery-oriented instructional experiences.

A strategy is a series of steps one can follow to analyze content or solve problems. However, not all strategies are created equal. "Narrow" strategies tend to result in rote learning, instead of understanding. For instance, an algorithm in math, such as "invert and multiply" for dividing fractions, could technically be considered a strategy, but it is too narrow for consideration as an *effective strategy,* as the term is used in this chapter.

A strategy may also be too broad if it does not *reliably* lead to most students successfully solving problems. Telling students to "plan before you write" could, technically, be considered a strategy, but it lacks sufficient guidance to be useful to the majority of students.

An effective strategy, then, is "intermediate in generality," just right, neither too narrow nor too broad. In fact, there is little point in explicitly (or otherwise) teaching strategies of questionable effectiveness, those that are too broad or too narrow. Therefore, developing **explicit strategies** for teaching **Big Ideas** is a challenging enterprise.

Finally, and obviously, **explicit strategies** should be *accurate* portrayals of content. When all the qualifications for a "good" **explicit strategy** are met (accuracy and generality), the strategy should effectively cut across a variety of learning difficulties. Why? Because a good strategy gives learners of various descriptions "inside looks" at content. The *content* being made explicit *does not vary according to differences in students*. Therefore, like **Big Ideas**, well-designed **explicit strategies** are appropriate for a broad variety of students.

CONTENT EXAMPLES

As mentioned earlier, "plan before you write" is too broad a strategy to be generally effective. The following two strategies for planning to write are neither too narrow nor too broad, that is, they are explicit.

1. General Strategy for Any Text Structure

- Who will be my audience?
- What is my goal?
- What are all the things I already know about this topic?
- What are some possible ways to group my ideas?

These questions encourage the writer to consider his or her audience and purpose in writing, to brainstorm, and finally, to do some preliminary, tentative organization.

2. Planning Specifically to Write an Explanation

- What am I explaining?
- What will the reader need (if anything)?
- Is there any special setting for this? If so, what?
- What are the steps, in order?
- Am I using good connecting words between steps?

Each question in this strategy applies specifically to elements common among explanations. Both sets of questions are strategies in that students learn to always ask themselves the indicated questions in preparation for writing. Asking, then answering each question is a step in the strategy.

Mathematics

The **Big Idea** of proportions has a wide-ranging applicability beyond proportions themselves: rate, measurement equivalencies, percent, probability, the coordinate system, and functions. A strategy for "setting up" problems across these subcategories is:

1. Map the units involved.
2. Insert the relevant information.
3. Solve for the answer.

The application of this mapping strategy can be illustrated with examples from two subcategories of mathematics.

Rate. How long will it take a train to go 480 miles to Paris if it travels at 120 m.p.h.?

1\. Map $\dfrac{\text{miles}}{\text{hour}}$

2\. Insert $\dfrac{\text{miles}}{\text{hour}} \quad \dfrac{120}{1} = \dfrac{480}{\square}$

3\. Solve $\dfrac{\text{miles}}{\text{hour}} \quad \dfrac{120}{1} = \dfrac{480}{\text{4 hours}}$

Probability. There are 52 cards in a deck. Thirteen of them are hearts. The rest are not hearts. If you took trials (drew a card and then replaced it) until you drew 26 hearts, about how many trials would you expect to take?

1\. Map $\dfrac{\text{hearts}}{\text{trials}}$

2\. Insert $\dfrac{\text{hearts}}{\text{trials}} \quad \dfrac{13}{52} = \dfrac{26}{\square}$

3\. Solve $\dfrac{\text{hearts}}{\text{trials}} \quad \dfrac{13}{52} = \dfrac{26}{\square} = \text{104 trials}$

Social Studies

The **Big Idea** of *success factors* (discussed in Chapter 1) can be turned into a strategy by having students explicitly identify the impact of those factors upon a given group effort. How was it, for example, that Lewis and Clark succeeded in their mission when other similar (and simpler) expeditions had failed before them?

1. *Motivation:* Lewis wanted desperately to please Jefferson, and Clark, in part, wanted to match the exploits of his older brother, George Rogers Clark, a Revolutionary War hero. Both men had tremendous self-pride.
2. *Leadership:* The expedition was in large part a military one. Both men were experienced Army officers, and the others on the expedition were enlisted men. Clark (and his brothers) were personable and seemed to have natural leadership qualities.
3. *Resources:* Technically, resources for the expedition were limited, but in practice Jefferson was able to procure nearly limitless resources.

4. *Capability:* Lewis, and especially Clark, were in excellent physical shape, and their constitutions withstood incredible challenges from the elements. (Both William Clark and George Rogers had walked for miles through chest-deep water so cold that they had to break up thin layers of ice as they walked, without apparent ill-effects.)

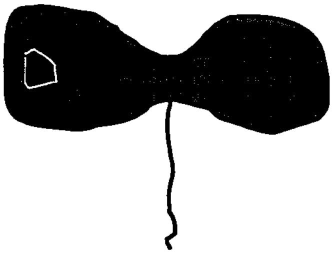
Reading

A decoding strategy for beginning reading would have students follow a series of steps:

1. Begin at the left of the words.
2. Say the sound for the first letter.
3. Without stopping, say the sound for the next letter.
4. When you've said all the sounds, say the word.

Science

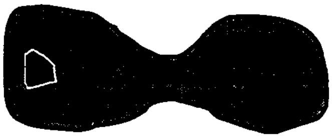
In science, the steps in a strategy for implementing a critical aspect of the scientific method—controlling variables—can be made explicit. Imagine an inquiry activity (taken from a once-popular science curriculum) in which students are shown a figure, given a label for the figure ("mellinark"), and asked to determine which features of the figure define mellinark and which do not.



Mellinark

The steps in the strategy are:

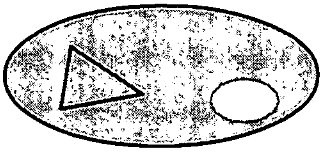
1. Form a hypothesis: For example, a mellinark must have a "tail."
2. Control for the variable identified in the hypothesis: Draw a figure without a tail.



3. Test the hypothesis: Receive information either confirming or denying that the new figure is a mellinark. For instance if the figure without the tail is *not* a mellinark, then in fact, tails of some sort are critical to mellinarks.
4. Repeat steps until all features are exhausted.

EXPLICIT STRATEGIES AND STUDENTS WITH LEARNING DIFFICULTIES

For higher performing students, the difference between **explicit strategies** of "intermediate generality" and no such strategies might be simply one of efficiency. However, **explicit strategies** are not only more efficient for students with learning disabilities, but in many cases, are probably the key to "getting it" at all. Envision, for example, a student trying to do the mellinark task just described without a strategy for controlling variables. Such a child might draw:



If the student is told that this is *not* a mellinark, what knowledge of the critical features of mellinarks has been gained? Such a child might endlessly draw "non-mellinarks," finally giving up in frustration. Scientific inquiry can be daunting to even educated adults, let alone for younger students with learning difficulties.

For students with learning disabilities, **explicit strategies** particularly help to provide cognitive access often preempted by slow learning rate, language deficits, attention disorders, and memory deficits.

3

Scaffolding

In its most general sense, **scaffolding** is help or guidance given to students as they acquire new knowledge. As such, it may be the most intuitive of the six guidelines discussed in this book, particularly with respect to students with learning difficulties. The benefits of **scaffolding** may be most apparent with children learning new physical tasks. Parents at a playground, for example, use numerous examples of **scaffolding** as their young children learn a new activity, such as going down a slide: Parents will help the child climb the ladder; catch the child at the bottom, perhaps sliding with the child a few times; or set the child just part of the way up the slide.

Cognitive **scaffolding** is similar. First, the goal is for students to "get it," just as the parents' goal is for their children to enjoy success on the playground equipment. The role of the **scaffolding**, however, is to eliminate many problems along the way to getting it: falling off the slide, not understanding or remembering something, or developing a dislike for the activity. Finally, the **scaffolding** is *temporary*. Few parents would insist upon providing help their children do not need. Students acquiring knowledge should become as self-regulated and independent as possible, as quickly as possible. To accomplish this, **scaffolding** is gradually removed.

EXAMPLES

In this chapter, rather than providing one example each for different content areas, as was done in earlier chapters, three major categories of **scaffolding** are described and illustrated.

Teacher-Mediated Scaffolding

Teachers can guide students through the steps of applying strategies, thus ensuring that each step is well-understood. The steps for a **scaffolded** volume strategy involving a cone 5" tall with a radius of 1.6" might take a form like this:

Teacher	Student
Write a formula for the volume of the figure	$B \bullet {}^{1}/_{3} \bullet h$
Calculate the area of the base	$3.14(1.6)^2 = 8.04$
Calculate the volume	$8.04 \bullet 13 \bullet 5 = 13.4$
Write the answer with units	13.4 cubic inches

As part of teacher-mediated **scaffolding**, teachers should check the work of students at each step so that errors or confusion in earlier steps do not compound in later steps.

Materials-Mediated Scaffolding

In Chapter 2, we outlined these **explicit strategies** for planning to write:

General Strategy for Any Text Structure

- Who will be my audience?
- What is my goal?
- What are all the things I already know about this topic?
- What are some possible ways to group my ideas?

Planning Specifically to Write an Explanation

- What am I explaining?
- What will the reader need (if anything)?
- Is there any special setting for this? If so, what?
- What are the steps, in order?
- Am I using good connecting words between steps?

In order to support students as they work toward mastering this relatively crucial and complex stage of the writing process, the strategy can be incorporated into instructional materials. Figure 1 illustrates a "think sheet" derived from the strategy for writing any text structure, and Figure 2 illustrates another think sheet derived from the strategy for specifically writing an explanation.

In textbooks, such as a history text, **scaffolding** can take the form of frequent questions interspersed throughout passages. Such questions help students to focus on the most critical aspects of a passage. The following example is taken from a middle-school history text:

Name of Writer ______________________ Date ______________

Topic ____

Who will be my audience? ____________________________

What is my goal? _________________________________

What are all the things I already know about the topic?

What are some possible ways to group my ideas?

Figure 1. Prewriting Think Sheet

What am I explaining? ______________________________

What will the reader need (if anything)? Is there any special setting for this?

If so, ... ______________________________

____

What can I tell readers at the beginning to get them interested?

____

____

What are the steps, in order?

1. ______________________________

2. ______________________________

3. ______________________________

4. ______________________________

5. ______________________________

6. ______________________________

First Next Then After Second Third Finally

Figure 2. Organization Think Sheet for Planning to Write an Explanation

An economic problem involves difficulty in getting and keeping items that people need or want.

- *What is an economic problem?*

At a basic level, people need three things: (a) food to eat, (b) shelter to keep them dry and out of the weather, and (c) clothing to keep them warm. People require these three basic items to live. For centuries, people have found ways to meet these basic needs.

- *What three basic things must people have to live?*

Peer-Mediated Scaffolding

Various forms of collaborative work among students are in widespread use. In the case of such peer-mediated **scaffolding**, the guidance comes not from teachers or materials but from other students. For example, students might work together in a cooperative learning group to write an explanation. During planning, if one student cannot think of a good answer for one of the strategy questions, another student can try.

On a cautionary note, peer-mediated **scaffolding** should not be overused or abused. One potential abuse is allowing students to instruct one another *initially*. That practice can easily result in the dissemination of misinformation, poor communication of crucial strategies, and frustration for students with learning difficulties. Also, peer-mediated **scaffolding** can be seductive: Students may appear to be doing so well in the group setting that it does not get systematically removed, as **scaffolding** should be, thus creating a dependence among some students upon group support.

SCAFFOLDING AND STUDENTS WITH LEARNING DIFFICULTIES

While all students are likely to benefit from **scaffolding**, students with learning disabilities are likely to benefit from *more* **scaffolding** than their higher performing peers. For students with learning disabilities, **scaffolding** particularly helps to provide cognitive access often preempted by attention disorders and memory deficits.

4

Integrated Information

Integrated curricula are currently popular. However, the term ***integration*** is somewhat ambiguous as the following analogy helps to illustrate. Most people are familiar with the elementary chemistry concept about materials being combined (or **integrated**) to form either mixtures or new compounds. In mixtures, materials retain their original properties while in compounds, properties change and something new emerges.

There is no particular advantage to mixing knowledge for the simple sake of mixing. In fact, there may be some inefficiency in doing so because students may try to make connections among the "mixed knowledge" that do not exist. In contrast, however, there is tremendous potential benefit in "compounding knowledge": **integrating** aspects of knowledge for which there are important interrelationships. In that case, new, more complete knowledge structures result. And in addition, many potentially confusing concepts can be preempted or corrected through the careful **integration** of knowledge. Meaningful **integration**, then, can be defined as relationships among knowledge that result in new or more complete knowledge.

AN EXTENDED EXAMPLE

The concept of meaningful integration might best be illustrated with an extended, detailed example. Chapter 2 detailed **explicit strategies** based upon **Big Ideas** and the potential for getting more knowledge from less instruction. We pointed out that the **Big Idea** of proportions has a wide-ranging applicability beyond proportions themselves—rate, measurement equivalencies, percent, probability, the coordinate system, and functions—and illustrated that application with both rate and probability. As typified by that example, strategies based upon **Big Ideas** have great potential for meaningful **integration**. Instructional materials, of course, must take advantage of that potential by demonstrating for students the full applicability of a given strategy.

Arguably, the most important benefit of **integration** is the prevention or correction of misconceptions. Misconceptions most frequently manifest themselves as confusion over similar concepts, principles, or strategies. Such confusion is notorious in mathematics although it occurs in other content areas as well. For instance, one can predict with great assurance that some students will confuse adding fractions with multiplying fractions, given that these processes are infrequently **integrated** in instructional materials.

It is especially crucial for students with learning disabilities that instructional materials anticipate and "design against" predictable confusion. **Integration** is the principal means for doing that. For example, Problem A is a straightforward proportion problem that can be solved by applying the mapping strategy outlined in the **explicit strategies** chapter.

Problem A: A truck delivers cartons of juice to a store. $^2/_7$ of the juice is grape. The truck has 8,400 cartons of juice. How many are grape juice?

a.	Map	$\frac{\text{grape}}{\text{total}}$				
b.	Insert	$\frac{\text{grape}}{\text{total}}$	$\frac{2}{7}$	=	$\frac{\square}{8400}$	
c.	Solve	$\frac{\text{grape}}{\text{total}}$	$\frac{2}{7}$	=	$\frac{2400}{8400}$	= 2400 grape cartons

Problem B appears to be quite similar to Problem A, but there is a crucial difference: There are *three* elements in Problem B (total juice, apple juice, grape juice) instead of the two elements in Problem A (total juice and grape juice).

Problem B: A truck delivers cartons of grape and apple juice to a store. $^2/_7$ of the juice is grape. The truck will deliver 8,400 cartons of apple juice. How many cartons of grape juice will the truck deliver?

If an instructional program did not anticipate the confusion some students might have over the highly similar types of problems, then those students would likely apply the basic-proportions mapping strategy that worked for Problem A and get a wrong answer for Problem B. To prevent such confusion, instructional materials should explicitly teach advanced-mapping strategies (for problems such as Problem B) and explicitly integrate the basic and advanced strategies so that students learn when to apply each. Figure 3 illustrates such an advanced-mapping strategy for solving more complex proportions problems, such as Problem B.

As with the basic-proportions mapping strategy, this more advanced strategy can be applied to a variety of problem situations. Figure 4 is a map for the application of the strategy to a discount problem.

Step 1:

The students map three units, not just two, and insert the relevant information.

	Ratio	*Juice Cartons*
Grape	2	☐
Apple	☐	8400
Total	7	☐

Step 2:

The students use their knowledge of missing addends to come up with the unknown value in the ratio column.

$7 - 2 = \boxed{5}$

	Ratio	*Juice Cartons*
Grape	2	☐
Apple	$\boxed{5}$	8400
Total	7	☐

Step 3:

The students write and solve the proportion to determine the number of cartons of grape juice.

$$\frac{2}{5} = \frac{\boxed{3360}}{8400}$$

	Ratio	*Juice Cartons*
Grape	2	$\boxed{3360}$
Apple	$\boxed{5}$	8400
Total	7	☐

Figure 3. Advanced Mapping Strategy for Solving Complex Problems

Problem: A shirt was on sale. The discount was $2. The sale price was $18. What percent was the discount?

	Dollars	*Percent*
Sale Price	18	☐
Discount	2	☐
Original Price	☐	100

Figure 4. Applying the Mapping Strategy to a Discount Problem

OTHER CONTENT AREAS

Writing

As students advance in their schooling, demands are placed upon them for writing more complex than a basic explanation, argument, or story. Students need to learn to **integrate** different text structures to produce more mature, complex writing. It probably goes without saying that, in addition, students need many opportunities to **integrate** composition knowledge with knowledge of writing mechanics, toward the goal of producing complete text.

Reading

Prereading activities, such as phonemic awareness and alphabetic recognition, must be **integrated** to be of any use as students initially learn to decode words. And as is the case with writing, decoding and comprehension instruction needs to be frequently **integrated**.

History

In Chapter 1, we outlined four factors that historically explain group successes (and failures): (a) motivation, (b) leadership, (c) resources, and (d) capability. Another **Big Idea** of history is that problems arise, solutions are proposed and implemented, and certain effects result: hopefully, an intended solution to the problem but, frequently, new and often unanticipated problems. By **integrating** the **Big Ideas** of problem-solution-effect and group-success factors, students can systematically analyze historical events for deep understanding.

For example, the colonies-turned-states tried to cooperate with one another voluntarily following the Revolutionary War. However, states taxed one another for interstate commerce, thus limiting trade. Also, the states could not cooperate with one another sufficiently to raise a peacetime navy, needed for protecting shipping activities, and they could not raise taxes for other purposes, such as paying off the war debt.

To solve such problems, wealthy landowners, called Federalists, proposed adopting a strong central constitution that would govern all the states. That solution, however, would have effects that other new Americans did not want to see: powers of the states superseded by the powers of a central government. The factors of group success largely explain why the Federalists won out against the anti-Federalists in the battle to form a central United States government.

Science

Also discussed in Chapter 1, convection is a **Big Idea** in science instruction. But in addition to the many dynamic phenomena that occur in the solid earth (geology), convection also plays an important role in the atmosphere (meteorology) and the ocean (oceanography). Unless the connections among those diverse areas of science are made explicit in instructional materials, however, many students are unlikely to develop a deep understanding of any of those areas.

INTEGRATION AND STUDENTS WITH LEARNING DIFFICULTIES

Integration benefits all students, in that it is a major key to achieving a depth of understanding within a content area. Also, to the extent that **integration** is a principal means for preventing or correcting stubborn but predictable misconceptions, students with learning difficulties are likely to especially benefit. For students with learning difficulties, **integration** particularly helps to provide cognitive access often preempted by attention disorders.

5

Background Knowledge

As discussed earlier, students with learning difficulties frequently enter new instructional situations with a dearth of relevant **background knowledge**. Desirable or necessary **background knowledge** might take the form of general knowledge of the world or more specific academic knowledge assumed by new instruction. For example, students might have difficulty understanding a reading passage related to harvesting wheat if they have no general knowledge of farms and farming. Similarly, students can have a hard time understanding a new strategy if that strategy assumes students have mastered some specific prior academic knowledge.

Instructional materials can acknowledge the importance of **background knowledge** in two ways. First, students can be pretested for important **background knowledge**. Such tests can be used to determine placement within an instructional program or to alert teachers to the need for allocating time to background topics. It is often useful to assess the **background knowledge** of students with learning difficulties using formats other than reading and writing because these students frequently have difficulties with such formats. They may have understanding that they are unable to express through reading and writing.

Second, instructional programs can include important **background knowledge** in the scope of topics taught. Ideally, such background topics would be taught or reviewed a few days before the introduction of new strategies that depend upon those topics. If background topics are introduced earlier than that, students may forget some relevant aspects by the time the new strategy is introduced. If background topics are introduced in the same lesson as the new strategy, some students are likely to become overwhelmed by the quantity of new knowledge.

Clearly, the concept of **integrated knowledge** discussed in the last chapter is closely related to essential **background knowledge**. The focus on integrated knowledge, however, emphasized increasing the *depth of understanding* of important concepts. Here, the focus is on the prerequisites for learning important concepts so that they might later be integrated meaningfully.

CONTENT EXAMPLES

History

Lack of **background knowledge** impedes comprehension of textual material in history. Imagine, for example, the difficulties some students might have in understanding the following primary source passage.

> The Indians never hurt anything, but the White people destroy all.
> They blast rocks and scatter them on the ground. The rock says,
> "Don't. You are hurting me." But the White people pay no attention …
> how can the spirit of the earth like the White man? … Everywhere the
> White man has touched, it is sore"
> (McLuhan, 1971, p. 15).

This passage could strike many students as light and fanciful if they did not possess **background knowledge** on Native Americans, their cultures, and their beliefs prior to colonization. Almost all tribes of American Indians were accommodating of their environment: When they acted "correctly," the earth provided them with abundant natural resources. Before mountain men began trading guns to some tribes, most tribes accommodated one another because they were unwilling to lose lives as a means of solving problems. In contrast, European pioneers brought to the New World their beliefs of dominating both the environment and other peoples.

Writing

Any strategy to help students with composition is likely to include important **background knowledge**. Consider the following strategy for writing short essays, developed by Graham and Harris (1989):

1. *Think* who will read this and why I am writing it.
2. *Plan* what you will say, using the TREE mnemonic
   (Topic sentence, Reasons, Examine reasons, and Ending).
3. *Write* and say more.

This strategy assumes **background knowledge** of a "topic sentence," which traditionally is a difficult concept for many students, both in reading and writing. If students lack understanding of a topic sentence (or other components of the strategy), then the overall effectiveness of the strategy could very well be diminished.

Mathematics

Problem solving nearly always assumes a relatively broad range of **background knowledge**. Consider this problem:

> At lunch, each student can choose a carton of white or chocolate milk.
> Each fifth-grade class is to estimate how many cartons of chocolate
> and white milk should be ordered for the entire school.

In addition to computational ability and the ability to read with comprehension, students must have well-developed knowledge for data gathering, proportions, and probability to solve this problem.

Reading

Both phonemic awareness and understanding of alphabetic/sound relationships have been shown as prerequisite to beginning decoding success. If students are to successfully sound out a word such as "stop," for instance, they must know generally that the letters in the word correspond to sounds and, more specifically, the most usual sounds for the particular letters in "stop." In addition, they must be able to blend isolated phonemes into complete words. Research has shown both that beginning decoding instruction is the most effective when students have such **background knowledge** and that the **background knowledge** itself is of limited value when not incorporated into explicit decoding instruction.

Science

If students are to understand the basic concept of convection, for example, and to eventually apply it to a broad range of scientific phenomena, they must first understand density; the effect of heat on density; and the interaction of pressure, heat, and density. Science texts frequently introduce new concepts based upon the assumption that students have adequate **background knowledge**, but with little or no **review** of essential **background knowledge** prior to the introduction of the new concept.

BACKGROUND KNOWLEDGE AND STUDENTS WITH LEARNING DIFFICULTIES

Background knowledge is essential for all students, regardless of performance level. Students with learning difficulties, however, are the ones most likely to lack essential **background knowledge** or to forget such knowledge over time. It should be noted that deficits in essential **background knowledge** is very idiosyncratic. A given child might lack only a "small amount" of **background knowledge** and yet that lack could have far-reaching consequences.

Assume, for example, that a student does not know how to set up a simple verbal problem in mathematics. She might lack that knowledge because of one of the characteristics of students with learning difficulties, such as memory deficits or attention disorders.

On the other hand, maybe the girl has no identifiable characteristic but nonetheless did not master the strategy for simple problems. She might have been absent during a few crucial days, or her attention might have wandered during instruction on the strategy (even though she normally has no troubles attending to instruction). Perhaps no strategy for solving the simple problems was ever taught explicitly, and this girl just happened to infer an erroneous strategy. Maybe a good strategy was taught explicitly but without adequate **scaffolding** for this girl.

Whatever the case, the outcome will be similar: The strategy for solving simple verbal problems is essential **background knowledge** for subsequent—and more complex—verbal mathematics problems, and the girl will undoubtedly have difficulty solving the more complex problems, regardless of the reasons that led to her lack of mastery of the simpler problem-solving strategy.

Thus, the importance of assessing for **background knowledge** and for teaching unknown but essential **background knowledge** is self-evident, even when the causes of difficulties vary considerably. In addition, this hypothetical example illustrates the importance of the interactions among the several features of instruction discussed in this book.

For students with learning difficulties, **background knowledge** particularly helps to provide cognitive access often preempted by language deficits, attention disorders, memory deficits, and a lack of prior knowledge.

6

Review

Research has consistently shown that there are four characteristics of effective **review**. **Review** should be (a) adequate, (b) distributed, (c) cumulative, and (d) varied. It is worth noting, however, that the overall contribution of **review** to knowledge and understanding is no doubt dependent upon the quality of what is being reviewed. That is, if "small" or marginal ideas are taught in the first place, then the best that might be expected from the implementation of effective **review** characteristics is mastery of small ideas.

Each of these four characteristics suggests something different about the way instructional materials can be designed to best facilitate learning.

ADEQUATE REVIEW

This is perhaps the most intuitive aspect of **review**. Some students need more **review** than others to achieve fluency and long-term retention. Just how much **review** is "adequate"? If instructional materials are field-tested before they are widely disseminated, then the developers should be able to build in enough **review** to meet fluency and retention goals for nearly all students. But in the final analysis, teachers must decide how much **review** is adequate for individual learners.

DISTRIBUTED REVIEW

Adequate **review** refers to the sheer amount of **review** provided. *Distributed* **review** refers to *when* that **review** is provided. Few aspects of instruction have been as well researched as distributed practice. The consistent conclusion of the research studies is that practice should be initially massed and thereafter distributed.

An effective distribution schedule for **review** is some version of an increasing ratio **review**. "Increasing ratio" refers to gradually greater periods of "nonreview" between **review** sessions. For example, when a new **Big Idea** is introduced, students might apply the new knowledge daily for a few days, then just every other day, then every third day for a while, then every fifth day, and only occasionally thereafter. Such a schedule "stretches" retention.

Note that on an increasing ratio schedule of distributed practice, students need only a small amount of practice during each **review** session. By distributing **review**, less total **review** is adequate than if most of the **review** were massed. This principle is in sharp contrast to some traditional practices. For example, in a traditional "unit" on solving verbal proportions problems in mathematics, students might apply strategies to 20 or 40 such problems, all within the time span of one week. It might then be weeks or even months before students see another such problem. The principle of massed and distributed practice suggests that students should work a few such problems initially (five to seven, for instance), then a couple more for the next 2 or 3 days, and finally, perhaps just one or two every fourth or fifth day for a few weeks. The total number of applications, over several weeks, might be only 16 to 25. Not only are fewer items necessary but a higher level of fluency is usually achieved by working on those well-distributed but fewer items.

Finally, distributed **review** sessions provide natural, built-in assessment, from which teachers may determine that more or less subsequent instruction is needed. Distributed **review**, therefore, reduces the need to wait for some sort of formal assessment as a means of evaluating student needs.

CUMULATIVE REVIEW

As the label implies, *cumulative* **review** is **review** that *accumulates*. That is, *all* important knowledge, not just recently introduced material, is reviewed throughout the school year. The greatest advantage of cumulative **review** is that it helps prevent or remediate common confusion.

The problems that many students experience within a content area are usually the result of confusion over similar but different facts, concepts, principles, or strategies. For example, many mathematics students confuse the addition and multiplication of fractions. Both types of problems appear similar but, of course, are conceptually quite different. Science students often confuse the concepts of mass, volume, and density, resulting in misconceptions such as, "bigger objects float and smaller objects sink." Beginning readers confuse the letters "b" and "d." Beginning (and sometimes, advanced) writers confuse "its" and "it's."

As discussed in the chapter on **integrated information,** instruction can help prevent or correct such misconceptions by integrating them during initial instruction. That strategy has proven effective for preventing many misconceptions in science. Cumulative **review** is an effective follow-up to integration for preventing or correcting misconceptions. Assume, for instance, that students are learning how to multiply fractions. During initial instruction, a program might put what seems to be unusual emphasis upon the process of multiplication and the multiplication sign, in anticipation of later instruction on adding fractions. But after adding fractions has been introduced and mastered fairly well, it is important to integrate *both* multiplying and adding fractions. Then they can be cumulatively reviewed within the same review session.

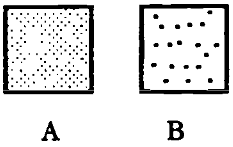
Such mixing is crucial for understanding. Perhaps even more compelling, though, is that in the real world of mathematics, all the mathematics knowledge a person possesses is mixed and cumulative. In order for knowledge to accumulate, review should be cumulative.

VARIED REVIEW

A major goal of instruction is the generalization or transference of learning. It is impossible to show the entire range of possible applications of knowledge when students are first acquiring that knowledge. Therefore, varied review, combined with distributed and cumulative review, is a major means for accomplishing transference.

A criticism of much instruction is that it is contrived and decontextualized: not authentic or real-world. The criticism is frequently valid. One response to that criticism, however, is to attempt to make the initial instruction on new strategies as authentic as possible. Theoretically, that serves the goal of transference. However, new knowledge is often very difficult to acquire when it is initially applied to a broad range of contexts. Therefore, the goal of transference may become inadvertently subverted.

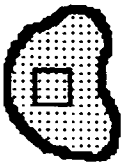
Varied review offers a powerful alternative for achieving transference. At first, students learn to apply a new strategy to decontextualized, possibly contrived tasks. For example, the first step in teaching students to understand density could be to have them compare the masses of substances when they are mixed, as below.



Which substance is more dense?
Which substance will sink?

Two same-sized cubes with differing numbers of dots can be used to teach this step. A dot can represent one gram of mass. In this case, more dots inside a cube (i.e., greater mass) means greater density.

Next, students can learn to identify equivalent volumes of substances of unequal sizes and predict which will sink when the substances are mixed.



A

B

Which substance is more dense?
Which substance will sink?

Figures of different sizes can be shown with empty cubes placed over segments of equal size, directly confronting the misconception that more mass means greater density. By looking at the number of dots in the equal-sized cubes, students can tell that substance B is more dense than substance A, although substance B is smaller in volume. Students are then able to compare the density of a series of substances like those in the second task, where the size and number of dots varies.

These contrived tasks serve to clearly communicate a deep but decontextualized understanding of mass and volume, which provides the foundation for subsequent, varied activities with actual substances in a naturalistic context. In conjunction with appropriate measurement skills, students have the basis to predict which substance will sink when the substances come together.

Show students equal quantities of water and oil. Ask them to hold each container and predict which liquid will sink. After the prediction, pour the liquids together.

As related concepts are subsequently introduced, such as the effect of heat on density, **review** becomes increasingly varied and natural. Thus, the goal of transference to realistic contexts is uniformly achieved.

REVIEW AND STUDENTS WITH LEARNING DIFFICULTIES

The different categories of effective **review** apply differently to students of varying performance levels. For example, some students with learning difficulties are likely to need more **review** than other students *on some occasions.* That is, the amount of **review** that will prove to be *adequate* might be greater for some students with learning difficulties, for some topics. However, all students benefit equally from distributed **review**, cumulative **review**, and, especially, varied **review**, in that varied **review** is so crucial to understanding. For students with learning difficulties, **review** particularly helps to provide cognitive access often preempted by memory deficits, attention disorders, and automaticity.

Summary

Students with learning difficulties vary among one another considerably, in terms of the characteristics they display, the possible causes of those characteristics, and the depth of those characteristics. A student might have severe memory difficulties within some aspects of some content area and no such difficulties in other contexts. Another student might generally have difficulties remembering almost everything. And the combinations of learner characteristics are uncountable.

What, then, are teachers to do as they seek to accommodate so much performance diversity, whether in a pull-out program or within the context of general education classes? The characteristics of instruction outlined in this book have shown themselves to be effective in the face of widespread variability among students—effective not only for students with learning difficulties but for students without disabilities as well. To put it another way, we have focused primarily upon the factor over which teachers have the greatest control: the instruction they deliver.

Finally, we have focused not only on *effective* instruction but also on *efficient* instruction. There are two reasons for this. First, students who are "behind" their peers need efficient instruction if they are ever to catch up. Moreover, the instructional time available to teachers seems to be at an ever-increasing premium. Instructional materials, we believe, should accommodate this reality by providing teachers with all the major tools necessary for effectively addressing the needs of widely varying student-performance levels. Without such tools, teachers are faced with the daunting task of creating such tools themselves, which is not only inefficient but, in most cases, impractical as well.

References

Ashcraft, M. (1985). Is it farfetched that some of us remember our arithmetic facts? *Journal for Research in Mathematics Education, 16*(2), 99-105.

Bauer, R. H. (1987). Control processes as a way of understanding, diagnosing, and remediating learning disabilities. *Advances in Learning and Behavioral Disabilities, Suppl., 2,* 41-81.

Bransford, J., Sherwood, R., Vye, N., & Rieser, J. (1986, October). Teaching, thinking and problem solving. *American Psychologist,* 1078-1089.

Bryan, T., Bay, M., Shelden, C., & Simon, J. (1990). Teachers' and at-risk students' simulated recall of instruction. *Exceptionality, 1,* 167-179.

Cawley, J. F., Fitzmaurice, A. M., Shaw, R. A., Kahn, H, & Bates III, H. (1978). Mathematics and learning disabled youth: The upper grade levels. *Learning Disability Quarterly, 1*(Fall), 37-52.

Cooper, D. H., & Farran, D. C. (1988). Behavioral risk factors in kindergarten. *Early Childhood Quarterly, 3,* 1-19.

Dempster, F. N. (1991, April). Synthesis of research on reviews and tests. *Educational Leadership, 48,* 71-76.

Deshler, D. D., & Schumaker, J. B. (1986). Learning strategies: An instructional alternative for low-achieving adolescents. *Exceptional Children, 52,* 583-590.

Donahue, M. (1987). *Interactions between linguistic and pragmatic development in learning disabled children: Three views of the state of the union.* In S. Rosenberg (Ed.), Advances in applied psycholinguistics (Vol. 1, pp. 126-179). Cambridge: Cambridge University Press.

Dunlap, W. P., & Strope, G. J. (1982). Reading mathematics: Review of literature. *Focus on Learning Problems in Mathematics, 4,* 39-50.

Graham, S., & Harris, K. R. (1989). A components analysis of cognitive strategy instruction: Effects on learning disabled students' compositions and self-efficacy. *Journal of Educational Psychology, 81,* 356-361.

Hallahan, D. R., & Reeve, R. E. (1980). Selective attention and distractibility. In B. K. Keogh (Ed.), *Advances in special education* (Vol. 1, pp. 141-181). Greenwich, CT: J.A.I. Press.

Kolligian, J., & Sternberg, R. J. (1987). Intelligence, information processing, and specific learning disabilities: A triarchic synthesis. *Journal of Learning Disabilities, 20*(1), 8-17.

Koppitz, E. M. (1971). *Children with learning disabilities: A five-year follow-up study.* New York: Grune & Stratton.

Krupski, A. (1985). Variations in attention as function of classroom task demands in learning handicapped and CA-matched nonhandicapped children. *Exceptional Children, 52*, 52-56.

Levy, W., & Shenck, S. (1981). The interactive effect of arithmetic and various reading formats upon the verbal problem solving performance of learning disabled children. *Focus on Learning Problems in Mathematics, 3,* 5-10.

Loper, A. B., Hallahan, D. P., & Ianna, S. O. (1982). Meta-attention in learning disabled and normal children. *Learning Disability Quarterly, 5,* 29-36.

Marston, D., & Magnusson, D. (1985). Implementing curriculum based measurement in special and regular education settings. *Exceptional Children, 52*, 266-276.

McLuhan, T. C. (1976). *Touch the earch: A self-portrait of Indian existence.* Touchstone Books.

McKinney, J. D. (1989). Longitudinal research on the behavioral characteristics of children with learning disabilities. *Journal of Learning Disabilities, 22*(3), 266-276.

Miller, P. H. (1985). Metacognition and attention. In D. L. Forrest-Pressley, G. E. MacKinnon, & T. G. Waller (Eds.), *Metacognition, cognition and human performance* (Vol. 2, pp. 181-218). New York: Academic Press.

Dempster, F. N. (1991, April). Synthesis of research on reviews and tests. *Educational Leadership, 48,* 71-76.

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for mathematics.* Reston, VA: National Council of Teachers of Mathematics.

O'Shea, L. J., & Vacante, G. (1986). A comparison over time of relative discrepancy of low achievers. *Exceptional Children, 53,* 253-259.

Palinscar, A. M., & Brown, A. L. (1986). The reciprocal teaching of comprehension-fostering and comprehension-monitoring activities. *Cognition and Instruction, 1*(2), 117-175.

Pellegrino, J. W., & Goldman, S. R. (1987). Information processing and elementary mathematics. *Journal of Learning Disabilities, 20*(1), 23-32.

Samuels, S. J. (1986). Why children fail to learn and what to do about it. *Exceptional Children, 53,* 7-16.

Samuels, S. J., & Miller, N. L. (1985). Failure to find attention differences between learning disabled and normal children on classroom and laboratory tasks. *Exceptional Children, 51,* 358-375.

Schumaker, J., Deshler, D., Alley, G., Warner, M., & Denton, P. (1984). Multipass: A learning strategy for improving reading comprehension. *Learning Disability Quarterly, 5*(2), 295-304.

Smiley, S. S., Oaken, D. D., Worthen, D., Campione, J. D., & Brown, A. L. (1977). Recall of thematically relevant material by adolescent good and poor readers as a function of written versus oral presentation. *Journal of Educational Psychology, 69*(4), 381-387.

Snef, G. M. (1971). An information-integration theory and its application to normal reading acquisition and reading disability. In N. D. Bryand & C. E. Kass (Eds.), *Leadership training institute in learning disabilities: Final report* (Vol. 2, pp. 305-391). Tucson, AZ: University of Arizona.

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. *Journal of Learning Disabilities, 21,* 590-604.

Swanson, H. L. (1988). Memory subtypes in learning disabled readers. *Learning Disabilities Quarterly, 11,* 342-357.

Swing, S., & Peterson, P. (1988). Elaborative and integrative thought processes in mathematics learning. *Journal of Educational Psychology, 80*(1), 54-66.

Synder, V. E., & Tarver, S. G. (1987). The effects of early reading failure on acquisition of knowledge among students with learning disabilities. *Journal of Learning Disabilities, 10*(6), 351-356.

Tarver, S. G., Hallahan, D. P., Kaufman, J. M., & Ball, D. W. (1976). Verbal rehearsal and selective attention in children with learning disabilities: A developmental lag. *Journal of Experimental Psychology, 22*(4), 375-385.

Torguson, J., & Goldman, T. (1977). Verbal rehearsal and short-term memory in reading-disabled children. *Child Development, 48,* 56-60.

Torguson, J., & Kail, R. V. (1980). *Memory processes in exceptional children. Advances in special education* (Vol. 1). Greenwich, CT: JAI.

Torguson, J., Murphy, H. A., & Ivey, C. (1979). The influence of an orienting task on the memory performance of children with reading problems. *Journal of Learning Disabilities, 12*(6), 396-401.

Trafton, P. R. (1984). Toward more effective, efficient instruction in mathematics. *The Elementary School Journal, 84*(5), 514-530.

Wagner, R., & Torgensen, J. (1987). The nature of phonological processing and its causal role in the acquisition of reading skills. *Psychological Bulletin, 101,* 192-212.

Wong, B. Y. L. (1978). The effects of directive cures on the organization of memory and recall in good and poor readers. *Journal of Educational Research, 72*(1), 32-38.

Wong, B. Y. L. (1985). Metacognition and learning disabilities. In D. L. Forrest-Pressely, G. E. MacKinnon, & T. G. Waller (Eds.), *Metacognition, cognition and human performance* (Vol. 2, pp. 137-175). New York: Academic Press.

Vellutino, F. R. (1987). Dyslexia. *Scientific American, 256*(3), 34-41.

Selected Bibliography

The following summations of the six tools described in this book are followed by suggested readings that either amplify or underpin the concepts used to establish these tools.

1. BIG IDEAS

The concept of **Big Ideas** is not actually supported by direct empirical evidence. Rather, it is a theoretical notion widely discussed in recent educational literature, a notion supported by considerable common sense. The alternative to teaching **Big Ideas** is to teach ideas that are "small" in some sense: of marginal importance for understanding a content area, of little value for knowledge transference, and the like. Small ideas render less learning for more teaching; **Big Ideas** render more learning for less teaching.

Ehri, L. C. (1991). Development of the ability to read words. In R. Barr, M. L. Kamil, P. B. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 383-417). New York: Longman.

Englert, C. S., Raphael, T., Anderson, L., Anthony, H., Stevens, D., & Fear, K. (1991). Making writing strategies and self-talk visible: Cognitive strategy instruction in writing in regular and special education classrooms. *American Educational Research Journal, 28,* 337-372.

Graham, S., & Harris, K. R. (1989). A components analysis of cognitive strategy instruction: Effects on learning disabled students' compositions and self-efficacy. *Journal of Educational Psychology, 81,* 356-361.

Herum Cummings

Hillocks, G. (1984, November). What works in teaching composition: A meta-analysis of experimental treatment studies. *American Journal of Education, 93,* 133-170.

Juel, C. (1988). Beginning reading. In R. Barr, M. L. Kamil, P. B. Mosenthal, & P. D. Pearson (Eds.), *Handbook of reading research* (Vol. 2, pp. 759-788). New York: Longman.

Kuhn, D. (1993). Science as argument: Implications for teaching and learning scientific thinking. *Science Education, 77*(3), 319-337.

Meyer, B. F. J., & Freedle, R. O. (1984). Effects of discourse type on recall. *American Education Research Journal, 21,* 122-144.

National Council of Teachers of Mathematics Commission on Standards for School Mathematics. (1989). *Curriculum and evaluation standards for mathematics.* Reston, VA: National Council of Teachers of Mathematics.

Perkins, D. N., & Simmons, R. (1988). Patterns of misunderstanding: An integrative model for science, math, and programming. *Review of Educational Research, 58*(3), 303-326.

Porter, A. (1989). A curriculum out of balance: The case of elementary school mathematics. *Educational Researcher, 18*(5), 9-15.

Stanovich, K. E. (1986). Matthew effects in reading: Some consequences of individual differences in the acquisition of literacy. *Reading Research Quarterly, 21,* 360-407.

Vellutino, F. R. (1991). Introduction to three studies on reading acquisition: Convergent findings on theoretical foundations of code-oriented versus whole-language approaches to reading instruction. *Journal of Educational Psychology, 83,* 437-443.

Wagner, R., & Torgesen, J. (1987). Phonological coding, phonological awareness, and reading ability: Evidence from a longitudinal and experimental study. *Merrill-Palmer Quarterly, 33,* 321-363.

2. EXPLICIT STRATEGIES

Research in this area generally examines explicit-versus-inquiry (discovery) teaching methods. One can usually find a study within this research base to support just about any belief. This may be due in large part to the fact that "explicit instruction" and "discovery instruction" are not single variables but are more like clusters of variables. Also, many studies in this area are poorly designed. Finally, the underlying assumption of many empirical studies on explicit and inquiry instruction is that only one approach can be appropriate, to the exclusion of the other.

When studies of explicit and inquiry instruction are well designed, with experimental and control groups robustly pursuing the same objectives, the following conclusions generally hold:

1. *Initial* teaching is more effective when it is explicit or conspicuous.
2. *Initial* teaching is more *efficient*, even when not particularly more effective—an important finding with respect to students who are faced with "catching up" with their peers.
3. Strategies for learning complex problem solving are learned more effectively and efficiently when they are presented conspicuously to learners.
4. Students with learning disabilities almost always benefit from explicit instruction.
5. All students benefit from inquiry instruction—particularly affectively—when it is based upon well-established strategic knowledge.

Adams, M. (1990). *Beginning to read: Thinking and learning about print.* Cambridge, MA: MIT Press.

Armbruster, B. (1984). The problem of "inconsiderate text." In G. G. Duffy, L. R. Roehler, & J. Mason (Eds.), *Comprehension instruction* (pp. 202-217). New York: Longman.

Armbruster, B., Anderson, T. H., & Ostertag, J. (1987). Does text structure/summarization instruction facilitate learning from expository text? *Reading Research Quarterly, 22,* 331-346.

Ball, E. W., & Blackman, B. A. (1991). Does phoneme awareness training in kindergarten make a difference in early word recognition and developmental spelling? *Reading Research Quarterly, 24,* 49-66.

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic awareness and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology, 81,* 313-321.

Carnine, D. W., & Stein, M. (1981). Organizational strategies and practice procedures for teaching basic facts. *Journal for Research in Mathematics Education, 12*(1), 65-69.

Charles, R. I. (1980). Exemplification and characterization moves in the classroom teaching of geometry concepts. *Journal for Research in Mathematics Education, 11*(1), 10-21.

Cunningham, A. E. (1990). Explicit versus implicit instruction in phonemic awareness. *Journal of Experimental Child Psychology, 50,* 429-444.

Darch, C., Carnine, D. C., & Gersten, R. (1989). Explicit instruction in mathematics problem solving. *Journal of Educational Research,* 77(6), 351-358.

Englert, C. S., Raphael, T., Anderson, L., Anthony, H., Stevens, D., & Fear, K. (1991). Making writing strategies and self-talk visible: Cognitive strategy instruction in writing in regular and special education classrooms. *American Educational Research Journal, 28,* 337-372.

Felton, R. H. (1993). Effects of instruction on the decoding skills of children with phonological-processing problems. *Journal of Learning Disabilities, 26,* 583-589.

Fielding, G. D., Kameenui, E., & Gersten, R. (1983). A comparison of an inquiry and a direct instruction approach to teaching legal concepts and applications to secondary school students. *Journal of Educational Research, 76*(5), 287-293.

Fisher, C. W., Berliner, D. C., Fibly, N. N., Marliave, R., Cahen, I. S., & Dishaw, M. M. (1980). Teaching behaviors, academic learning time, and student achievement: An overview. In C. Denham & A. Lieverman (Eds.), *Time to learn.* Washington, DC: National Institute of Education.

Fuson, K. C. (1986). Teaching children to subtract by counting up. *Journal for Research in Mathematics Education, 17,* 172-189.

Gleason, M, Carnine, D., & Boriero, D. (1990). Improving CAI effectiveness with attention to instructional design in teaching story problems to mildly handicapped students. *Journal of Special Education Technology, 10*(3), 129-136.

Grayson, H. W., & McHugh, D. O. (1977). A comparison of two methods of column addition for pupils at three grade levels. *Journal for Research in Mathematics Education, 8*(5), 376-378.

Grossen, B., & Carnine, D. (1990). Review of empirical evaluations of interventions for teaching logical and analogical reasoning. *Learning Disability Quarterly, 13*(3), 168-182.

Guzzetti, B. J. (1990). Effects of textual and instructional manipulations on concept acquisition. *Reading Psychology, 11*, 49-62.

Guzzetti, B., Snyder, T. E., Glass, G. V., & Gamas, W. S. (1993). Promoting conceptual change in science: A comparative meta-analysis of instructional interventions from reading education and science education. *Reading Research Quarterly, 28*(2), 116-159.

Kameenui, E. J., Carnine, D. W., Darch, C. B., & Stein, M. (1986). Two approaches to the development phase of mathematics instruction. *The Elementary School Journal, 86*(5), 633-650.

Kantor, R. N., Anderson, T. H., & Armbruster, B. B. (1983). How inconsiderate are children's textbooks? *Journal of Curriculum Studies, 15*, 6-72.

Kirby, J. R., & Becker, L. D. (1988) Cognitive components of learning problems in arithmetic. *Remedial and Special Education, 9*(5), 7-16.

Leinhardt, G. (1987). Development of an expert explanation: An analysis of a sequence of subtraction lessons. *Cognition and Instruction, 4*(4), 225-282.

Liberman, I. Y., Shankweiler, D., Camp, L., Blachman, B., & Werfelman, M. (1986). Steps toward literacy. In P. Levinson & C. Sloan (Eds.), *Auditory processing and language: Clinical and research perspectives* (pp. 189-215). New York: Grune & Stratton.

Marcucci, R. B. (1980). *Meta-analysis of research on methods of teaching mathematical problem solving.* Unpublished doctoral dissertation, University of Iowa.

Mayer, R. E. (1989). Models for understanding. *Review of Educational Research, 59*(1), 43-64.

Mayer, R. E., & Gallini, J. (in press). When is a picture worth a thousand words? *Journal of Educational Psychology.*

McDaniel, M. A., & Schlager, M. S. (1990). Discovery learning and transfer of problem-solving skills. *Cognition and Instruction, 7*(2), 129-159.

Muthukrishna, A., Carnine, D., Grossen, B., & Miller, S. (1993). Children's alternate frameworks: Should they be directly addressed in science instruction? *Journal of Research in Science Teaching, 30*(3), 233-248.

Niedelman, M. (1992). Problem solving and transfer. In D. Carnine & E. Kameenui (Eds.), *Higher order thinking: Designing curriculum for mainstreamed students* (pp. 137-156). Austin, TX: Pro-Ed.

Pellegrino, J. W., & Goldman, S. R. (1987). Information processing and elementary mathematics. *Journal of Learning Disabilities, 20*(1), 23-32.

Prawat, R. S. (1989). Promoting access to knowledge, strategy, and disposition in students: A research synthesis. *Review of Educational Research, 59*(1), 1-41.

Pressley, M., Symons, S., Snyder, B. B., & Cariglia-Bull, T. (1989). Strategy instruction research comes of age. *Learning Disability Quarterly, 12*, 16-31.

Resnick, L. B., Cauzinille-Marmeche, E., & Mathier, J. (1987). Understanding Algebra. In J. A. Sloboda & D. Rogers (Eds.), *Cognitive processes in mathematics* (pp. 169-203). Oxford, England: Clarendon Press.

Resnick, L. B., & Omanson, S. F. (1987). Learning to understand arithmetic. In R. Glaser (Ed.), *Advances In instructional psychology* (pp. 41-95). Hillsdale, NJ: Erlbaum.

Ross, J. A. (1988). Controlling variables: A meta-analysis of training studies. *Review of Educational Research, 58*(40), 405-437.

Rubin, R., & Norman, J. (1992). Systematic modeling versus the learning cycle: Comparative effects on integrated science process skill achievement. *Journal of Research in Science Teaching, 29*(7), 715-727.

Smith, E., Blakeslee, T., & Anderson, C. (1993). Teaching strategies associated with conceptual change learning in science. *Journal of Research in Science Teaching, 30*(2), 111-126.

Swing, S., & Peterson, P. (1988). Elaborative and integrative thought processes in mathematics learning. *Journal of Educational Psychology, 80*(1), 54-66.

Woodward, J. (in press). Effects of curriculum discourse style on eighth graders' recall and problem solving in earth science. *Elementary School Journal.*

Yates, G. C., & Yates, S. (1990). Teacher effectiveness research: Towards describing user-friendly classroom instruction. *Educational Psychology, 10*(3), 225-238.

3. SCAFFOLDING

The empirical research base for scaffolded instruction is nearly unequivocal: Scaffolded instruction is more effective than unscaffolded instruction. Very generally, **scaffolding** can be defined as procedures designed to assist students as they apply newly acquired knowledge.

Outside school settings, **scaffolding** is a "natural" instructional device, employed almost universally by loving parents as they informally teach their children. Parents tend to give their children all the help they need, on the one hand, but no more help than they need on the other. This phenomenon is most obvious in reference to physical activities, such as learning how to use a slide at a playground. Few parents will allow their children to attempt potentially dangerous activities without support, and few will insist on providing that support after their children clearly no longer need it.

Bereiter, C., & Scardamalia, M. (1982). From conversation to composition: The role of instruction in a developmental process. In R. Glaser (Ed.), *Advances in instructional psychology* (Vol. 2, pp. 1-64). Hilldsale, NJ: Lawrence Erlbaum Associates.

Cooper, G., & Sweller, J. (1987) Effects of schema acquisition and rule automation on mathematical problem-solving transfer. *Journal of Educational Psychology, 79*(4), 347-362.

Englert, C. S., Raphael, T., Anderson, L., Anthony, H., Stevens, D., & Fear, K. (1991). Making writing strategies and self-talk visible: Cognitive strategy instruction in writing in regular and special education classrooms. *American Educational Research Journal, 28*, 337-372.

Graham, S., & Harris, K. R. (1989). A components analysis of cognitive strategy instruction: Effects on learning disabled students' compositions and self-efficacy. *Journal of Educational Psychology, 81*, 356-361.

Paine, S. C., Carnine, D. W., White, W. A. T., & Walters, G. (1982). Effects of fading teacher presentation structure (covertization) on acquisition and maintenance of arithmetic problem-solving skills. *Education and Treatment of Children, 5*(2), 93-107.

Pressley, M., Harris, K. R., & Marks, M. B. (1992). But good strategy instructors are constructivists! *Educational Psychology Review, 4*(1), 3-31.

Pressley, M., Symons, S., Snyder, B. B., & Cariglia-Bull, T. (1989). Strategy instruction research comes of age. *Learning Disability Quarterly, 12,* 16-31.

Resnick, L. (1988). Treating mathematics as an ill-structured discipline. In R. I Charles & E. A. Silver (Eds.), *The teaching and assessing of mathematical problem solving.* Hillsdale, NJ/Reston, VA: Erlbaum and National Council of Teachers of Mathematics.

Swing, S., & Peterson, P. (1988). Elaborative and integrative thought processes in mathematics learning. *Journal of Educational Psychology, 80*(1), 54-66.

4. INTEGRATED INFORMATION

Knowledge in isolation—strategic knowledge or otherwise—is of limited value to the learner. The research support for strategic **integration** of knowledge is strong but indirect in that few studies have focused upon **integration** per se. Rather, studies in support of **integration** tend to examine the effects of combining one category of knowledge with another, such as phonemic awareness in reading with letter-sound correspondence knowledge.

Bransford, J., Sherwood, R., Vye, N., & Rieser, J. (1986, October). Teaching, thinking and problem solving. *American Psychologist,* 1078-1089.

Byrne, B., & Fielding-Barnsley, R. (1989). Phonemic awareness and letter knowledge in the child's acquisition of the alphabetic principle. *Journal of Educational Psychology, 81,* 313-321.

Haskell, D. W. , Foorman, B. R., & Swank, P. R. (1992). Effects of three orthographic/phonological units on first-grade reading. *Remedial and Special Education, 13,* 40-49.

Lenz, B. K., & Alley, G. R. (1983). *The effects of advance organizers on the learning and retention of learning disabled adolescents within the context of a cooperative planning model.* Final research report submitted to the U.S. Department of Education, Office of Special Education, Washington, DC.

Nickerson, R. S. (1985). Understanding. *American Journal of Education, 93,* 201-239.

Piaget, J. (1973). *The child and reality: Problems of genetic psychology.* New York: Viking Press.

Prawat, R. S. (1989). Promoting access to knowledge, strategy, and disposition in students: A research synthesis. *Review of Educational Research, 59*(1), 1-41.

Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia: A review. *Reading Research Quarterly, 27,* 29-53.

Raphael, T., & Englert, C. S. (1990, February). Writing and reading: Partners in constructing meaning. *The Reading Teacher,* 388-400.

Snowling, M. J. (1991). Development reading disorders. *Journal of Child Psychology Psychiatry, 32,* 49-77.

Van Patten, J., Chao, C., & Reigeluth, C. M. (1986). A review of strategies for sequencing and synthesizing instruction. *Review of Educational Research, 56*(4), 437-471.

5. BACKGROUND KNOWLEDGE

Research across content areas supports the rather common-sense notion that the extent of students' **background knowledge** influences the extent to which they acquire new knowledge. Some **background knowledge** is general "knowledge of the world." Much is specific knowledge required for understanding new concepts, principles, and strategies. Students with learning disabilities are generally weak in both. Instructional materials may compensate for these deficits by providing crucial **background knowledge** for those who need it.

Ashcraft, M. (1985). Is it farfetched that some of us remember our arithmetic facts? *Journal for Research in Mathematics Education, 16*(2), 99-105.

Barron, B., Bransford, J., Kulewicz, S., & Hasselbring, T. (1989). *Uses of macrocontexts to facilitate mathematical thinking.* Paper presented at the Annual Meeting of American Educational Research Association, San Francisco, CA.

Behr, M. J., Wachsmuth, I., Post, T. R., & Lesh, R. (1984). Order and equivalence of rational numbers: A clinical teaching experiment. *Journal for Research in Mathematics Education, 15*(5), 323-341.

Carnine, D. (1980). Preteaching versus concurrent teaching of the component skills of a multiplication algorithm. *Journal for Research in Mathematics Education, 11*(5), 375-378.

Cooper, G., & Sweller, J. (1987). Effects of schema acquisition and rule automation on mathematical problem-solving transfer. *Journal of Educational Psychology, 79*(4), 347-362.

Kameenui, E. J., & Carnine, D. W. (1986). Preteaching versus concurrent teaching of component skills of a subtraction algorithm to skill-deficient second graders: A components analysis of direct instruction. *The Exceptional Child, 33*(2), 103-115.

Leinhardt, G., Zaslavsky, O., & Stein, M. K. (1990). Functions, graphs, and graphing: Tasks, learning, and teaching. *Review of Educational Research, 60*(1), 1-64.

Lenz, B. K., & Alley, G. R. (1983). *The effects of advance organizers on the learning and retention of learning disabled adolescents within the context of a cooperative planning model.* Final research report submitted to the U.S. Department of Education, Office of Special Education, Washington, DC.

McKeown, M. G., Beck, I. L., Sinatra, G. M., & Loxterman, A. (1991). The contribution of prior knowledge and coherent text to comprehension. *Reading Research Quarterly, 27*(40), 78-93.

Pellegrino, J. W., & Goldman, S. R. (1987). Information processing and elementary mathematics. *Journal of Learning Disabilities, 20*(1), 23-32.

6. REVIEW

Review may be one of the most studied of all instructional variables, with serious investigations beginning in the 1920s. The results are unequivocal: **Review** should be (a) adequate, (b) distributed, (c) cumulative, and (d) varied.

The major research support for this contention comes from a recent review:

Dempster, F. N. (1991, April). Synthesis of research on reviews and tests. *Educational Leadership, 48,* 71-76.

Other Research

Covington, M. V., & Crutchfield, R. S. (1965). Facilitation of creative problem solving. *Programmed Instruction, 4,* 3-5, 10.

Felton, R. H. (1993). Effects of instruction on the decoding skills of children with phonological-processing problems. *Journal of Learning Disabilities, 26,* 583-589.

Gick, M. L., & Holyoak, K. (1980). Analogical problem solving. *Cognitive Psychology, 12,* 306-355.

Kayser, J. E., Billingsley, F. F., & Neel, R. S. (1986). A comparison of in-context and traditional instructional approaches: Total task, single trial versus backward chaining, multiple trials. *Journal of the Association of the Severely Handicapped, 11*(1), 28-38.

Kirby, J. R., & Becker, L. D. (1988). Cognitive components of learning problems in arithmetic. *Remedial and Special Education, 9*(5), 7-16.

Mulligan, M., Lacey, L., & Guess, D. (1982). Effects of massed, distributed, and spaced trial sequencing on severely handicapped students' performance. *Journal of the Association for the Severely Handicapped, 7,* 48-61.

Olton, R. M., & Crutchfield, R. S. (1969). Developing the skills of productive thinking. In P. Mussen, J. Langer, & M. Covington (Eds.), *Trends and issues in developmental psychology* (pp. 68-91). New York: Holt, Rinehart and Winston.

Pellegrino, J. W., & Goldman, S. R. (1987). Information processing and elementary mathematics. *Journal of Learning Disabilities, 20*(1), 23-32.

Resnick, L. (1989). Developing mathematical knowledge. *American Psychologist, 44*(2), 162-169.

Schmidt, R., & Bork, T. (1992). New conceptualizations of practice: Common principles in three paradigms suggest new concepts for training. *Psychological Science, 3*(4), 207-217.

Trafton, P. R. (1984). Toward more effective, efficient instruction in mathematics. *The Elementary School Journal, 84*(5), 514-530.

Wardrop, J. L., Goodwin, W. L., Klausmeier, R. M., Olton, M. W., Covington, R. S., Crutchfield, R. S., & Ronday, T. (1969). The development of productive thinking skills in fifth grade children. *Journal of Experimental Education, 37,* 67-77.