ADI NEWS

VOLUME 9, NUMBER 3 THE ASSOCIATION FOR DIRECT INSTRUCTION SPRING, 1990

Plan Now for the Eugene DI Conference

August 5–9, 1991

The **Direct Instruction News** is published Fall, Winter, Spring and Summer, and is distributed by mail to members of the Association for Direct Instruction. Membership and subscription information may be found on page 41 of this newsletter. Readers are invited to submit articles for publication relating to DI. Send contributions to: The Association for Direct Instruction, P.O. Box 10252, Eugene, Oregon, 97440.

Beyond Technique—*Direct Instruction and Higher-Order Skills*

by Doug Carnine,
University of Oregon

"Goals are easy to describe. What matters more is a strategy for reaching them." Stanley Hoffmann
C. Douglas Dillon Professor at Harvard University.

In the early 1900s, the challenge of integrating thinking and content area knowledge was formidable even for elite education (Resnick, 1987). The challenge is much greater now. "Although it is not new to include thinking, problem solving, and reasoning in *someone's* school curriculum, it is new to include it in *everyone's* curriculum" (Resnick, p. 7).

One aspect of higher-order skills , as Prawat (1989) pointed out in a superb review of the current findings from cognitive psychology, has to do with the organization of knowledge to show connections (Polya, 1973; Flavell, 1971; Bruner, 1960). "The ability to access knowledge varies dramatically as a function of how well linked the knowledge is" (Prawat, 1989, p. 4). One major problem Prawat noted is helping students acquire linked knowledge, for example in mathematics: " 'Rarely, if ever,' von Glaserfeld adds, 'is there a hint, let alone an indication, of what one must do in order to build up the conceptual structures that are to be associated with the symbols.' "(p. 6).

Approaches designed to respond to the needs of students who require such hints (direct instruction, mastery learning, active teaching, Madeline Hunter's program, and so forth) emphasize teaching techniques, not how content is organized to show important relationships. When the content is not organized to show connections, effective teaching techniques would be hard pressed to foster higher-order thinking, particularly with lower performing students. The issue then is not merely whether effective teaching techniques are used, but how the content to be taught is organized.

The Direct Instruction Model at the University of Oregon has endeavored to deal with both effective teaching techniques (Becker, Engelmann, Carnine & Rhine, 1981) and with the organization of content (Engelmann & Carnine, 1982). A program of research has addressed a variety of subject areas that involve higher-order skills:

literary analysis (Dimino, Gersten, Carnine & Blake, in press; Gurney, Gersten, Domino & Carnine, in press);
chemistry (Hofmeister, Engelmann & Carnine, 1989);
earth science (Woodward, 1989);
legal reasoning (Fielding, Kameenui & Gersten, 1983);
problem solving (Woodward, Carnine & Gersten, 1988);
critical reading (Patching, Kameenui, Carnine, Gersten & Colvin, 1983);
ratio and proportions (Moore & Carnine, 1989);
fractions (Kelly, Carnine, Gersten & Grossen, 1986; Kelly, Gersten & Carnine, in press);
word problem analysis (Darch, Carnine & Gersten, 1984);
social studies (Darch & Carnine, 1986; Darch, Carnine & Kameenui, 1986); and
syllogistic reasoning (Collins, Carnine & Gersten, 1987; Collins & Carnine, 1988; Grossen & Carnine, in press).

In every study, the primary objective was to create a model of how to link knowledge. Both the importance and nature of such linkages can best be understood by analyzing a number of examples of creative problem solving. The focus of the analysis is on the mechanism underlying these insights, which is a key in unlocking the puzzle of how to organize content so that it models higher-order thinking.

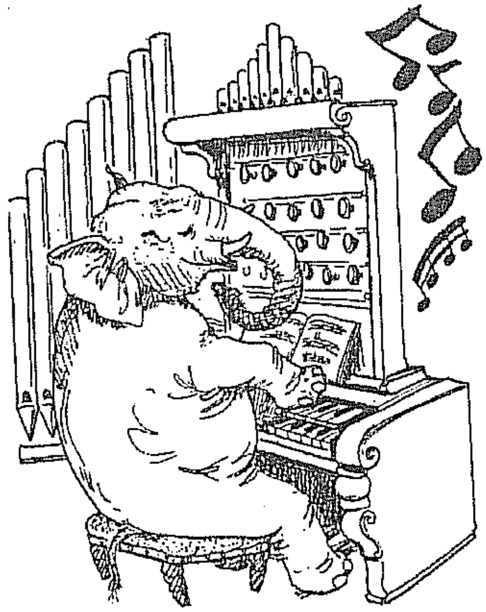
First, Katharine Payne, a biologist, describes her insight in the study of elephant communication.

> Some capacity beyond memory and the five senses seems to inform elephants, silently and from a distance, of the whereabouts and activities of other elephants.
>
> I stumbled on a possible clue to these mysteries during a visit to the Metro Washington Park Zoo in Portland, Oregon, in May, 1984. While observing three Asian elephant mothers and their new calves, I repeatedly noticed a palpable throbbing in the air like distant thunder, yet all around me was silent.
>
> Only later did a thought occur to me: As a young choir girl in Ithaca, New York, I used to stand next to the largest, deepest organ pipe in the church. When the organ blasted out the bass line in a Bach chorale, the whole chapel would throb, just as the elephant room did at the zoo. Suppose the elephants, like the organ pipe, were the source of the throbbing? Suppose elephants communicate with one another by means of calls too low-pitched for human beings to hear? (Payne 1989 p. 266)

For Katherine Payne, the sameness between the sounds of the bass pipes of the organ and the sounds of the elephants' low-frequency vibrations accounted for elephant communication. (See Figure 1.)

The next example finds Elias Howe trying to invent a machine that sewed. He reportedly dreamed he was captured by African natives carrying spears with holes

Figure 1.



in their tips. Upon waking, Howe realized he should put the hole for the thread at the end of the needle, not the middle. The sameness between the location of a hole in a spear tip and a sewing needle–at the end–led to the invention of the sewing machine. (See Figure 2.)

The third example occurred at the turn of the century. A physician vacationing in Egypt was asked to treat a severely stricken boy who'd been bitten by a cobra. When asking how the incident occurred, the physician found that the boy's father had been bitten first, yet lacked the ominous symptoms present in his son. When questioned by the physician, the father said he had been bitten on two previous occasions, with the severity of the symptoms diminishing on each occasion. When he returned to Germany, the physician hypothesized that the same progression of dosages might be relevant to preventing diphtheria, which was ravaging Europe at the time. He began a series of experiments by injecting horses with increasingly potent doses of diphtheria toxins until the horses developed antitoxins against the disease. Then he developed a serum from the horses. The serum led to a vaccine that immunized children against diphtheria. The sameness between the immunity of the father to a cobra bite and of the children to diphtheria— development of serum through progressive doses—made vaccines possible. (See Figure 3.)

The last example reaches back to the early 1400s. Paolo del Pozzo Toscanelli's study of perspective geometry led to the first perspective painting. However, far closer to Toscanelli's heart, and pocketbook, was cartography. Toscanelli's family had been traders in spice for several generations. Because of an impending Turkish occupation of Constantinople, his family would probably be driven out of business. Toscanelli applied perspective geometry to the recently re-discovered system of latitude and longitude coordinates to create a scaled map. The application allowed the Toscanelli ships to sail south of the equator, out of sight of the polar star, and still navigate. An Italian captain convinced the Spanish court to support him in using Toscanelli's map to find a new route to the Spice Islands. Alas, Toscanelli's particular map was fatally flawed because of inaccurate information provided by Marco Polo. So instead, Captain Columbus discovered America. The sameness between perspective geometry in art and in cartography—scaled representation—freed navigators to sail south of the equator. (See Figure 4.)

What do these examples of creative problem solving have in common? Each person noted a sameness between something in his or her experience and a problem the person was intent on solving. These relationships are summarized in Table 1.

Figure 2.

The Sameness Analysis—Teaching Smart

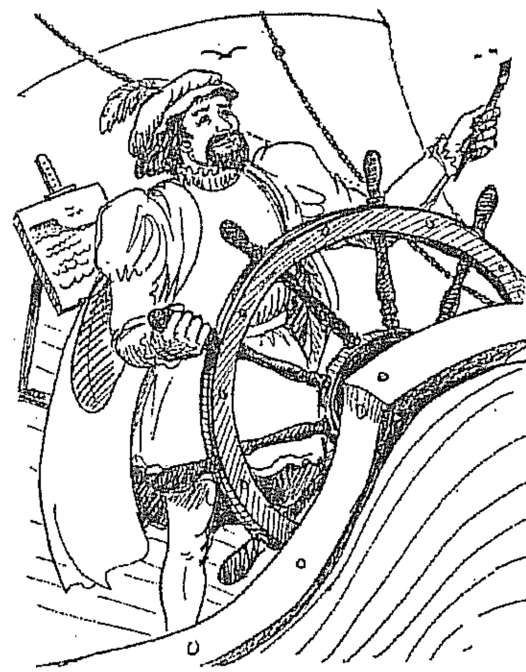
The examples in Table 1 offer a key to building cognitive structures as defined by Flavell (1971):

> The really central and essential meaning of "cognitive structure" ought to be a set of cognitive items that are somehow interrelated to constitute an organized whole or totality; to apply the term "structure" correctly, it appears that there must be, at minimum, an ensemble of two or more elements together with one or more relationships interlinking these elements. (p.443)

The examples suggest that one of the cornerstones of cognitive structures is noting important samenesses. This is not an original observation. Aristotle, several thousand years ago, described two fundamental reasoning processes–logical and analogical. Analogical reasoning, involving noting important sameness, is still acknowledged as the basis for all concept and rule learning (Gagne & Briggs, 1979).

Figure 3.

Figure 4.



In the 1800s, Aristotle's formulations about logical thinking were extended by the philosopher, John Stuart Mill (1844), who developed methods for teaching important samenesses and developed the basic principles for "knowing" in science. In the early 1900s, implications of the sameness analysis for problem solving were articulated by the philosophers Moore (1903) and Ewing (1947). (See Engelmann and Carnine, 1982, for elaboration.)

The noting of samenesses, relied on by problem solvers and prized by philosophers, has also been identified as crucial by neuroscientists such as Nobel

Table 1. The Sameness Between a Person's Experience and a Problem to be Solved.

Problem	Experience	Sameness
1. Understand elephant communication	Vibrations from a Pipe organ.	Low frequency vibrations.
2. Design sewing machine.	Dream about spear tips with a hole near the end.	Put a hole near end of needle.
3. Diphtheria epidemic.	Man who developed immunity from snake bite	Gradually increase dosage.
4. Reach the spice islands via the southern hemisphere.	Perspective in art.	Calibration based on geometric perspective to show distance.

Prize Winner Gerald Edelman, who directs the Neurosciences Institute at the Rockefeller University. The central procedure in Edelman's scheme (1987) of brain functioning is categorization and recategorization–in perception, in recognition, and in memory (Rosenfield, 1988). Categorization and recategorization are viewed as the overriding activity of the brain, serving as the basic mechanism for the various brain functions. The capacity to categorize depends on the learner's ability to note samenesses. This process is often carried out many times in just one minute. Obviously, such a basic process does not always lead to problem-solving insights such as those cited earlier. In fact the process is quite indiscriminate in terms of the samenesses it identifies.

> But neither can one predict what constitutes information for an organism. The brain must try as many combinations of incoming stimuli as possible, and then select those combinations that will help the organism relate to its environment (Rosenfield, 1988, p. 149).

The samenesses that learners select to help them relate to their environment are often not the ones intended by their teachers, and such *misrules* are not restricted to academic study. Consider this counseling example. The mother of twin first grade boys met with the school counselor one evening because the twins were swearing in class. The parent acknowledged that swearing was also a problem at home. The counselor advised the mother to use corporal punishment for the next occurrence and to make sure the other twin was there, so he could learn by observing. The next morning at breakfast, one twin said, "Pass the damn Cheerios." The mother smacked him. The other twin's eyes opened in shock and disbelief. She turned to him and asked, "What would you like for breakfast?" He responded, "I don't know, but you can bet your sweet ass it's not the Cheerios." Now, the second twin had learned a sameness–Cheerios leads to a smack–but not the sameness intended by the mother.

A famous psychiatrist used jokes, such as this one about the Cheerios, to make a point which is very germane to educators: Assume that all phenomena, even laughter following a joke, are lawful. The psychiatrist , Siegmund Freud, in *The Psychopathology of Everyday Life* (1938), gave a lawful account of jokes, explaining their structure and purpose. Interestingly enough, many jokes are humorous because of an unintended sameness, as was the case for the twin who was certain that Cheerios meant trouble. But the educational importance of Freud's point comes in how educators view their students' mistakes. By assuming mistakes are lawful, educators are more likely to seek instructional causes. They will evaluate their teaching to see how they might have unintentionally induced a sameness, in this case a misrule, that caused the mistake. The next section illustrates several common misrules that students inadvertently learn from the elementary grades mathematics curriculum. Remember, there is no way to "make" students learn the sameness a teacher wants to teach.

Unintended Samenesses

As Resnick (1987) noted, "To an important degree, calculation errors derive not from random or careless 'slips,' but from systematically applying incorrect procedures" (p. 13).For problems such as:

$$\begin{array}{r} 24 \\ \underline{+\ 13} \end{array}$$

students learn that they can start with the bottom number or with the top number: 4 + 3 equals 7, and so does 3 + 4. The sameness is that these problems can be worked in either direction, from top to bottom or from the bottom up. Soon thereafter comes subtraction problems, such as:

$$\begin{array}{r} 24 \\ \underline{-\ 13} \end{array}$$

Students can still apply the sameness learned in addition,thinking of the difference between 4 and 3, or 3 and 4. In both cases, they subtract the smaller number from the larger. Later, students encounter:

$$\begin{array}{r} 74 \\ \underline{-\ 15} \end{array}$$

The sameness they apply is that whether they go from the top down, or vice versa, they subtract the smaller number from the larger,

$$\begin{array}{r} 74 \\ \underline{-\ 15} \\ 61 \end{array}$$

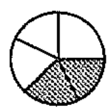
(see Brown and Burton, 1978, for more on subtraction "bugs").

By the time the students learn to borrow, they usually have learned a key word method for analyzing word problems. For the sentence, "There are 26 sheep *and* 10 goats on a ship," students would add. Three-quarters of 97 second graders did so, even though the following question was asked: "How old was the captain?" Another key word, *left*, signifying subtraction, resulted in many students subtracting in a work problem calling for addition, primarily because the problem began, "Mr. Left ... (cited in Prawat, 1989).

Some students analyze word problems according to the nature of the numbers in the problems, rather than key words. A fifth-grade girl summarized her samenesses for analyzing word problems in this way:

> If there are lots of numbers, I add. If there are only 2 numbers with lots of parts, I subtract. But if there are just 2 numbers, and one is a little harder than the other, then it is a hard problem, so I divide if they come out even, but if they don't, I multiply.

The final example involves basic fraction analysis. Typically, a textbook's first introduction of fractions restricts the examples to fractions equal to or less than one, e.g.,$\frac{1}{4}, \frac{2}{4}, \frac{3}{4}, \frac{4}{4}, \frac{1}{3}, \frac{2}{3}, \frac{3}{3}$, and so forth. In the textbook for the next grade level, mixed numbers are introduced, but the fractional part is still less than one: $2\frac{1}{4}$, $2\frac{3}{4}$, $3\frac{1}{3}$, and so forth. Thus, for two years, students learn this sameness about fractions–they are part of one whole. What happens in the third year, when the students encounter a fraction such as $\frac{5}{2}$? Students apply their sameness: $\frac{5}{2}$ must be part of a whole and interpret it is $\frac{2}{5}$ths:



These misrules from elementary grade mathematics can be difficult to appreciate, because the desired "samenesses" are all familiar to adults. To help you better understand the problem, look for the sameness that will make sense out of *damon*, another elementary grade mathematics concept.

I'll start with a **damon** and add **damon** Now tell me the new **damon**:

My turn: 9 and we add 1. What's the new **damon**? 10.

My turn again: 10 and we add 2. What's the new damon? 12.

3 and we add 4. What's the new **damon**? 7

3 and we add 6. What's the new **damon**? 9

Your turn: 4 and we add 11. What's the new damon?

Your turn again: 9 and we add 7. What's the new damon?

Did you answer 15 and 16? If so, you learned an obvious sameness, but your answers are still wrong. The correct answers are 3 and 4. The purpose of this exercise is to engender empathy for low-achieving students who encounter such confusion and frustration many times each day. We'll return to **damon** later.

Inducing Intended Samenesses

The previous examples illustrate how students often learn unintended samenesses. However, recognition of the brain's search for samenesses does more than explain student misconceptions. It can also guide the development of curricular materials that model higher-order thinking.

Geometry. Consider geometry, where students learn equations, first for surface area and later for volume of various figures. Students are typically expected to learn seven equations to calculate the volume of three-dimensional figures (see Table 2). The sameness analysis reduces the number of equations students must learn from seven to slight variations of a single equation; area of the base times the height (Bxh). Of course, students would be expected to know the equations for the area of common two dimensional figures, referred to as area of the base, B, in Table 2. For the regular figures–rectangular prism (box), wedge, cylinder—the equation is Bxh. For figures that come to a point (pyramid with a rectangular base, pyramid with a triangular base, and a cone), the volume is 1/3 Bxh. The sphere, in a sense, comes to two "points;" thus the volume is 2 times 1/3 Bxh or 2/3 Bxb, where B is the area of a circle that passes through the center of the sphere, and the height is the diameter. The *sameness analysis* makes explicit the relationships that are obscured by the seven different equations typically presented in textbooks. Presenting simple variations of Bxh in graphic form (see Figure 5) makes remembering the equations easier and calculating volume more comprehensible. Such "relational learning" is also more lasting and accessible (Skemp, 1978).

Table 2. Seven Equations for Volumes Can be Reduced to one with Qualifications.

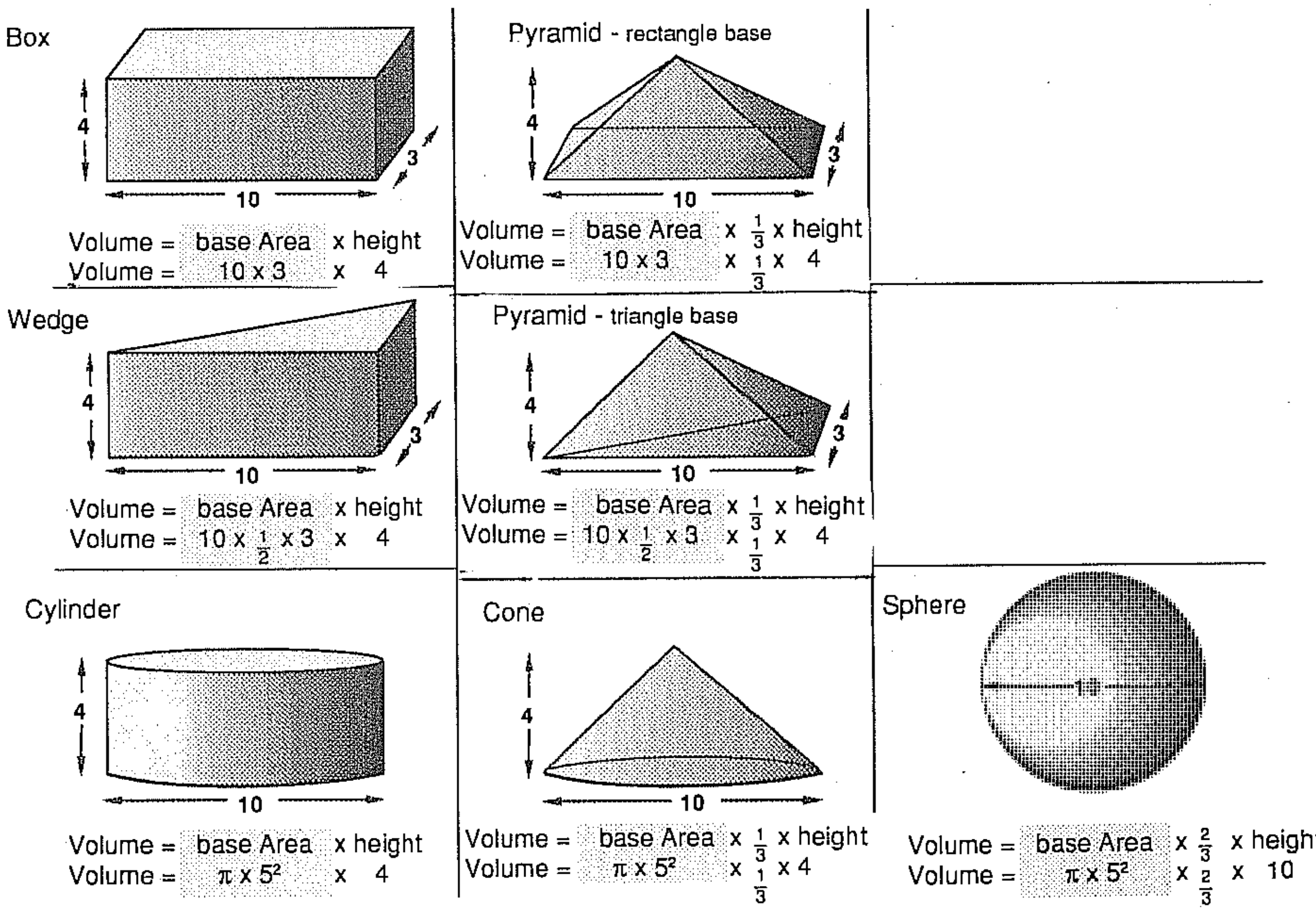
	Box	Wedge	Cylinder
Sameness Analysis	B x h	B x h	B x h
Conventional	L x w x h	$\frac{1}{2}$ L x w x h	$\pi r^2 h$

	Pyramid: Rectangular	Pyramid: Triangular	Cone	Sphere
Sameness Analysis	$\frac{1}{3}$ B x h	$\frac{1}{3}$ B x h	$\frac{1}{3}$ B x h	$\frac{2}{3}$ B x h
Conventional	$\frac{1}{3}$ L x w x h	$\frac{1}{6}$ L x w x h	$\frac{1}{3} \pi r^2 h$	$\frac{4}{3} \pi r^3$

The purpose of learning important samenesses is particularly crucial in science and social science where students are inundated with a great number of seemingly unrelated facts and concepts. By one estimate, *students would need to learn, on the average, a new biology concept every two minutes to cover the content of a high school biology textbook.* A typical biology textbook introduces twice as many new concepts as the American Foreign Language Association recommends introducing new terms that are merely new labels for familiar concepts.

Figure 5. Volumes of 3-Dimensional Figures

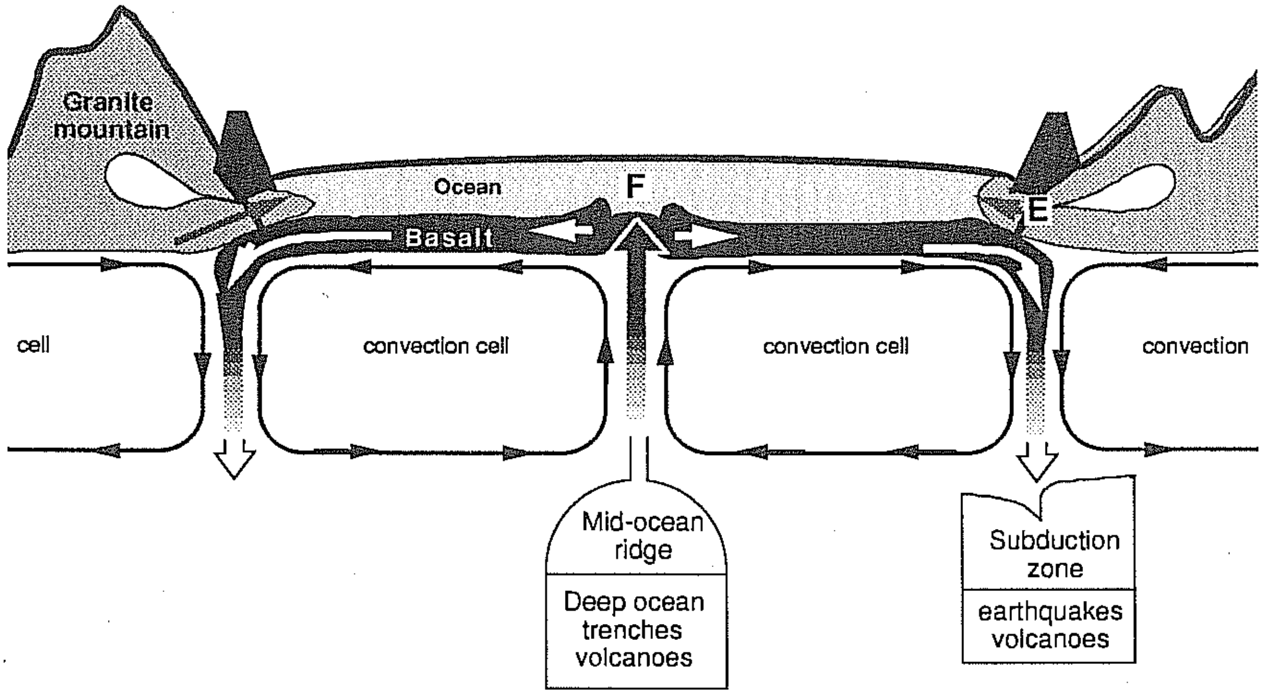
Volume is the number of cubic units.



Earth Science. One way of reducing misconceptions about the nature of science is to apply the sameness analysis to identify the underlying principles of a discipline (Hofmeister, Engelmann and Carnine, 1989). For example, earth science covers a wide variety of phenomena about the solid earth, oceans and atmosphere. Yet textbooks do not emphasize the underlying principle of convection, which explains large scale ocean currents, air currents, vulcanism, and many other phenomena. These phenomena are the same in that they are caused, at least in part, by convection. Figure 6 for example, graphically depicts convection cells in the solid earth and how they account for plate tectonics, which in turn can explain the formation of granite mountains, volcanoes, earthquakes, mid-ocean trenches, and so forth. Figure 6 illustrates how the crust of the earth actually rides on top of the convection cells. At point E in Figure 6, the convection cells push the crusts together at a subduction zone, where the ocean crust goes under the continental crust, causing earthquakes, rift valleys, and volcanoes. At point F in Figure 6, the ocean crust is pulled apart by two convection cells, causing deep ocean trenches and volcanoes. The unifying principle of convection reveals a fundamental sameness of many phenomena, not only in the solid earth, but also in the atmosphere and the oceans.

The preceding examples from geometry and earth science demonstrate how the sameness analysis, presented as conceptual models (Mayer, 1989), can turn fragmented knowledge into a coherent, elegant whole. The sameness analysis in curriculum design thus serves as a model of one of the primary goals of higher-order thinking. As the physicist Zee (1986) said, "When I was learning about such things as Hooke's law in high school, I got the impression that physicists try to find as many laws as possible, to explain every single

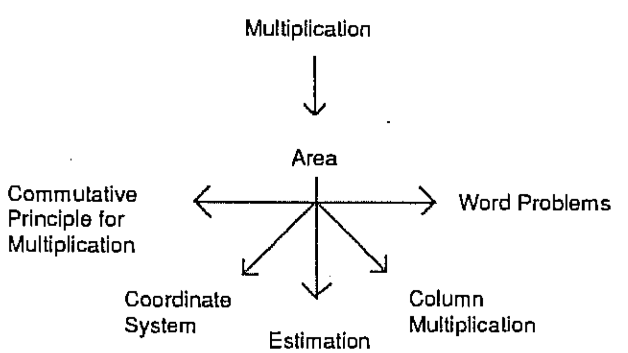
Figure 6. Convection Cells in the Earth



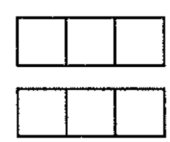
phenomenon observed in the physical world. In fact, my colleagues and I in fundamental physics are working toward having as few laws as possible. The ambition of fundamental physics is to replace the multitude of phenomenological laws with a single fundamental law, so as to arrive at a unified description of Nature" (p. 7).

Multiplication. The final example of the sameness analysis will illustrate how a single concept can be used to introduce many new concepts. Low performing students often don't spontaneously see the sameness that connects mathematics' concepts. An example is the student who told his teacher he couldn't remember whether to add or subtract the numbers he wrote after multiplying 25 x 14. This student doesn't understand the relationships among place value, multiplication and addition. The discussion that follows illustrates how the concept of area can be used as a sameness to introduce a wide range of topics (see Figure 7 for a list of these topics). As Bruner (1960) noted, "The basic ideas that lie at the heart of all science and mathematics and the basic themes that give form to life and literature are as simple as they are powerful" (p. 12).

Figure 7. Concepts Developed by Building from the Familiar to the Unfamiliar

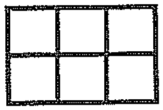


At the top of Figure 7 is multiplication, which is based on counting. For example to introduce 3 x 2, students create or are shown two rows of blocks, each with three blocks.



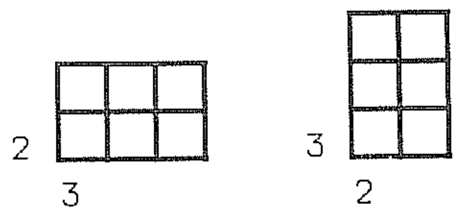
The teacher says, "I can figure out how many blocks by counting a fast way. There are 3 blocks in each row, so I count by 3 for each row: 3, 6. Let's see if the fast way works. You count the blocks one at a time: 1, 2, 3, 4, 5, 6." Students then write multiplication equations, such as 3 x 2 = 6. Later they work from pictures of columns or blocks and eventually work symbolic problems without pictorial representations.

Next, the columns of blocks are joined and the concept of *area* is introduced. Rather than two separate rows of blocks, students see this figure:



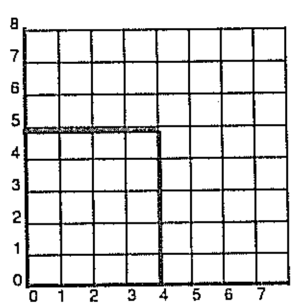
Students are told that they can use multiplication to figure out how many squares are in the figure. Three squares in each row and two rows, or 3 x 2. The *area* of the figure is six square units.

The bridge to the *commutative principle for multiplication,* which is important in teaching multiplication facts, occurs in this way. Students are shown



and are told that the figures have the same area; the second figure is just turned up on its end so the 2 is on the bottom. The students write a statement for each figure; 3 x 2 = 6 and 2 x 3 = 6. Both figures have the same number of squares and therefore the same area. The figures illustrate that the answers for 3 x 2 and 2 x 3 are the same. Subsequently, when students learn the answer to 6 x 8, for example, they realize they also know the answer for 8 x 6.

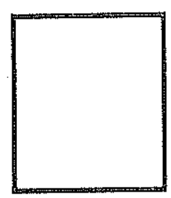
The *coordinate system* provides reference numbers for any point on a 2-dimensional grid. When one corner of a rectangle is placed at the origin of a 2-dimensional grid (0,0), the opposite corner of the rectangle is represented by the coordinates for that point. For example, the corner of a 4 x 6 rectangle has coordinates of x = 4 and y = 6.



Students are simply told that the coordinate system gives a code for drawing rectangles. The students start at a point called the origin, which is zero. The code for how wide to make a rectangle is the number given for the letter x. The code for how high to make a rectangle is the number given for the letter y. The students work from values for x and y to identify the far corner of the rectangle. From that point, they draw the sides of the rectangle, and calculate its area.

Estimation is often difficult for students because they don't have the frame of reference for "guessing intelligently," a prerequisite for checking the reasonableness for their answers. Introducing estimation in the context of area provides a good demonstration of how to guess intelligently. In the introductory estimation exercises, students use a ruler to draw a side of a rectangle (e.g., 4 inches wide). The students draw the next side (e.g., 5 inches) without the ruler. They use the 4-inch line as a basis for estimating the length when drawing the 5-inch side. The frame of reference for estimation comes into play because the 5-inch side they make without the ruler is slightly longer than the 4-inch side. The students can visually check the reasonableness of their answer. They can see if the rectangle they drew is a little taller than it is wide. They then multiply to calculate the area.

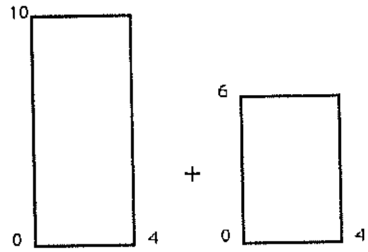
Another estimation activity provides both dimensions for one rectangle, but just the dimensions for a second rectangle:



4 x 6 3 x 7

The students use estimation to draw a second rectangle that is supposed to be 3 inches wide and 7 inches high. In this exercise, the basis for estimation is the original rectangle. The new rectangle should be a little narrower, but a little higher, than the original rectangle. Again students can visually check the reasonableness of their answer. In both estimation exercises, students are learning a new skill, estimation, in the content of a familiar skill, area.

Area can also be used to introduce *column multiplication.* In introductory exercises, students are shown how to calculate the total area for two figures that both have the same width (e.g. 4' x 10' & 4' x 6').



Students figure out the area for each rectangle by constructing simple multiplication facts. They then add to find the total area, 40 + 24 or 64.

$$\begin{array}{r} 10 \\ \underline{\times 4} \\ 40 \end{array} \qquad \begin{array}{r} 6 \\ \underline{\times 4} \\ 24 \end{array}$$

Next column multiplication is introduced as a short cut for figuring the area of any two rectangles with a side the same length. The students write the width, e.g., 4, just one time. Initially the heights for the two rectangles—10 for the first and 6 for the second—are written as an added number (10 + 6):

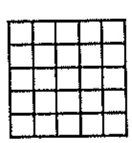
$$\begin{array}{r} (10+6) \\ \underline{\times \quad 4} \\ 24 \\ \underline{+ \quad 40} \end{array}$$

The students first multiply 4 x 6, then 4 x 10. Next, the students are shown that the 10 + 6 can be written as 16; the problem, though, is still worked by multiplying 4 x 6 and 4 x 10, then adding the products:

$$\begin{array}{r} 16 \\ \underline{\times \quad 4} \\ 24 \\ \underline{+ \ 40} \\ 64 \end{array}$$

At this point students are working column multiplication problems.

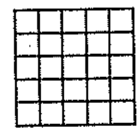
A final skill that can be integrated into students' prior knowledge of area is solving multiplication and division *word problems*. At first, word problems are introduced in exercises in which students work with blocks or a coordinate system grid:



An early word problem might tell about squares on a grid (or blocks) e.g., below is a typical problem:

> A rectangle has two squares in each row. There are eight squares in all. How many rows of squares does the rectangle have?

The students draw a line under two squares on the bottom of the grid to show how wide the rectangle is. Next, they count the squares two at a time (2, 4, 6, 8), marking a completed row each time they count, until they reach 8. They then can see the number of rows, 4.



Students learn to solve word problems without a grid or blocks next and then problems involving a variety of objects and events.

Enough geometry, earth science and multiplication. Remember **damon**? **Damon** is clock time, involving addition with base 12.

My turn: 11 and we add 1. What's the new damon?
12
My turn: 12 and we add 1. What's the new **damon**?
1
New example: 6 and we add 8. What's the new **damon?**
6 and we add 9. What's the new **damon**?

When the sameness is made explicit, the examples make sense.

The Need for Efficiency—Teaching Fast

These examples illustrate how the sameness analysis leads to a wholistic understanding of a content area, rather than fragmented knowledge. This is the overriding purpose of the sameness analysis—to foster coherent schemas of important bodies of knowledge. At a simplistic level, the notion is to "teach smart." However, the realities of schools force another priority upon educators–efficiency. Sameness analyses leads to certain efficiencies, in that related information is easier to learn, remember and apply than fragmented information. However, even greater efficiencies are required for at-risk and handicapped students. As Haynes and Jenkins reported (1986), handicapped students in an eclectic resource room program ended up getting no more instructional time than their non-handicapped peers. In addition, students with special needs, particularly those from disadvantaged backgrounds, typically receive less help from their parents at home. Finally, these students typically receive instruction in a small group or entire class, limiting the attention they can receive from the teacher. These factors make the case for efficiency, to "teach fast," overwhelming.

Efficient and effective teaching techniques were given prominence by Rosenshine (1976). He noted that higher academic achievement scores are demonstrated when teachers observe the following practices:

1. Devote substantial time to active instruction.
2. Break complex skills and concepts into small, easy-to-understand steps and systematically teach in a step-to-step fashion.
3. Provide immediate feedback to students about the accuracy of their work.
4. Conduct much of the instruction in small groups to allow for frequent student-teacher interactions.

Many other similar reviews of effective teaching practices have been published since 1976, one recent one being called Critical Instructional Factors (Christenson, Ysseldyke & Thurlow, 1989). In addition, recent research bears out these recommendations. For example, Haynes and Jenkins (1986) compared special education instruction in an eclectic district and in a Direct Instruction district:

> "The [Direct Instruction] sample showed lower proportions of academic other, out of room, off-task, individual seatwork, one-to-one instruction, and interactions with teachers. They showed higher proportions of small group instruction, cognitive instruction, and direct reading. The Direct Instruction sample spent nearly three times more minutes daily in direct reading than did the eclectic sample (24 vs. 8.5)." (P. 23.)

It is important to note that effective practices for "teaching fast"—frequent questions, small steps, constructive feedback, active monitoring, sufficient time, and so forth—could be applied to a conventional analysis of complex topics—geometry, earth science, word problems—or to a conventional analysis of relatively simple topics. For a comparatively simple topic , such as subtraction facts, the outcome would be fairly reasonable. Students would memorize the subtraction facts as unrelated pieces of information and could be successful. For the more complex topic of word problem analysis, however, effective teaching practices are not enough (Moore & Carnine, 1989). In fact, when students are taught to analyze word problems in a conventional manner, such as read, analyze, plan and solve, the lack of a strategy based on a sameness analysis can lead to frustration. Darch, Carnine, and Gersten (1984) found that effective teaching practices, such as frequent assessment with extra instruction, were not beneficial and possibly harmful. In short, effective teaching techniques by themselves do not necessarily lead to the acquisition of higher-order skills, but possibly just more efficient learning of lower order skills.

The Role of Direct Instruction

The Direct Instruction system that originated in 1968 with the federal program, Follow Through, utilized most of the techniques Rosenshine (1976) wrote about. In addition, the analysis of sameness was applied to content areas to create curricular material. Thus, Direct Instruction comprises both a set of teacher practices and curricular analyses that manifest themselves in instructional programs. The instructional programs are means by which the sameness analysis can be communicated clearly and efficiently to students.

Each instructional program is a series of tasks to be taught. The instruction takes the form of frequent interchanges between the teacher and the students. To ensure that the sameness analysis is clearly communicated, daily lessons are designed in script form, showing the teacher what to do and what to say during these interchanges. The use of scripted lesson plans has been criticized as restricting the teacher's initiative. However, some important values derive from the use of scripts. One goal is designing disseminable procedures for improving instruction and learning. Scripts permit the use of examples and explanations that have been field tested and demonstrated to work before publication. The teacher knows that if the students have the relevant background knowledge, the teaching sequence will work. The teacher does not have to spend time experimenting with various possible illustrations, choosing appropriate language, and searching for important samenesses.

However, the use of scripts symbolizes a major barrier to the adoption of Direct Instruction because of its high degree of structure and teacher-centered philosophy. Many educators favor more child-centered, indirect, and reflective approaches. These educators feel that the scripted lessons and extensive practice and assessment are unnecessary, at best. On the other hand, less able students seem to suffer when instruction is not sufficiently explicit. This belief is expressed by Delpit (1988) in her *Harvard Education Review* article: "If such explicitness is not provided to students, what it feels like to people who are old enough to judge is that there are secrets being kept, that time is being wasted, that the teacher is abdicating his or her duty to teach" (p. 287).

The apparent dilemma is whether to make important samenesses more explicit for average and below-average students, and "hold back" the above-average students, or to keep instruction geared to above-average students. A key assumption of this dilemma is that making important samenesses explicit is inappropriate for higher-order skills with above-average students. Some recent reviews of research indicate that this is not the case, at least for problem solving in computer science (Dalley & Linn, 1985), in learning to design scientific experiments (Ross, 1988), and in logical and analogical reasoning (Grossen & Carnine, 1989). It might be more accurate to say that Direct Instruction with above-average students is not as important for *less* cognitively complex topics. For below-average students, making important samenesses explicit is fairly important at all levels of cognitive complexity. The hypothesized relationships are displayed in Figure 8.

Whitener's (1989) meta-analysis of aptitude treatment interactions between prior achievement and instructional support is consistent with these hypothesized relationships. For students with greater prior knowledge, she found stronger effects for instructional support; the academic content of the studies was of relatively high cognitive complexity: algebra, calculus, error of measurement, social studies, networks, logic, math rules, and problem solving. A meta-analysis of studies with content of a low level of cognitive complexity could determine whether instructional support would have relatively little effect for more-able students.

The basis for the hypothesized relationships in Figure 8 lies in the findings from the brain research cited earlier–the noting of samenesses. Edelman's work (1987) on the brain's overarching capacity to categorize in connected ways has direct implications for educators, as illustrated earlier in this article. Students who are facile, intuitive learners (i.e., above-average students) note important samenesses fairly readily. They categorize and recategorize at a rapid rate and in a flexible manner, without need for an instructional environment that emphasizes important samenesses and in effect warns the learner about unintended samenesses. With content that is not highly complex, these students can "figure out" important samenesses without getting seriously mislead.

Less capable students benefit from Direct Instruction that points out these important samenesses. Kail (1984) reviewed several studies showing significantly longer memory search times for handicapped individuals. This slower rate could reflect inefficient processes for identifying samenesses.

Figure 8. Relationship Between Importance of Direct Instruction and Cognitive Complexity for Above-average (AA), Average (A), Below Average (BA), and Special Education (SE) Students.

Importance of Direct Instruction	Great	SE	SE BA
		BA	A AA
	Moderate	A AA	
	Slight		
		Low	High
		Cognitive Complexity	

Less capable students clearly benefit from Direct Instruction (White, 1988)—a melding of effective teaching techniques and curriculum designed according to the sameness analysis.

Providing such instruction is not easy. On the one hand, scripts reduce teacher preparation time by reducing the need for teachers to develop their own consistent instructional language, and more critically, by reducing the need for teachers to spend long hours identifying the kinds of samenesses that must be communicated to learners for them to perform at higher cognitive levels. On the other hand, the use of scripts in no way diminishes the need for teachers to govern their interactions with students according to student performance. Thus, the teacher is continually deciding: (a) how to relate what students have learned previously to any current misrules, and (b) how much demonstration and guided practice to provide, given the typical spread of student abilities found in a classroom.

The point is to look beyond techniques, whether effective teaching techniques for teachers or metacognitive techniques for students, to the organization of the content itself. Does it model higher-order thinking in ways suggested by Prawat (1989): (1) developing correspondences between various ways of representing concepts and procedures, (2) making explicit how important elements of the knowledge base relate to each other, and (3) acknowledging and being sensitive to students' naive knowledge or misconceptions.

Conculsion

Effective teaching techniques, cooperative learning, and metacognition are to some degree wasted when curricular material organizes content in a fragmented manner that is most amendable to rote learning. The problem of fragmented knowledge is particularly acute for at-risk students who are not typically offered alternative, richer organizations from family or peers. To develop higher-order thinking skills, these students require instructional material that is organized to model higher-order thinking and is taught efficiently, so they have an opportunity to master, apply and remember important information. With Direct Instruction, at-risk and special education students have learned higher-order skills at levels comparable to or surpassing those of their advantaged peers:

in literary analysis
in chemistry
in earth science
in problem solving
in syllogistic reasoning
in ratio and proportions
in fractions

Current Direct Instruction research on the transfer of thinking abilities addresses two issues raised by Resnick (1987). First, the research uses the earth science course from which the convection example was drawn, to investigate the role of subject matter teaching that is designed to develop transferable skill and knowledge. Second, the research looks closely at skills for acquiring and using knowledge. This represents an important extension of Direct Instruction into problem solving, including the question of transfer from science to math. The sophistication exhibited by the middle school subjects has been both surprising and encouraging. The next phase focuses on replicating the research with remedial and learning-disabled students.

The importance of considering the actual consequences of educational approaches for low-performing students cannot be overemphasized. Unfortunately, the judicial system sometimes has to force educators to act on this seemingly obvious dictum. In November of 1989, a California Superior Judge overturned all the procedures and evaluation guidelines dealing with language arts that had been promulgated by the California State Board of Education. Board documents stated that it would ignore a 1976 statute involving learner verification and did not use learner verification as a criterion for adopting programs to be used in California. Such disregard of evidence does not further educators' efforts to promote thinking in the content areas. As educators are quick to point out, problem solving involves analyzing data in devising solutions. Only by taking our own advice and acting on what we learn will we be able to promote learning and thinking in *all* students. ◆

References

Becker, W. C., Engelmann, S., Carnine, D. & Rhine, R. (1981). The Direct Instruction Model. In R. Rhine (Ed.), *Encouraging change in America's schools: A decade of experimentation* (pp. 95-154). New York: Academic Press.

Brown, J. S. & Burton, R. R. (1978). Diagnostic models for procedural bugs in basic mathematical skills. *Cognitive Science*, 2, 155-192.

Bruner, J. S. (1960). *The process of education*. New York: Vintage.

Christenson, S., Ysseldyke, J. & Thurlow, M. (1989). Critical instructional factors for students with mild handicaps: An integrative review. *Remedial and Special Education*, 10(5), 21-31.

Collins, M. & Carnine, D. (1988). Evaluating the field test revision process by comparing two versions of a reasoning skills CAI program. *Journal of Learning Disabilities*, 21(6), 375-379.

Collins, M., Carnine, D. & Gersten, R. (1987). Elaborated corrective feedback and the acquisition of reasoning skills: A study of computer-assisted instruction. *Exceptional Children*, 54(3), 254-262.

Dalley, J.& Linn, M. C. (1985). The demands and requirements of computer programming: A literature review. *Journal of Educational Computing Research*, 2(3), p. 253.

Darch, C. & Carnine, D. (1986). Approaches to teaching learning-disabled students literal comprehension during content area instruction.*Exceptional Children*, 53(3), 240-246.

Darch, C., Carnine, D. & Gersten, R. (1984). Explicit instruction in mathematics problem solving. *Journal of Educational Research*, 77(66), 350-359.

Darch, C., Carnine, D. & Kameenui, E. (1986). The role of visual displays and social structure in content-area instruction. *Journal of Reading Behavior*, 18(4), 275-295.

Delpit, L. D. (1988). The silenced dialogue: Power and pedagogy in educating other people's children. *Harvard Education Review*, 58, 280-298.

Dimino, J., Gersten, R., Carnine, D. & Blake, G. (in press). Using story grammar to promote ninth graders' comprehension of literature. *Elementary School Journal*.

Edelman, G. (1987). *Neural Darwinism: The theory of neuronal group selection*. New York: Basic Books.

Engelmann, S. & Carnine, D., (1982). *Theory of instruction*. New York: Irvington.

Ewing, A. C. *The definition of good*. N.Y.: Macmillin, 1947.

Fielding, G., Kameenui, E. & Gersten, R. (1983). A concern of inquiry and direct instruction approaches towards teaching legal concepts and applications to secondary students. *Journal of Educational Research*, 76, 287-293.

Flavell, J. H. (1971). Stage-related properties of cognitive development. *Cognitive Psychology*, 2, 421-453.

Freud, S. *The basic writings of Sigmund Freud*. New York: Random House, 1938.

Gagne, R. & Briggs, L. (1979). *Principles of instructional design* (2nd ed.). New York: Holt, Rinehart and Winston.

Grossen, B. & Carnine, D. (in press). Diagramming a logical strategy: Effects in difficult problem types and transfer. *Learning Disability Quarterly*.

Gurney, D., Gersten, R., Dimino, J. & Carnine, D. (in press). Story grammar: Effective literature instruction for high school students with learning disabilities. *Journal of Learning Disabilities*.

Haynes, M. C. & Jenkins, J. R. (1986). Reading instruction in special education resource rooms. *American Educational Research Journal*, 23, 161-190.

Hofmeister, A., Engelmann, S. & Carnine, D. (1989). Developing and validating science education videodiscs. *Journal of Research in Science Teaching*, 26(7).

Kail, R. (1984) *The development of memory in children*. New York: W. H. Freeman and Company.

Kelly, B., Carnine, D., Gersten, R. & Grossen, B. (1986). The effectiveness of videodisc instruction in teaching fractions to learning-handicapped and remedial high school students. *Journal of Special Education Technology*, 8(2), 5-17.

Using Story Retell as a Measure of Comprehension*

by Mary Gleason
University of Oregon
Jane Krauss
Eugene School District 4J
Gerald Tindal
University of Oregon

Introduction

Teachers of mildly handicapped, Chapter 1, and other at-risk students are concerned with two related aspects of teaching reading: effective intervention and assessment of student progress. In the area of reading comprehension, teachers typically have used two kinds of testing to determine whether the intervention has been successful and students have made progress. They either administer standardized achievement tests at the end of the year (Jenkins & Pany, 1978), or they collect data from informal observations throughout the year as they ask students comprehension questions about the material they've read (Salmon-Cox, 1981; Clark, 1982). Both methods are of limited value for measuring achievement for several reasons (Deno, 1985). No determination is made of comprehension of information that was not tested (Farr, 1969), questions frequently are not passage dependent (Hansen, 1979; Johnston, 1982), and questions may either lead students to the right answer (Goodman & Burke, 1972) or inadvertently lead students away from the right answer (Howell & Kaplan, 1980).

Teachers of special populations have been frustrated by their attempts to monitor student progress via standardized achievement tests, particularly in the area of reading comprehension. Many special education teachers have worked tirelessly throughout the year only to face standardized achievement test scores at the end of the year that appear to demonstrate no improvement. It has been well documented that there is little overlap between test items and curriculum content and objectives with standardized reading test (Good & Salvia, 1987; Jenkins & Pany, 1978; Shapiro & Derr, 1987). In addition, reading comprehension in particular is not adequately measured by standardized tests because of the manner in which it is tested (Howell & Kaplan, 1980). Comprehension items on standardized tests typically are limited to questions with multiple choice answers. Because of the lack of congruence between the instructional intervention and the test used to measure progress, and the infrequency of administration of these tests, the global scores obtained from these tests are not sufficiently sensitive to growth over time and consequently fail to reflect instructional interventions.

*Reprinted from *The Oregon Conference Monograph, 1990*, with permission of the editors. © 1990 University of Oregon

Beyond Technique—*Concluded*

Kelly, B., Gersten, R. & Carnine D. (in press). Student error patterns as a function of instructional design: An analysis of two curricula for teaching fractions to low-achieving students. *Journal of Learning Disabilities.*

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

Mill, J. S. (1844). *John Stuart Mill's philosophy of scientific method.* E. Nagel (ed.) New York: Hafner Publishing Company, 1950.

Moore, L. & Carnine, D. (1989). Evaluating curriculum design in the context of active teaching. *Remedial and Special Education, 10*, 28-37.

Patching, W., Kameenui, E., Carnine, D., Gersten, R. & Colvin, G. (1983). Direct instruction in critical reading. *Reading Research Quarterly, 18*(4), 406-418.

Payne, K. (1989). Elephant Talk. *National Geographic, 176*(2), 264-277

Polya, G. (1973). *Induction and analogy in mathematics.* Princeton, NJ: Princeton University Press.

Prawat, R. S. (1989). Promoting access to knowledge, strategy, and disposition in students: A research synthesis. *Review of Educational Research, 59*(1), 1-42.

Resnick, L. B. (1987). *Education and learning to think.* Washington, D.C.: National Academy Press.

Rosenfield, I. (1988). *The invention of memory*, Basic Books, Inc., Publishers, New York, N.Y.

Roseshine, B. (1976). Recent research on teaching behavior and student achievement. *Journal of Teacher Education, 27*, 61-64.

Ross, J. (1988). Controlling Variables: A meta-analysis of training studies. *Review of Educational Research, 58*(4), 405-437.

Skemp, R. R. (1978). Relational understanding and instrumental understanding. *Arithmetic Teacher, 26*, 9-15.

White, W.A.T. (1988). A meta-analysis of the effects of Direct Instruction in special education. *Education and Treatment of Children, 11*(4), 364-374.

Whitener, E. M. (1989). A meta-analytic review of the effect on learning of the interaction between prior achievement and instructional support. *Review of Educational Research, 59*(1), 65-86.

Woodward, J. (1989). *Developing schema in earth science*, Technical Report, 89-3, Eugene, OR: University of Oregon.

Woodward, J., Carnine, D. & Gersten, R. (1988). Teaching problem solving through a computer simulation. *American Educational Research Journal, 25*(1), 72-86.

Zee, A. (1986) *Fearful symmetry.* New York: Macmillan.

However, the alternative used by teachers is not adequate either. When evaluating reading comprehension in particular, teachers have relied on the use of informal questioning procedures (Clark, 1982; Salmon-Cox, 1981). In one study of the reliability and validity of this type of informal observational assessment, Fuchs, Fuchs, and Warren (1982) found that special education teachers consistently overestimated the progress of their students when they relied on informal observation. Questions used in basal readers and those designed by classroom teachers have the same drawbacks as questions presented in standardized tests; these drawbacks may be even more pronounced because informally designed questions tend to be technically inadequate (Johnston, 1982).

In summary, conventional strategies for assessing reading comprehension may be inadequate, and sensitive classroom-relevant measures of reading comprehension are urgently needed.

A potential alternative could be Curriculum-Based Measurement (CBM), begun by Stanley Deno and his associates at the University of Minnesota Institute for Research on Learning Disabilities (Deno, 1985). When Deno and company began their research approximately fifteen years ago, the focus was on developing sensitive achievement measures that could be used to formatively evaluate instructional programs. A number of correlational and experimental studies were completed in the basic skill areas of reading, spelling, and written expression, using a variety of measures having potential relevance for use in the classroom.

In identifying relevant classroom behaviors that would be useful in frequently monitoring students' learning in reading, Deno, Mirkin, Chiang, and Lowry (1980) reported on five measures from curriculum material: (a) oral reading from passages (Oral Reading), (b) oral reading from word lists (Words in Isolation), (c) identifying missing words (Cloze), (d) defining key words from passages (Word Meaning), and (e) reading key words within passages (Words in Context). All five measures were designed for frequent use, necessitating brief measures; as a consequence, one-minute timed tasks were devised. In the initial three validation studies, high correlations were found between these measures, particularly oral reading fluency, and reading comprehension as measured by published achievement tests (Deno, 1985).

Curriculum-Based Measurement for reading (oral reading fluency) has received strong support in the research field, but questionable acceptance in the schools. The biggest problem is that teachers question its face validity regarding comprehension. A typical response by teachers in workshops is that oral reading fluency fails to identity students who can read but don't understand what they read. These students are often labeled "word callers". The arguments about the high correlations with published achievement tests generally do not satisfy teachers, in great part because of the lack of content validity of these criterion measures and their lack of relevance to classroom practices (Jenkins & Pany, 1978; Shapiro & Derr, 1987).

We wanted to investigate a measure of reading comprehension that would be both technically adequate and have great potential as a formative measure, useful for evaluating instructional programs for low achieving and mildly handicapped students. We wanted the measure to be sensitive to growth over time as a result of instruction and to have no floor or ceiling effect.

Oral retell is a measure that has considerable potential, but almost no empirical support. although retelling has been employed within instructional programs designed to increase regular education student comprehension, the technical adequacy of retelling has not been investigated (Gambrell, Pfeiffer, & Wilson, 1985); retell procedures have rarely been used with mildly handicapped students.

To date, two studies have looked at retell as a curriculum-based measure. Fuchs, Fuchs, and Maxwell (1988) found a high relationship between the number of words written and special education students' performance on other measures (e.g. Stanford Achievement Test, cloze, and oral retell). Parker and Tindal (1989), using regular education students from three grade levels (6, 8, 11) employed written retell along with two other criterion measures: a maze comprehension task and a creative writing sample. The retell measure was scored for the number of words written and idea units presented; students also completed a creative story as a measure of written expression. They found that the distributions for the retell measure were very narrow for the number of idea units produced, accounting for roughly 10% of the information in the text; furthermore, the average retell measures changed little over the grades. Finally, no relationship was found between retell and creative writing. In summary, the technical adequacy data supporting retell as a measure of comprehension are limited.

The purpose of our study was to assess the validity of oral retell as an informal reading comprehension measure. Students' retell responses were evaluated in three major ways: (a) holistically, according to quality (similar to procedures used to evaluate writing). (b) counting the number of ideas expressed in each retell response; and (c) counting the number of words in each retell. If these different indices of oral retell are related, perhaps they can assist in defining comprehension, and evaluating instruction as a unitary construct. If oral retell is a measure of comprehension, how highly correlated is it with oral reading fluency? In addition, if indices of retell did indeed measure comprehension, perhaps teachers would respond favorably to the use of oral retell as a curriculum-based measure.

Method

Subjects

Subjects were drawn form the various schools in which practicum students were teaching and included 35 third- and fourth-grade students from a school district located in a middle SES community on the west cost. University practicum students in special education served as the data collectors. In each school, teachers submitted class rosters totalling 115 students. Parents of 39 students returned informed letters of consent.

The potential subjects completed a timed screening test to determine their eligibility. A ceiling level of 150 words per minute and a basal level of 21 errors was established. Students who performed between the basal and ceiling levels of the screening test became eligible for participation in the study. The final 35 subjects comprised three subgroups: 12 subjects were third-grade and 12 were fourth-grade students receiving regular classroom reading instruction; 11 were fourth-grade students receiving special instruction in reading (Chapter 1 or resource room services).

Materials

The study used short, expository passages of 105 to 175 words excerpted from *New Practice Readers*, Levels A through C (McGraw Hill Publishers, Webster Division, 1978). Each passage represented a single topic or theme from the natural and social sciences, similar to those taught in content area classes in the lower and intermediate grades. The passages were evaluated for readability levels with a computerized readability program (MECC Teacher Utilities, 1977). Spache and Fry Readability Test scores were used to derive a composite score and ten passages ranging from a grade equivalency of 2.1 to that of 4.1 were chosen. Passages were randomly ordered for presentation during a 10-week test period.

Procedures

Before the first test was administered, selected subjects participated in a practice session in which they were taught to orally retell information from a reading passage. As each student recalled information from the passage, the tester recorded the number of ideas the students expressed. If the student recalled two or fewer ideas from the passage, the tester demonstrated how to read and retell that same passage. The students then reread the passage and retold it again. If two or more ideas were recalled from the repeated passage, the students then read another passage and recalled it. This procedure continued until all subjects could read a new passage and orally retell more than two ideas.

Data collectors were trained to use scripted wording and prescribed administration procedures. Students read aloud from short expository passages once a week for 10 weeks. Two tests were administered each week: an oral reading fluency test, followed by an oral retell test. The data collector timed the oral reading of a passage and recorded the number of errors made. After reading, the students recalled all that he or she could remember from that same passage without prompts from the data collector. Each testing session was audiotaped for reliability checks and for scoring.

Scoring

Oral Reading Scoring Methods

When the test was administered, the data collector recorded the time in which the passage was read and the number of errors made. This information was then translated into the rate of words read correctly and incorrectly per minute.

Comprehension Scoring Methods

The students' oral retells were audiotaped during every session, then transcribed for scoring and analyzed for quantitative and qualitative scores.

Quantitative analyses were based on transcripts of retell responses using *Word Tools* (Clapp, 1986) to count the total number of words, as well as the number of unique words, adjectives, articles, and conjunctions occurring in the retell responses.

Two qualitative analyses were based on the number of ideas in the retell that reflected the content of the original passage and independent judgments using a holistic scoring procedure. An idea unit was defined as a simple T-unit or kernel sentence represented in each independent clause (Hunt, 1964). Information from subordinate clauses was disregarded. A loss of information would be an issue with more sophisticated prose, but the test passages were simple, and the sentences generally were made up of one or two clearly defined independent clauses. Student responses had to clearly express ideas form the original passage in order for those ideas to be credited. For instance, if the original idea unit was, "There is a tube that connects the middle ear to the inner ear" (an idea showing relationship), and the students stated, "There is a middle ear" (a single fact), this statement was not credited as representing the original idea unit.

Holistic judgments were made by three individuals who evaluated the retell responses using a 1 to 5 scale of quality. A score of 5 was assigned to the best retells, and a score of 0 was assigned to students who recalled nothing about the passage. The 350 retells were scored with an interscorer agreement of approximately .75.

Results

Relationships Among Oral Reading Scores and Indices of Retell

The following relationships between oral reading and the different retell measures were analyzed. First, we correlated the rate at which students orally read passages with the number of words in the retell response (range - .16 to .22), with the number of idea units retold (range .05 to .38), and with the holistic judgment scores (range .06 to .39). Then, we correlated the rate at which students made errors during oral reading with the number of words in the retell response (range -.21 to .35) and with the number of idea units retold (range -.35 to .09). See Tables 1, 2, and 3 for specific scores for each of the ten weeks.

Relationships Among Indices of Oral Retell

Two relationships between different indices of oral retell were analyzed. For each of ten weeks, we correlated the number of words in the retell response with the number of idea units retold (range .48 to .83) and with the holistic judgment scores (range .71 to.89). We also correlated the number of idea units with the holistic judgment scores (range .59 to .87). See Tables 1, 2, and 3 for specific scores.

Discussion

The purpose of the present study was to assess the validity of oral retell as an informal reading comprehension measure and to ask several questions. Were different indices of oral retell related to each other? If so, could they assist in defining comprehension as a unitary construct? If oral retell was a measure of comprehension, would it correlate with oral reading fluency? Is oral retell a practical approach to measuring comprehension?

Relationships Among Indices of Reading Retell

The results of qualitative and quantitative analyses indicate a strong relationship among the indices of oral retell. Because the holistic scoring and the idea-unit scoring were significantly correlated with the number of words in each retell, it appears that the quality of retelling is directly related to the quantity of it. This finding is consistent with that of Fuchs et al. (1988). In other words, students who retell more are also judged as having a higher level of comprehension.

The fact that such a simple measure as the number of words retold correlates with such well-accepted procedures as holistic judgments and idea-unit scoring is fortuitous. Holistic scoring and idea-unit scoring are evaluation methods that represent values teach-

Table 1. Correlations Among Total Number of Words in Retell and Other Indices of Reading Retell

Test Week	1	2	3	4	5	6	7	8	9	10
Correct Words per minute	-.21	-.18	.19	-.02	.05	.18	.12	.35	.21	-.06
Erred words per minute	.02	.03	.11	-.02	.05	-.16	.11	-.15	.22	.06
Idea Units per retell	.61	.63	.63	.82	.74	.48	.83	.67	.72	.72
Holistic judgment scores	.81	.80	.75	.84	.82	.78	.89	.78	.71	.71

Table 2. Correlations Among Idea Unit Scores and Other Indices of Reading Retell

Test Week	1	2	3	4	5	6	7	8	9	10
Correct words per minute	.62	.63	.66	.83	.74	.49	.83	.67	.70	.73
Erred words per minute	-.19	-.16	-.16	-.06	-.11	.03	.04	.01	-.21	-.23
Characters per retell	.62	.63	.66	.83	.74	.49	.83	.67	.70	.73
Words per retell	.61	.63	.63	.82	.74	.48	.83	.67	.72	.72
Holistic judgment scores	.77	.61	.59	.84	.86	.78	.87	.66	.87	.72

ers bring to the task of measuring students achievement. Holistic scoring is a tool that is accepted by teachers, as evidenced by its wide use for judging writing. Idea-unit scoring, which was significantly correlated with the holistic method in this study, is similar to what teachers often do when they assess reading comprehension. Just as teachers ask questions to determine how thoroughly students retain information, idea-unit scoring provides a way to quantify how much is retained. Holistic scoring and idea-unit scoring are not only valued by teachers, but they also offer objective control to the relatively subjective task of measuring comprehension. However, both scoring approaches are too unwieldy and time-consuming to be used for frequent progress monitoring or to be used practically by classroom teachers. Given that the number of words in a retell response is significantly correlated with these otherwise acceptable indices, a simple word count may serve as a valid method for estimating reading comprehension. Ongoing measurement of the total number of words in a retell may serve as a useful means of monitoring growth in comprehension over time.

Retell and Comprehension

This study also sought to understand the various dimensions of recalling expository prose as measures of reading comprehension. In the past, retell has been positively correlated with comprehension subtests on standardized achievement tests and with other informal measures of comprehension such as cloze, maze, and question-based tests. Retell has also been positively correlated with an indirect index of comprehension, oral reading fluency. In this study, idea-unit scores were highly correlated with holistic scores. Whereas idea-unit scoring credits only information that matches the original passage (verbatim recall), holistic judgment can be more sensitive to how well the student integrates new information with what s/he already know. Memory and comprehension appear to be inexorable linked; it is difficult to remember what is not understood. As a curriculum-based measure, oral retell appears to have greater face validity than oral reading fluency.

Practicality of Oral Retell

Retell tests can be constructed inexpensively and with alternate forms from classroom reading materials. Retell administration procedures are simple; they take little time to administer, and can be used reliably with minimal training. However, as practical measures, oral retells must be easy to score. In this study, oral retells were audiotaped and transcribed for later scoring, which appears to make it unfeasible for frequent measurement. Written retell may be more practical for this use. Further research must look at a comparison of results between oral and written retells to examine whether information gained through written retell (ease of scoring) is economic in terms of results sought (measurement of comprehension). The most obvious problem is that teachers are in danger of losing information because of student's difficulties with writing and spelling. More able writers might achieve better retell scores even if their recall of information is similar. The results of this study indicate that at the very least, teachers using oral retell would simply record and count the number of words in each retell. It would not be necessary to use the more time-consuming procedures of counting idea units and conducting holistic scoring.

Relationships Among Oral Reading Fluency and Retell Scores

We did not find a significant relationship between oral reading rate and retell scores in this study. This finding is inconsistent with results from other studies and is probably related to a number of factors involving differences in subjects, reading material, procedures, etc., used in this study compared to other studies (Krauss, 1989)

Summary

That recall is an important component of comprehension is not disputed (Hansen, 1979), but appropriate scoring procedures for recall tests have yet to be fully explored and validated. Written retell tests may be more useful for measuring comprehension than

Table 3. Correlations Among Holistic Judgment Scores and Other Indices of Reading Retell

Test Week	1	2	3	4	5	6	7	8	9	10
Correct words per minute	.06	.28	.24	.06	.16	.09	.24	.11	.39	.32
Erred words per minute	.06	-.35	-.17	-.01	-.20	.01	.09	.08	-.18	-.15
Charactersper retell	.83	.82	.76	.84	.81	.79	.91	.72	.69	.74
Words per retell	.81	.80	.75	.84	.82	.78	.89	.78	.71	.71
Idea Units per retell	.77	.61	.59	.84	.86	.78	.87	.66	.87	.72

oral retell tests (Fuchs et al; 1988), but the degree to which the expression of recall is influenced by writing ability needs to be explored. The number of words in a written retell response is positively correlated with oral reading fluency. In other studies, oral reading fluency correlates highly with the formal information measures of comprehension, indicating that reading rate may be as good an index of reading, including comprehension, as any metric currently used. Methods for scoring retell tests that appear to be most appropriate are those that evaluate recall in both quantitative and qualitative ways (Kalmbach, 1986). The use of a combined scoring procedure may be appropriate for approaching the validation of recall as a measure of comprehension. ◆

References

Clapp, D. (1986). *Word Tools.* Computer program, Aegis Development, Inc.

Clark, C.H. (1982). Assessing free recall. *The Reading Teacher, 35,* 434-39.

Deno, S.L. (1985). Curriculum-based measurement: The emerging alternative. *Exceptional Children, 52* (3), 219-232.

Deno, S.L, Mirkin, P.K., Chiang, B., & Lowry, L. (1980) *Relationships among simple measures of reading and performance on standardized achievement tests.* (Research Report No. 20). Minneapolis: University of Minnesota Institute for Research on Learning Disabilities.

Farr, R. (1969). *Reading: What can be measured.* Newark, DE: International Reading Association Research Fund.

Fuchs, L., Fuchs, D., & Maxwell, L. (1988). The validity of informal reading comprehension measures. *Remedial and Special Education, 9* (2), 20-28.

Fuchs, L.S., Fuchs, D., & Warren, L. (1982). *Special education practice in evaluating students progress toward goals* (Research Report No. 21). Minneapolis: University of Minnesota: Institute for Research on Learning Disabilities.

Gambrell, L.B., Pfeiffer, W.R., & Wilson, R. M. (1985). The effects of retelling upon reading comprehension and recall of text information. *Journal of Educational Research, 78,* 216-220.

Good, R.H., & Salvia, J. (1987). Curriculum bias in published, norm-referenced reading tests: Demonstrable effects. *School Psychology Review, 17,* 51-60.

Goodman, Y., & Burke, C. (1972). *Reading miscue inventory: Procedure for diagnosis and evaluation.* New York: Macmillan.

Hansen, C. L. (1979). Chicken soup and other forms of comprehension. In J.E. Button, T.C. Lovitt, & T.D. Rowland (Eds.), *Communications research in learning disabilities and mental retardation* (pp. 67-91.) Baltimore, MD: University of Park Press.

Howell, K., & Kaplan, J. (1980). *Diagnosing basic skills: A handbook for deciding what to teach.* Columbus, OH: Charles E. Merrill.

Hunt, K. (1964). *Differences in grammatical structures written at three grade levels, the structures to be analyzed by transformational methods.* Cooperative Research Project #1998, Office of Education, U.S. Department of Health, Education, and Welfare.

Jenkins, J.R., & Pany, D. (1978). Curriculum biases in reading achievement tests. *Journal of Reading Behavior, 10* (4), 345-357.

Johnston, P.B. (1982). *Implications of basic research for the assessment of reading comprehension* (Tech. Rep. No. 206). Urbana-Champaign: University of Illinois, Center of the Study of Reading (ERIC Document Reproduction Service No. ED01 987).

Kalmbach, J.R. (1986). Evaluating informal methods for the assessment of retellings. *Journal of Reading, 30,* 119-126.

Krauss, J. (1989). *Measurement of reading comprehension using oral retell.* Unpublished master's thesis, University of Oregon, Eugene.

Parker, R., & Tindal, G. (1989). *Initial validation of two classroom materials-based measures of reading comprehension.* Unpublished manuscript, University of Oregon.

Salmon-Cox, L. (1981). Teachers and standardized achievement tests: What's really happening? *Phi Delta Kappan, 62,* 631-634.

Shapiro, E. S., & Derr, T. F. (1987). An estimation of overlap between reading curricula and standardized achievement tests. *The Journal of Special Education, 21* (2), 59-67.

Some Effects of Direct Instruction in Comprehension Skills on Intellectual Performance*

by Graham Clunies-Ross
EPIC Children's Centre,
Preston Institute for Advanced Education
Melbourne, Australia

Many studies have investigated the academic outcomes achieved as a result of implementing commercially available Direct Instruction (DI) programs (Becker, 1986; Lockery & Maggs, 1982). There has also been detailed examination of components of DI teaching strategies (Gersten, Woodward, & Darch, 1986; Moore, 1986). This research has found DI to be a very effective teaching system, at least in respect to socio-economically disadvantaged students and students with learning difficulties. The students undertaking the programs typically made rapid academic gains, and usually improved their normative levels of performance substantially. Comparative evaluations of DI and other approaches to teaching basic academic material (e.g., literacy, numeracy, and spelling) have reported significantly higher levels of performance flowing from DI (Becker & Carnine, 1980; Somerville &

*This article was originally published in Volume 7, Number 2 of *Behavior Change*, and is reproduced with the permission of Pergamon Press Australia, Sidney.

Leach, 1988).

Much of the research referred to above was concerned with the Distar programs designed for children in early primary grades, and involved students experiencing difficulties in acquiring basic academic skills. Less attention has been given to evaluating the Corrective Reading Program (CRP), designed for upper primary and lower secondary level students. The CRP includes two strands, decoding and comprehension. The work reported with the program has used mainly the decoding strand with learning disabled students (e.g., Campbell, 1983, cited by Becker, 1984; Gersten, Brockway & Henares, 1983; Gregory, Hackney & Gregory, 1982; Lloyd, Cullinan, Heins & Epstein, 1980; Polloway, Epstein, Polloway, Patton & Ball, 1986).

A study carried out in Australia by Noon and Maggs (1980), however, examined the effects of the CRP Comprehension B strand on the written language achievements of "normal" and "gifted" upper primary students. The students completed the 140 lesson program within one school year, and were administered the Myklebust Picture Story Language Test (PSLT) as a pre– and post– test measure of achievement. It was reported that all of the students gained five to eight years ahead of their chronological ages on the PSLT dimensions of productivity, correctness, and meaning. While these findings seem remarkable, a limitation of the study was that it did not include a control or comparison group This has, in fact, been a methodological weakness in many Australian DI evaluation studies.

Although the development of basic academic skills in literacy and numeracy has been of particular interest to DI researches, it was found in Project Follow Through that the Distar programs also had strong positive effects in the affective area (Becker & Carnine, 1980). More recent DI program developments have included compliance training (Engelmann & Colvin, 1983), computer programming (Maggs, Hermann & Croyle, 1986), and social skills training (Walker, McConnell, Holmes, Todis, Walker & Golden, 1983). In one of the earliest studies which used an experimental version of the Distar, Engelmann (1970) found that in addition to academic gains, socially disadvantaged children averaged 20 points higher in IQ than a comparison group after two years of DI.

The purpose of the present study was to extend this early finding by investigating the intellectual gains achieved by regular primary students undertaking the CRP. It can be predicted that DI programs focussing on academic skill development should also enhance general intellectual performance because of the emphasis given in DI program design to maximizing attention, generalization, meaningfulness, retention, and the development of functional cognitive structures (Becker, Engelmann, Carnine & Maggs, 1982).

The Comprehension B strand of the CRP (Engelmann, Osborne, & Hanner, 1978) was used. This program was designed to teach students how to understand what they read. In particular, it aims to teach reasoning skills, comprehension skills, information skills, vocabulary skills, sentence skills, and writing skills.

DI research has predominantly involved disabled and/or disadvantaged students. A resulting tendency has developed for teachers and others to regard DI programs and procedures as applicable only to special or remedial education. There is a need for further studies to investigate the effects of using DI programs with regular education students.

Method

Participants

The experimental group consisted of 31 Year 6 students (13 girls, 18 boys) attending a non-government primary school in a rapidly developing outer suburb of Melbourne. The school had been established three years previously under the auspices of a "parent" school in an adjacent suburb, in order to take enrollment pressure off the "parent" school. Twenty-six Year 6 students (14 girls, 12 boys) attending the "parent" school served as a comparison group.

The two schools had very similar educational philosophies. In relation to literacy, both schools were following an interest based thematic approach. The schools used components of several reading schemes, but none of these incorporated DI principles.

Assessment of intellectual performance

The ACER Tests of Learning Ability for Year 6 students (TOLA 6) (Australian Council for Educational Research, 1977) were used as the dependent variable measure. TOLA 6 was constructed to provide measures of verbal comprehension, problem solving, and verbal analysis as well as an overall measure of general intellectual performance. It consists of three subtests; Verbal Comprehension (35 vocabulary-synonym items) General Reasoning (24 items involving problem solving and reasoning within a mathematical framework), and Syllogistic Reasoning (24 items requiring the respondent to reason from stated premises to necessary conclusions).

Procedure

TOLA 6 was administered to all students in mid-March as a pretest and again in mid-November as a posttest. During the intervening eight months the experimental group was taught CRP Comprehension B at the rate of two or three lessons per week by their regular classroom teacher. These lessons, each of which required 40-45 minutes, used periods that had been timetabled for teaching reading and related activities. Being totally scripted, the CRP is a straight forward program for an experienced teacher to present. Seventy-two of the 140 lessons in the program were completed prior to post-testing. Students in the comparison group were involved in variety of literacy activities for equivalent periods of time.

Table 1. Pretest and Posttest Means, SDs, and Percentile Ranks on the ACER Tests of Learning Ability (TOLA 6)

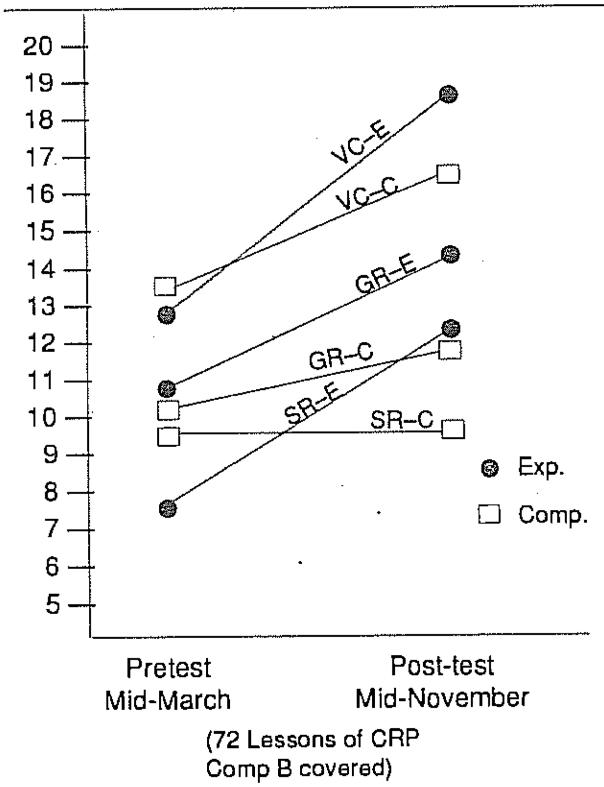
	Experimental Gp (n = 31)			Comparison Gp (n = 26)		
Subtest	Mean	SD	%ile R	Mean	SD	%ile R
			Pretest			
VC	12.9	6.91	32	13.5	5.67	35
GR	10.7	4.22	43	10.4	4.31	42
SR	7.7	4.27	38	9.7	3.88	54
TT	31.3	14.12	33	33.6	11.76	39
			Post-Test			
VC	18.6	7.19	60	16.5	4.95	50
GR	14.0	4.29	72	11.8	4.95	54
SR	12.1	4.95	70	9.6	4.56	53
TT	44.7	14.83	68	38.0	13.02	50

Note: VC = Verbal Comprehension; GR - General Reasoning; SR = Syllogistic Reasoning; TT = Total Test.

Results

The pretest and posttest scores obtained by the experimental and comparison groups on the TOLA 6 Subtests and Total Test are summarized in Table 1 and the subscores are graphed in Figure 1. The percentile ranks shown in the table were derived from the Victorian normative data included in the test manual. Inspection of Table 1 indicates that: (1) The pretest means of the groups were similar in respect to Verbal Comprehension (VC) and General Reasoning (GR), (2) The comparison group achieved a higher pretest mean on Syllogistic Reasoning (SR), which resulted in this group also scoring a higher Total Test pretest mean, and (3) Higher posttest means were obtained by the experimental group in all cases.

Figure 1. Pretest and Posttest Mean Raw Scores for Experimental and Comparison Groups on the ACER Tests of Learning Ability (TOLA 6).



Note: VC = Verbal Comprehension
GR = General Reasoning
SR = Syllogistic Reasoning

The differences between the posttest means of the groups were examined by t tests for VC and GR, and by analyses of covariance for SR the Total Test (using the respective pretest scores as the covariants). The results of these analyses indicated that: (1) The groups did not differ significantly on VC (t = 1.24, p = .217), (2) a moderately reliable difference occurred for GR (t = 1.79, p = .076), and (3) the experimental group was significantly superior on SR [F (1,54) = 19.73, p < .0001], and on the Total Test [F (1,54) = 19.02, p < .0001].

The percentile rank data in Table 1 show that the normative performance of both groups improved across time (with the exception of the comparison group on SR). At the time of posttesting the comparison group's performance was at an average level, whereas the experimental group had achieved an above average level.

Discussion

Educators have often presumed that DI teaching strategies and programs are useful only for students with learning disabilities, and are unsuitable for teaching comprehension and reasoning skills (Engelmann & Carnine, 1982, reprinted as Engelmann & Carnine, 1989; Schaefer, 1986). The results of the present study challenge the validity of such assumptions, and raise the question of whether regular students would be advantaged by the inclusion of DI programs in their curriculum.

The superior posttest performance of the experimental group was achieved after only half of CRP Comprehension B had been taught. As it was the last year of attendance at the primary school for the students involved, the program could not be continued to completion. One may speculate, however, that completion of the program would have produced even larger experimental-comparison group differences.

The findings suggest that the CRP might have a greater impact on reasoning skills (as measured by GR and SR) than on vocabulary skills (as measured by VC). This is quite possible as a greater proportion of the total teaching time during the first half of the program is allocated to components of reasoning (including drawing conclusions and making deductions, formulating and applying analogies, recognizing contradiction, and analyzing similes) than to vocabulary definitions. It is also possible that the reasoning skills taught in the program generalize to a greater extent than the vocabulary skills. Firm conclusions about the relative effectiveness of components of the CRP cannot, however, be based on implementation of only half of the program.

The Victorian normative data included in the TOLA Manual was based on testing carried out during November 1975. The posttesting in the present study was also conducted during the month of November, and it was found that the mean scores for the comparison group were at or close to the 50th percentile. This suggests that the comparison group was a representative sample of the Victorian sixth grade population. Given the relative comparability of the pretest scores obtained by both groups, it can be inferred that the experimental group was similarly representative of the population. The above average percentile levels of the experimental group's posttest scores can therefore be interpreted as indicating that the students in the experimental group made educationally significant gains in intellectual performance as a result of being taught the CRP.

References

Australian Council for Educational Research (1977), *ACER tests of learning ability*. Victoria, Australia: ACER

Becker, W. (1984). Corrective reading program evaluated with secondary students in San Diego. *ADI News*, 3, 1, 23.

Becker, W.C. (1986). *Applied Psychology for Teachers: A behavioral cognitive approach*. Chicago, IL: Science Research Associates.

Becker, W.C., & Carnine, D. W. (1980). Direct instruction: An effective approach to educational intervention with the disadvantaged and low performers. *Advances in Clinical Child Psychology*, 3, 429-473.

Becker, W. C. , Engelmann, S., Carnine, D. W., & Maggs, A. (1982). Direct instruction technology: Making learning happen. In P. Karoly & J. J. Steffen (Eds.), *Improving Children's Competence: Advances in Child Behavioral Analysis and Therapy* (Vol. 1). Lexington, MA: D.C. Heath.

Engelmann, S. (1970). The effectiveness of direct instruction on IQ performance and achievement in reading and arithmetic. In J. Hellmuth (Ed.), *Disadvantaged Child* (Vol. 3). New York: Brunner/Mazel.

Engelmann, S., & Carnine D. (1989). DI outcomes with middle-class second graders. *ADI News*, *8*, 2-5.

Engelmann, S., & Colvin, G. (1983). *Generalized Compliance Training*. Austin, TX: Pro-Ed.

Engelmann, S., Osborne, S., & Hanner, S. (1978). *Corrective Reading Series: Comprehension B*. Chicago, IL: Science Research Associates.

Gersten, R., Woodward, J., & Darch, C. (1986). Direct Instruction: A research-based approach to curriculum design and teaching. *Exceptional Children*, *53*, 17-31.

Gregory, R. P., Hackney, C., & Gregory, N.M. (1982). Corrective reading programme: An evaluation. *British Journal of Educational Psychology*, *52*, 33-50.

Lloyd, J., Cullinan, D., Heins, E. D., & Epstein, M. H. (1980). Direct Instruction: Effects on oral and written comprehension. *Learning Disability Quarterly*, *4*, 70-76.

Lockery, L., & Maggs, A. (1982). Direct Instruction research in Australia: A ten year analysis. *Educational Psychology.*, *2*, 263-288.

Maggs, A., Hermann, G., & Croyle, L. (1986). *Beginner's BASIC Mastery: A Problem Solving Approach*. Sydney, Australia: Macquarie University.

Moore, J. (1986). Direct Instruction: A model of instructional design. *Educational Psychology*, *6*, 201-229.

Noon, L., & Maggs, A. (1980). Accelerating written language processes in normal and gifted children: Direct Instruction Strategies and Sequences. *Reading Education*, *5*, 11-26.

Polloway, E. A., Epstein, M H., Polloway, C. H., Patton, J. R., & Ball, D. W. (1986). Corrective reading program: An analysis of effectiveness with learning disabled and mentally retarded students. *Remedial and Special Education*, *7*, 41-47.

Schaefer, E. (1986). Is DI only for low achievers? *ADI News*, *6*, 10-11.

Somerville, D. E., & Leach, D. J. (1988). Direct or Indirect Instruction? An evaluation of three types of intervention programme for assisting students with specific reading difficulties. *Educational Research*, *30*, 46-53.

Walker, H. M., McConnell, S., Holmes, D., Todis, B., Walker, J., & Golden, N. (1983). *The Walker Social Skills Curriculum: The Accepts Program*. Austin, TX: Pro-Ed.

Teacher Use of Various Data Sources for Grouping, Placement, and Identifcation Decisions*

by Tracey E. Hall
Judith A. Gelbrich
Gerald Tindal
University of Oregon

Introduction

Ability grouping of students for instruction has been under study since the 1920s (Slavin, 1988; Anderson, Mason, & Shirey, 1984). Teachers use various forms of grouping to respond to student differences in knowledge, skills, and learning rate. To optimally present a lesson, teachers form instructional groups so that students may profit from the lesson, thus avoiding a presentation of skills that may be redundant for some learners and too difficult for others (Slavin, 1988; Carnine, Silbert, & Kameenui, 1990). Students must also receive instruction in materials that are at an appropriate level of difficulty.

Whether within classroom, within grade level, or across grade level, ability grouping is a very complex teacher decision-making phenomenon studied by many researchers to: (a) evaluate grouping procedures (Wiesendager & Birlem, 1981; Haller & Waterman, 1985; Wesson, Vietrhaler, & Haubrich 1989), (b) determine the function of grouping (Strike, 1983), and (c) evaluate student outcome as a function of group instruction (Anderson, Mason & Shirey, 1984; Strike, 1983). Beyond the normal range of students a teacher must teach within the classroom, there are often instances of students performing at the extremes. Teachers must decide whether these students would best be served within the curriculum and instruction of the regular classroom or outside of the classroom. Our investigation evaluates how teachers use various forms of data for grouping, placement, and potential identification.

Teachers have a variety of data sources available to help them in the grouping decision-making process. In a survey conducted by Haller and Waterman (1985), intermediate level teachers considered student ability, general academic competence, work habits, behavior, personality, and home background to place children in groups for instruction. By grouping students, teachers attempt to maximize instruction.

Although many factors appear influential, student ability and academic competence dominate the decision-making process. The main tool for documenting ability and achievement is standardized norm referenced tests. These tests are also the most prevalent tools available in American schools (Valancia & Person, 1987). While standardized achievement tests are rarely used as the sole criterion for admitting children to specialized programs, such as Talented and Gifted, they frequently serve as an important screening device. Generally, school districts set a standard for consideration, such as a score above the 95th or 98th percentile in reading and math (Eby & Smutny, 1990).

Recently, however, the usefulness of standardized tests for classroom teachers has been seriously contested (Salmon-Cox, 1981; Wesson et al., 1989). Test procedures have limited utility for placing pupils in specific groups because they lack content validity: test items rarely reflect the curriculum of instruction (Coleman & Harmer, 1982; Jenkins & Pany, 1978). Teachers value test scores, but they also search for instruments that are more diagnostic in nature, match the curriculum of instruction, and are timely (Salmon & Cox, 1981). Achievement tests were neither designed for, nor are they capable of carrying out such a function.

Teachers seem to be at an impasse, since predominant tests have serious technical problems. What choices, then, do teachers have available? Two familiar options are well known in reading. The first is published, teacher-made, and curriculum-based Informal Reading Inventories. The second alternative is to use diagnostic measures, such as the Gray Oral Reading Test (1986) and the Gates MacGinite Reading Test (1978). Additionally, many diagnostic measures have been developed by teachers. However, these procedures also suffer from problems with validity and reliability (Fuchs, Fuchs, & Deno, 1982; Salvia & Ysseldyke (1985).

Another procedure that has been recently developed is Curriculum-Based Measurement (CBM) (Deno, 1989). CBM is a method of analyzing academic performance using systematic procedures with brief measures in specific academic areas. It is accurate in grouping students for instruction when scores are rank ordered and students are grouped based on similar results (Hall & Tindal, 1989; Wesson, et al., 1989). This procedure can assist teachers with student grouping and placement decision-making quite efficiently. Curriculum Based Assessment has recently been investigated as a screening measure in the identification

*Reprinted from *The Oregon Conference Monograph, 1990*, with permission of the editors. © 1990 University of Oregon of giftedness with kindergarten and first-grade children (Joyce & Wolking, 1988). Their findings suggest that Curriculum Based Assessment is at least as effective as the Metropolitan Achievement Test in identifying students for gifted programs within that age group.

In summary, CBM may be a viable alternative to the need for technically adequate measures that are relevant for classroom use. They overcome the problems of many extant tests (published, norm-referenced and diagnostic) and have some initial validity data on making placement decisions. Furthermore, they reflect the call by school personnel and researchers for procedures by which standards can be developed to determine student instructional level. such measures should also be able to discriminate performance levels among students and be minimally time-consuming (Coleman & Harmer, 1982).

This study investigates how teachers value and actually use testing data to make placement decisions so that they can provide appropriate instruction to homogeneously grouped students. Teachers must also make reasonable referrals to special services at each end of the performance spectrum. Our investigation analyzes CBM to determine if it can serve as a tool for making qualitative decisions about instructional level, as well as the categorical decisions focusing on placement of students with extreme skills (either very low or very high). Since a considerable amount of research has already been done on the use of CBM for making placement decisions in special education (Shinn, Tindal, & Stein, 1988), we also looked at the use of CBM for making placement decisions with Talented and Gifted students. In this study, we were interested in both the process of decision making as well as the decision that was eventually made. In most previous research on CBM, only the outcome has been documented. To fully understand the context for decision making, however, more data need to be collected on how teachers make decisions and what types of information they value.

Subjects

Eighteen teachers from a semi-urban school district in the Pacific Northwest participated in this study. These teachers represent one elementary building faculty serving approximately 380 students, in a district with four other elementary schools and total student population of 1, 787. This particular staff has been using Curriculum-Based measurement procedures for two years on a school-wide basis, the teachers are familiar with the procedures and how to interpret normative data results. The emphasis of the decision making, however, has been confined to screening referrals for special education and writing IEP goals.

Teachers in this school have traditionally used ability grouping for reading instruction. The first and second grades maintain a self-contained structure and ability group within the homeroom setting. Each teacher had a wide range of student skills in the classroom. Third grade classes ability group across their grade level. Each teacher had a somewhat homogeneous group for that grade level. The fourth and fifth grades ability group across the two grades for reading. Each teacher had a relatively homogeneous group of students for both the fourth and fifth grades.

All teachers are state certified, with the majority (N=17) in elementary education. Several hold specialty endorsements in special education (N=4). One teacher is certified in secondary education, with a special education endorsement, and another teacher has an administrator's certificate in addition to an elementary certificate. Several teachers hold advanced degrees (N=8), ten teachers have a BS or BA. The ages of teachers in this study range between 26 and 57, with the majority between 32 and 45 years of age. Most teachers (N=11) had between 8 and 20 years of teaching experience. Only three teachers had less than five years, and three teachers had greater than 25 years of experience. There were more female (N=12) than male (N=6) teachers at this elementary school. This two-to-one ratio of females to males is typical at the elementary level in this school district.

Measures

The following procedures were investigated in this analysis: (a) direct observation of six teachers as they collaboratively grouped students for instruction in reading and math, (b) pencil-and-paper survey in which all teachers were asked to rank and assign a value to data sources available for decision making, (c) pencil-and-paper questionnaire in which all teachers described procedures and current practices for current grouping and instruction, (d) rank and sort of reading class roster, and (e) listing of referred and identified students for gifted and talented programs.

Direct Observation

A direct, non-interactive procedure was used to observe how teachers group students for reading and math. The trained observer sat in with one special education teacher and five fourth and fifth grade teachers during a one hour and twenty minute period as student instruction and placement decisions were made. Teachers were provided materials listing all students in the two grades as well as information from various data sources: (a) Stanford Achievement Test percentile scores by subject area, (b) Curriculum-Based Measurement percentile scores, (c) teacher recommendations, and (d) student's reading text placement form the previous spring.

Teacher Use of Various Data Sources for Grouping, Placement, and Identifcation Decisions*

by Tracey E. Hall
Judith A. Gelbrich
Gerald Tindal
University of Oregon

Introduction

Ability grouping of students for instruction has been under study since the 1920s (Slavin, 1988; Anderson, Mason, & Shirey, 1984). Teachers use various forms of grouping to respond to student differences in knowledge, skills, and learning rate. To optimally present a lesson, teachers form instructional groups so that students may profit from the lesson, thus avoiding a presentation of skills that may be redundant for some learners and too difficult for others (Slavin, 1988; Carnine, Silbert, & Kameenui, 1990). Students must also receive instruction in materials that are at an appropriate level of difficulty.

Whether within classroom, within grade level, or across grade level, ability grouping is a very complex teacher decision-making phenomenon studied by many researchers to: (a) evaluate grouping procedures (Wiesendager & Birlem, 1981; Haller & Waterman, 1985; Wesson, Vietrhaler, & Haubrich 1989), (b) determine the function of grouping (Strike, 1983), and (c) evaluate student outcome as a function of group instruction (Anderson, Mason & Shirey, 1984; Strike, 1983). Beyond the normal range of students a teacher must teach within the classroom, there are often instances of students performing at the extremes. Teachers must decide whether these students would best be served within the curriculum and instruction of the regular classroom or outside of the classroom. Our investigation evaluates how teachers use various forms of data for grouping, placement, and potential identification.

Teachers have a variety of data sources available to help them in the grouping decision-making process. In a survey conducted by Haller and Waterman (1985), intermediate level teachers considered student ability, general academic competence, work habits, behavior, personality, and home background to place children in groups for instruction. By grouping students, teachers attempt to maximize instruction.

Although many factors appear influential, student ability and academic competence dominate the decision-making process. The main tool for documenting ability and achievement is standardized norm referenced tests. These tests are also the most prevalent tools available in American schools (Valancia & Person, 1987). While standardized achievement tests are rarely used as the sole criterion for admitting children to specialized programs, such as Talented and Gifted, they frequently serve as an important screening device. Generally, school districts set a standard for consideration, such as a score above the 95th or 98th percentile in reading and math (Eby & Smutny, 1990).

Recently, however, the usefulness of standardized tests for classroom teachers has been seriously contested (Salmon-Cox, 1981; Wesson et al., 1989). Test procedures have limited utility for placing pupils in specific groups because they lack content validity: test items rarely reflect the curriculum of instruction (Coleman & Harmer, 1982; Jenkins & Pany, 1978). Teachers value test scores, but they also search for instruments that are more diagnostic in nature, match the curriculum of instruction, and are timely (Salmon & Cox, 1981). Achievement tests were neither designed for, nor are they capable of carrying out such a function.

Teachers seem to be at an impasse, since predominant tests have serious technical problems. What choices, then, do teachers have available? Two familiar options are well known in reading. The first is published, teacher-made, and curriculum-based Informal Reading Inventories. The second alternative is to use diagnostic measures, such as the Gray Oral Reading Test (1986) and the Gates MacGinite Reading Test (1978). Additionally, many diagnostic measures have been developed by teachers. However, these procedures also suffer from problems with validity and reliability (Fuchs, Fuchs, & Deno, 1982; Salvia & Ysseldyke (1985).

Another procedure that has been recently developed is Curriculum-Based Measurement (CBM) (Deno, 1989). CBM is a method of analyzing academic performance using systematic procedures with brief measures in specific academic areas. It is accurate in grouping students for instruction when scores are rank ordered and students are grouped based on similar results (Hall & Tindal, 1989; Wesson, et al., 1989). This procedure can assist teachers with student grouping and placement decision-making quite efficiently. Curriculum Based Assessment has recently been investigated as a screening measure in the identification

*Reprinted from *The Oregon Conference Monograph, 1990*, with permission of the editors.

of giftedness with kindergarten and first-grade children (Joyce & Wolking, 1988). Their findings suggest that Curriculum Based Assessment is at least as effective as the Metropolitan Achievement Test in identifying students for gifted programs within that age group.

In summary, CBM may be a viable alternative to the need for technically adequate measures that are relevant for classroom use. They overcome the problems of many extant tests (published, norm-referenced and diagnostic) and have some initial validity data on making placement decisions. Furthermore, they reflect the call by school personnel and researchers for procedures by which standards can be developed to determine student instructional level. such measures should also be able to discriminate performance levels among students and be minimally time-consuming (Coleman & Harmer, 1982).

This study investigates how teachers value and actually use testing data to make placement decisions so that they can provide appropriate instruction to homogeneously grouped students. Teachers must also make reasonable referrals to special services at each end of the performance spectrum. Our investigation analyzes CBM to determine if it can serve as a tool for making qualitative decisions about instructional level, as well as the categorical decisions focusing on placement of students with extreme skills (either very low or very high). Since a considerable amount of research has already been done on the use of CBM for making placement decisions in special education (Shinn, Tindal, & Stein, 1988), we also looked at the use of CBM for making placement decisions with Talented and Gifted students. In this study, we were interested in both the process of decision making as well as the decision that was eventually made. In most previous research on CBM, only the outcome has been documented. To fully understand the context for decision making, however, more data need to be collected on how teachers make decisions and what types of information they value.

Subjects

Eighteen teachers from a semi-urban school district in the Pacific Northwest participated in this study. These teachers represent one elementary building faculty serving approximately 380 students, in a district with four other elementary schools and total student population of 1, 787. This particular staff has been using Curriculum-Based measurement procedures for two years on a school-wide basis, the teachers are familiar with the procedures and how to interpret normative data results. The emphasis of the decision making, however, has been confined to screening referrals for special education and writing IEP goals.

Teachers in this school have traditionally used ability grouping for reading instruction. The first and second grades maintain a self-contained structure and ability group within the homeroom setting. Each teacher had a wide range of student skills in the classroom. Third grade classes ability group across their grade level. Each teacher had a somewhat homogeneous group for that grade level. The fourth and fifth grades ability group across the two grades for reading. Each teacher had a relatively homogeneous group of students for both the fourth and fifth grades.

All teachers are state certified, with the majority (N=17) in elementary education. Several hold specialty endorsements in special education (N=4). One teacher is certified in secondary education, with a special education endorsement, and another teacher has an administrator's certificate in addition to an elementary certificate. Several teachers hold advanced degrees (N=8), ten teachers have a BS or BA. The ages of teachers in this study range between 26 and 57, with the majority between 32 and 45 years of age. Most teachers (N=11) had between 8 and 20 years of teaching experience. Only three teachers had less than five years, and three teachers had greater than 25 years of experience. There were more female (N=12) than male (N=6) teachers at this elementary school. This two-to-one ratio of females to males is typical at the elementary level in this school district.

Measures

The following procedures were investigated in this analysis: (a) direct observation of six teachers as they collaboratively grouped students for instruction in reading and math, (b) pencil-and-paper survey in which all teachers were asked to rank and assign a value to data sources available for decision making, (c) pencil-and-paper questionnaire in which all teachers described procedures and current practices for current grouping and instruction, (d) rank and sort of reading class roster, and (e) listing of referred and identified students for gifted and talented programs.

Direct Observation

A direct, non-interactive procedure was used to observe how teachers group students for reading and math. The trained observer sat in with one special education teacher and five fourth and fifth grade teachers during a one hour and twenty minute period as student instruction and placement decisions were made. Teachers were provided materials listing all students in the two grades as well as information from various data sources: (a) Stanford Achievement Test percentile scores by subject area, (b) Curriculum-Based Measurement percentile scores, (c) teacher recommendations, and (d) student's reading text placement form the previous spring.

The observer recorded the proceedings verbatim noting time, teacher speaking, and item of discussion. Thus, a complete transcript of the proceedings was produced. At a later time, a participating teacher was asked to read and confirm the transcript for accuracy. To quantify the transcript, each statement was coded according to a classification system developed following the observation. Inter-rater agreement for coding the transcript was 75.4% following two sessions of definition and clarification.

Rank and Value of Data Sources

We administered a paper and pencil measure to evaluate how teachers assign a rank and value to specific data sources when making grouping decisions. Eight sources of student performance were listed alphabetically to avoid any ordering affect: (a) basal related tests, (b) behavior of a student. (c) fluency measures, (d) independent work, student performance, (e) informal reading inventories, (f) published achievement tests, (g) recommendations form previous teachers, and (h) teacher observations. There was also space to write any additional source used. Teachers were asked to rank the data sources they felt were most helpful (1-8) and then assign a vale of usefulness to each (1-4).

Questionnaire

A ten item questionnaire was given to each regular education classroom teacher in the school. The fundamental issues were related to decisions teachers made regarding placement of students into instructional groups, and the logistics, rationale, and procedures they used for the varying teaching structures in their individual classrooms.

Rank and Sort of Class Roster

Teachers were given their class roster for reading instruction with students listed alphabetically. We requested two tasks: first, teachers were asked to rank, by number, the students in their reading class from highest to lowest based on reading achievement; second, they were asked to sort the students according to reading ability into one of three categories, High, Medium, or Low. This procedure was completed prior to receiving CBM norm results for their classes.

Gifted Identification

To obtain information for this portion of the study, we asked the elementary teacher of the gifted program to identify the children at this school currently receiving services. In addition, the classroom teachers from grades two through five were asked to list students that they would refer to the gifted program. These two categories were compared to the academic performance of students on the Curriculum-Based Measures.

Procedures

Teachers completed the rating and value judging of information and written questionnaires between October 3 and 31, 1989. The sorting and ranking of students occurred before Fall CBM scores were made available to teachers. Throughout the collection of all information listed above, we attempted to be as unobtrusive as possible. Each teacher spent 20-30 minutes responding to the materials for this study. Data analysis included all of these sources of information as well as the Fall CBM norming data.

Results

Direct Observation

Teacher statements form this observation were categorized into six major headings: type of data, students, meeting organization, administrative concerns, placement decisions, and general comments (see Table 1). The student category comprised the largest number of comments, 40%. Within this category, the largest classification of statements was in reference to a specific child (69%). The second largest category was statements in direct reference to the data files available (19%). Thirty-one percent of these statements were related to achievement tests, and 29% were comments specific to CBM information. Only 16% of the statements referred to teacher recommendations; and reference to level of reading material comprised only 5% of the comments in this category.

Rank and Value of Data Sources

Table 2 presents a summary of the teachers' rank and value of the eight types of tools frequently used in placement and grouping decision-making, from highest ranked and valued to lowest. The teachers were consistent when assigning a rank order as they valued the measure as high, moderate, low, or no value.

Table 1. Summary: Coding and Classification of Comments in Grouping Meeting

Classification of Comments by Category	Number of Statements	%
Type of Data	77	19
Children	165	40
Meeting Organization	21	5
Administrative Concerns	60	14
Student Placement	74	18
General Comments	19	4
Total	416	100

Table 2. Teachers' Rank and Value of Data Sources

	Rank		Value	
	Mean	SD	Mean	SD
Student Indep Work	2.7	1.53	3.78	.43
Teacher Observe	2.9	2.22	7.78	.73
Teacher Recom.	5.4	2.21	3.53	.72
Inform. Rdg Inv.	4.8	2.01	3.06	.77
Curric.-Base Msr	4.9	2.05	2.65	.93
Pub. Ach. Tests	4.9	2.32	2.75	1.07
Basal Tests	5.1	2.10	2.33	.76
Student Behavior	6.1	2.12	2.39	.85

Paired t-tests were used to determine if there were significant differences in how teachers value these sources of information. There were significant differences in how teachers valued direct observations ($t(16) = -3.781, p = .0016$), children's independent work ($t(16) = -4.146, p = .0008$)) and teacher recommendations ($t(15) = -4.0012, p = .0012$), in relation to CBM. Again, significant differences were apparent when observations ($t(15) = 30, p = .0127$), children's independent work ($t(15) = 4.0, p = .0006$) were compared to the standardized achievement tests. However, when Curriculum-Based Measures were compared to standardized achievement tests, there were no significant differences in how teachers valued these two measures. Nor were there any significant differences in the value of teacher recommendations compared to teacher observations and children's independent work.

Questionnaire

All regular education teachers from the school responded to the questionnaire (N=17), though not every teacher answered each question. These teachers ability-group students primarily because of teaching skills (N=6), followed by student characteristics (N=5), and finally, by administrative arrangements (N=4) such as class size, or traditional practice. When asked how assignments are made to group levels, most teachers listed that they worked together to make decisions, using such criteria as individual teacher skills, trading low and high groups by year or by subject, student characteristics, and volunteering to teach a particular group.

In response to questions regarding the procedures for grouping, five teachers could not specify a starting point to the sorting process. Four teachers reported starting the assignment of students to groups with low ability students. Only one teacher reported this process beginning with the middle group. No one listed the high group as their starting point.

Teachers who ability-group for reading reported spending more time on the grouping process (mode 2-3 hours) than teachers who used a self-contained model with a mode of less than one hour. Generally, these teachers seemed to be satisfied with grouping students for instruction (N=14). No one expressed any dissatisfaction, although one teacher expressed willingness to change from across-grade grouping to self-contained if the opportunity arose.

Teachers' instructional delivery systems varied once students were placed in classrooms for instruction. Some (N=5) taught large groups for reading, since the class was ability-grouped. Those teachers (N=10) who grouped students within the classroom selected ability level of the students as their primary concern for grouping, with size ranging from less than 5 to 15. Teachers with one instructional group listed alternatives for flexible instruction such as cooperative learning groups, learning centers, or large group instruction.

Rank and Sort of Class Roster

Data collected from teacher ranking and sorting of students into high, medium, or low groups were analyzed in relation to reading proficiency as measured by Curriculum-Based Measures. Norming results from CBM were sorted by grade from the most proficient reader (highest reading rate) to least proficient reader (lowest reading rate). This resulted in a frequency distribution, a common practice in analyzing CBM norming scores (Deno, 1989). The distribution of scores was split into three groups by calculating the mean and standard deviation for each grade-level distribution. Scores below minus one standard deviation were assigned to group one (low), scores between one standard deviation below and one standard deviation above the mean were assigned to group two (medium), scores above plus one standard deviation were assigned to group three (high). A three-by-three Chi Square test was used to compare the teacher sorting of students into low, medium, and high groups and the CBM assignment to one of three groups. Teacher placement of students into groups was highly related to CBM rankings (2nd grade, $X^2(4, N=64) = 40.429, p =$

Table 3. Three by Three Comparison of Teacher and CBM Grouping

	Second Grade (N=64)			Third Grade (N=65)			4th & 5th Grade (N=124)		
	L	M	H	L	M	H	L	M	H
Low	9	6	0	8	9	0	17	17	0
Mid	4	28	4	2	21	2	2	51	4
Hi	0	4	9	0	11	12	1	15	17

Table 4. Using CBM and Achievement Test to Identify Students for Gifted Programs

Percentiles	80 PR				90 PR				95 PR				98 PR			
Test	CBM		Ach		CBM		Ach		CBM		Ach		CBM		Ach	
	+	–	+	–	+	–	+	–	+	–	+	–	+	–	+	–
TAG Ident.	5	2	7	0	5	2	5	2	5	2	4	3	4	3	2	5
TAG Ref.	13	7	18	2	5	15	11	9	4	16	3	17	1	19	3	17

Key: + = TAG identified by this criterion - = TAG Rejected by this criterion

.001; 3rd grade $X^2(4, N=65) = 34.182, p = .001$; 4 & 5th grade $X^2(4, N=124) = 73.749, p = .001$).

Within-class and within-grade teacher ranking of students correlated highly when teacher rank and CBM ranks were compared using a Pearson correlation coefficient, $\underline{r} = -.823$, $\underline{r} = -.60$, respectively. However the correlations were not high for across grade grouping.

Gifted Identification

Table 4 presents a matrix developed by using the percentile ranks of 80, 90, 95, and 98 for both Curriculum Based Measurement and the standardized achievement test. The students were separated into two groups, those receiving services for the gifted, and those who had been recommended to receive services, but who had not yet been identified as gifted. For each group, the number of students meeting the criteria at each percentile was calculated.

The majority of students identified as gifted received a score at or above the 90th percentile on CBM; this was also true of standardized test result. an equal number of students scored at or above the 98th percentile on both the CBM and standardized achievement tests. In this study CBM was comparable in accuracy for screening gifted students in relation to the less frequently administered standardized achievement tests.

For the group that had been recommended and not yet identified as needing services for the gifted program, the majority of students scored at or above the 80th percentile on both the CBM and the achievement test. However, at the 90th and higher percentiles, less than half of the students scored above this level on both the CBM and the achievement test, once again, demonstrating comparable results for both measure.

Discussion

The interest in this study developed from three basic questions surrounding assessment procedures in elementary schools: How do teachers value and use available measures? Is CBM a functional tool for grouping and placement decisions within classrooms? Could CBM norm results assist in the identification or screening of gifted students?

Teachers clearly indicated that they value and make use of a available data about their students. Of skills that can be directly observed. Our observation verified that teacher knowledge of the student is highly valued when available. This finding is very similar to Haller and Waterman's findings in 1985. However, direct observation also indicated that CBM and achievement tests were most useful for making grouping decisions. Teachers, when forced to rely on data sources, because of little exposure to students ant the beginning of a school year, used CBM first, and then published norm-referenced achievement test scores.

We found some interesting results when comparing information from the questionnaire to direct observation. Only three teachers from the 4th and 5th grades reported that they began the sorting process for ability grouping at the low level. However, when observing this process, all six teachers began at the low level, using teacher information and test scores to get those students into a group and keep that group as small as possible. In other instances, direct observation verified the questionnaire findings when decisions about teacher assignment to group and administrative issues were addressed.

These teachers find CBM a functional tool for use in the grouping and decision making process as demonstrated through observation and survey instruments. The accuracy of CBM for grouping students is further demonstrated by the high correlation of teacher judgment of students and the CBM rank results. Furthermore, we found that CBM was functional as a screener for identifying gifted students with this population. However, we recognize that, in this study, the number of gifted students was too small to be conclusive, and we would encourage further research in CBM and gifted screening to examine other curriculum areas. Teachers have shown that CBM scores for reading are as useful as the published achievement tests for grouping and placing students. These teachers like CBM because it confirms their judgments about student performance. It is an efficient tool for grouping, and CBM tests represent student performance in the curriculum of instruction. ◆

References

Anderson, R.C., Mason, J. & Shirey, L. (1984). The reading group: An experimental investigation of a labyrinth. *Reading Research Quarterly, 20,* 6-38.

Carnine, D., Silbert, J., & Kameenui, E.J. (1990). *Direct instruction reading* f(2nd ed.) Ohio: Merrill.

Coleman, M., & Harmer, W.R. (1982). A comparison of standardized reading tests and informal placement procedures. *Journal of Learning Disabilities, 9,* 396-398.

Deno, S.L. (1989). Curriculum-based measurement and special education services: A fundamental and direct relationship. In M.R. Shinn (Ed.), *Curriculum based measurement: Assessing special children* (pp. 1-17). New York: Guilford Press.

Fuchs, L.S., Fuchs, D. & Deno, S.L. (1982). Reliability and validity of curriculum-based informal reading inventories. *Reading Research Quarterly, 18,* 6-26.

Eby, J.W., & Smutny, J.F. (1990). *A thoughtful overview of gifted education.* White Plains, NY: Longman.

Hall, T., & Tindal, G. (1989) Using curriculum-based measures to group students in reading. In G. Tindal, K. Essick, N. George, M. George (Eds.), *The Oregon Conference '89 Monograph.* Eugene, OR: College of Education, University of Oregon.

Haller, E., & Waterman, M. (1985). The criteria of reading group assignments. *The Reading Teacher, 38,* 772-781.

Jenkins, J.R., & Pany, D. (1978). Standardized achievement tests: How useful for special education? *Exceptional Children, 44,* 448-453.

Joyce, B.G., & Wolking, W.D. (1988). Curriculum-based assessment: An alternative approach for screening young gifted children in rural areas. *Rural Special Education Quarterly, 8,* 9-14.

MacGuilt, W.H., Kamons, J., Kowalski, R., MacGinite, R.T., & McKay, T. (1978). *Gates MacGinite Reading Test* (2nd ed.). Chicago: Riverside.

Salmon-Cox, L. (1981). Teachers and standardized achievement: What's really happening? *Phi Delta Kappan, 62,* 631-643.

Salvia, J., & Ysseldyke, J. (1988). *Assessment in special and remedial education.* Boston: Houghton Mifflin.

Shinn, M.R., Tindal, G., & Stein, S. (1988). Curriculum-based measurement and the identification of mildly handicapped students: A research review. *Professional School Psychology,* 3 (1), 69-85.

Slavin, R.E. (1988). Synthesis or research of grouping in elementary and secondary schools. *Educational Leadership, 46,* 67-77.

Strike, K. (1983). Fairness and ability grouping. *Educational Theory, 33,* 125-134.

Valencia, S., Pearson, P.D. (1987). Reading assessment: Time for change. *The Reading Teacher, 40,* 726-732.

Wesson, C.L., Vierthaler, J.M., Haubrich, P.A. (1989). An efficient technique for establishing reading groups. *The Reading Teacher, 42,* 466-469.

Wiederhilt, J.L., & Bryant, B.R. (1986). *Gray Oral Reading Test.* Austin Texas: Pro-ed.

Wiesendager, K.D., Birlem, E. (1981). A critical look at the reading approaches and grouping patterns currently used in primary grades. *Reading Horizons, 22,* 54-58.

Teachers, Schema, and Instruction*

by Siegfried Engelmann
University of Oregon

Editor's note: This paper was written as a critique of a paper by Robert E. Floden "What Teachers Need to Know about Learning" which appeared in the volume referenced in the footnote. The critique is published by itself because it has much to say on its own.

The question this paper addresses is: What should teachers know about learning? I'll try to provide part of the answer in the first part of the paper. The second part expands on some details and focuses on why I would not follow any of Floden's recommendations.

Teachers should have a special kind of knowledge about teaching. That knowledge derives from the ability to execute the details of effective instruction. The teacher should know how to present tasks to kids in a way that makes it very clear that the teacher understands that teaching is acting—acting in a way that is appropriate for the situation. The teacher should demonstrate appropriate pacing, appropriate inflections and stress, appropriate responses to kids who perform well, and appropriate responses to kids who make mistakes. The teacher should be able to correct mistakes in a way that is technically sound but that doesn't "punish" the kids. The teacher should be able to demonstrate a range of presentational skills that permit "whole-class" responses and skills in terms of managing kids in a way that promotes hard work and positive work attitudes. The teacher, in summary, should be a technician.

In addition to these skills, the teacher should have the knowledge about diagnosing problems quickly and providing timely remedies. These skills are quite different from the probing and remedies that Floden describes. Rather, the teacher should be able to get information from kids at a high rate and know how to identify problems (based on kid responses) and how to fix up these problems the fast way, not by stepping outside the instructional program, but merely by repeating parts of the program that present difficulties to the kids. Related to this diagnostic issue, the teacher should know how to achieve a high criterion of performance, moving fast on activities that kids have already mastered and making sure that all new material is mastered. The teacher should be able to use kids' performance to determine whether kids are appropriately placed in an instructional sequence. (The basic

*Reprinted from *Competing Visions of Teacher Knowledge: Proceedings From An NCRTE Seminar for Education PolicyMakers.* Published by the National Center for Research on Teacher Education. Michigan State University, East Lansing, Michigan, October 1989 rule is that if a kid is perfectly firm on less than 70 percent of the tasks or activities the teacher presents, the kid is over his or her head. If the kid performs at much above 90 percent correct on "new material," the kid already knows the material and should be placed in a higher level of the program.)

Knowledge Teachers Need

The teacher should have knowledge about the relationship between teaching and kid performance. On a global level, they should know that all kids in a regular classroom can learn the various skills that are supposed to be taught in arithmetic, science, language, reading and other subject. Teacher should know that dyslexia is a myth, created by those who do not know how to teach decoding to young kids. They should understand that the corrective (remedial) reader is a product of what had been unintentionally taught, that the currently poor performance of kids in math and science represents a gigantic teacher failure—not a kid failure—and that teaching is a precise, logical game. They should know that the kids' responses are mainly a function of the teacher's behavior and that changes in the teacher's behavior cause changes in the kids' performance.

Teachers should understand why efficiency is important. The idea is to beat the clock to teach more in a specified amount of time so that the kids learn relatively more during that time. Over a school year, the minutes saved each period, each day create a substantial difference in how smart the kids are at the end of the year. Teacher should also know what is not efficient—lectures during which kids simply grow older, time-consuming demonstrations, poorly focused activities that are not targeted on identifiable instructional objectives, and tasks or activities that do not involve *all* the kids and yield responses from the kids at a high rate. (When the responses are at a low rate, the potential for diagnosis is at a low rate, and it becomes difficult to determine who is learning what and who is perfectly lost.) Teachers should be able to discriminate between a "lumpy" teaching sequence and a good one. They should be able to identify the activities that involve untaught skills, and the tasks that are far too ambitious in what they attempt to teach.

Problems in Establishing Knowledge

There are several problems with establishing this knowledge in teachers. The first is that it is impossible to induce this knowledge as knowledge (and not mere verbal tabloids) without a lot of direct experience. Furthermore, the experience must be with programs that have the *potential* to teach all the kids. Because most teachers are trained in traditional teacher-training institutions, they will probably never even observe *good* teaching. They may be fortunate enough to learn some good management skills, but the technology of good teaching goes far beyond these skills, and this technology simply cannot be taught if the instructional programs are poorly designed. The reason is that the instructional sequence is responsible for inducing the appropriate "schemata."

If the sequence is a spiral sequence, like that of the typical math basal, the kids work on a particular topic, like fractions, for a while. Then they launch into a sequence of other topics before returning to fractions. The return may be 60 school days later. Furthermore, the activities are very poorly designed. The number of "taught" examples is inadequate, and the applications prompt kids to figure out their own strategies for working the "practice exercises" that follow. If a teacher tries to teach this program well, the best she'll create are kids like Benny who have been "conditioned" not to attend to instructions, who make up strategies and interpretations that work for the various problem sets presented by the text, but that are dead ends. These kids also have incredible deficits in their knowledge (such as not knowing the 1/2 and 1.2 do not express the same value). Benny is *not* an unusual case.

A teacher teaching this kind of program will get nothing but bad information about what good teaching is and how it can change kids. If the teacher made sure that the kids were firm on ever "unit" presented in the program, the teacher would not cover very many units, and in the end, the kids would later revel problems. Similarly, the teacher teaching "fact versus opinion," as it is presented in reading basals, and teaching it well, would do her kids a great disservice because they would come away from the teaching with the misconception that there is some dichotomy between "fact" and "opinion." They would not understand that somebody could say, "I think the capital of California is Sacramento," and that the opinion could express a "truth." Similarly, every topic in science, math, and reading presented by the textbooks most widely used will induce misinformation or "distorted schemata" at a high rate.

Consider the kid learning fractions in a typical basal. The first three fractions presented are 1/2, 1/3, and 1/4. These are studied ad nausea, typically in the third grade. The "strategy" that the kids use to do the various worksheet problems is to count the pieces in the pie or the block. If there are 2 pieces, the fraction is 1/2. The kids usually perform well until they encounter a fraction that does not have 1 as the numerator.

Imagine the incredibly inappropriate schemata that are induced by this introduction. The kids assume that all fractions are less than 1, that they represent a piece of something, and that the top number of the fraction is simply a showpiece that has no significance. Of course these kids will have trouble later. But the cause of the problems they'll experience is the instructional sequence. Before a teacher could get good information about what excellent teaching is, the teacher (or somebody) would first have to rewrite the entire instructional sequence, as well as the instructional sequences for the other "topics" presented in the program.

Curriculum Sequence Causes Misconceptions

One fact that teachers should know is that the curriculum sequence is the basic cause of kid misconceptions. Another fact is that these misconceptions are very costly because reteaching the appropriate concepts or discriminations requires a far greater amount of time than appropriate initial teaching requires. A fifth-grade corrective reader, who has been unintentionally taught to guess at words and to try to figure out what the text says before decoding it, requires approximately 7 times the practice trials to become accurate on confused word pairs (like *a* and *the*). A 10th-grade corrective reader has practiced the inappropriate strategies longer and therefore requires a greater number of trials, possibly 12 times the number of trials required by good initial teaching in the first grade.

Finally, teachers should understand the realities of teaching and learning. They should know, for instance, that virtually without exception, major basal programs are *not* written by people who are able to view instruction from the perspective of the kids, are *not* field tested and revised substantially on the basis of problems that kids have with the program, and are *not* consistent with either how kids learn or with what they are expected to learn later. (See the NCTE *Report Card on Basal Readers*, National Council of Teachers of English, 1987.) Teachers should understand that these programs will induce misconceptions at a high rate, but that the solution would be either to scrap the programs or to rewrite them completely. Since neither alternative is realistic, the teacher must do the best that is possible.

Good Programs for Good Teaching

There are instructional programs that permit teachers to learn what good teaching can do. Although these programs are relatively unpopular among traditionalists, they have the potential to work. Certainly a teacher can butcher them because the program's potential is realized only if the teacher is technically good. We use these programs for training undergraduates and graduates.

As the teachers' skills improve, they learn by direct experience how a good activity is designed. They see that all the kids can do it. The teachers also see how much and what kind of practice is *actually* required to induce the various skills that are either taught glibly or not taught in traditional programs. Within this learning context, the teachers gain a precise understanding of how important *their* role is and the enormous difference in kid performance that is created by execution of details of their presentation their pacing, pausing, inflections, responses to kids' responses, use of challenges, and the other technical details of how they communicate and interact with the kids. Because it takes months to teach these various skills to the teachers, I can't go into great detail, but the point is that it is *all* very detailed—no global solutions, no glib formulas.

Teachers who work with well-designed programs, and who learn to teach well, become proficient at evaluating instructional programs. They can articulate why various traditional approaches are weak. And to an extent, they can fix up some of the major problems in a traditional program by applying what they have learned by going through effective instructional sequences. However, they are *not* instructional designers and wouldn't be effective without possibly five to eight years more training. But they can teach and teach well. They can diagnose specific problems, both in kids and in instructional sequences.

My description of what the teacher should know about learning is more like what the teacher should know about teaching, because we're not interested in some broad or unspecified category of learning, but rather the kind of learning that is caused by teachers. So the focus is on making sure that the teacher has the communication tools and interactional skills needed to do the job. This description is greatly different from that provided by Floden, but there are serious problems with Floden's position.

Major Problems With Schema Theory

I completely agree with Floden's observation that teachers frequently explain concepts accurately but can't understand why many pupils don't get it. I further agree that many teachers who have learned skills are incapable of distinguishing between whether an explanation is clear to somebody who already understands the concept or clear to a naive student who is trying to learn it. I agree that the response of teachers (a response that has been reinforced by the traditional view of education) is to blame the kids, attributing their poor performance to insufficient attention or lack of motivation. Finally, I agree that success in teaching depends on having the content "make sense to the pupils."

I disagree, however, with Floden's solutions to these problems. Here are the major problems with the use of schema theory to alter schemata:

1. It's impossible to teach just about anything in a major subject area without *altering* the schemata that kids have. Furthermore, virtually everything that is taught can be viewed as schema.

2. These alterations are a function of the instructional sequence that is presented not the framing statements and the window dressing, but rather the *details* of the instructional sequence. Distortions that are induced are a function of these details.

3. The proposed probing that teachers are to perform is not efficient and merely identifies problems. Understanding the problem does not guarantee the solution. The assumption that the teacher will be able to use this information to provide an effective remedy is perfectly unfounded.

4. Floden's suggestions for correcting distorted schemata will not work because they don't address the issue of "having the content make sense to the students." If it's true that distortions are a function of the instructional sequence (Point 3), then it follows that the only legitimate solution would be an overhaul of the sequence.

Schema

The first problem is schema and what they are. *Food*, according to Floden, is a schema within the constellation of other facts or relationships. We could therefore argue that any higher order class name functions in the same way – vehicles, buildings, animals, plants, etc. The problem is, where do higher order nouns end and lower order ones begin? Since these designations are a function of the particular context to which they are applied, virtually all nouns then become potential schema. *Ball* is a schema because in different situations, different balls would be "appropriate." Possibly baseball is a schema, too.

In addition to these nouns are rules that may run counter to experience, like "the earth is round." Is it possible that these are actually *superordinate* schemata of some sort? After all, we must distinguish between "earth" in the context of the world, not something used for planting things and building dikes. And we certainly don't mean *round* like a disc. In addition to these contextually embedded words is the meaning of the rule itself. Whether or not we consider rules as superordinate schemata, they would be in the class of schemata. But what wouldn't be in that class? We would have to search very far if the apparent criterion for calling something a schema is that it can be manifested in a variety of contexts. Something as elementary as the color purple resides in the sky, in perfume bottles, and in images created by closing your eyes and pressing against the lids (images that have no counterpart in the outside world). So whatever is not a schema must be rote labels of the highest order.

Possibly, it is not fair to try to categorize concepts and relationships as "schemata." Possibly, the valid test is simply whether kids use past knowledge to interpret present learning experiences. If so, then schema theory is perfectly trivial with respect to instruction. We don't need a theory to tell us that we would have great difficulty teaching a kid to add fractions with unlike denominators if the kid had precisely no arithmetic skills (couldn't count, couldn't identify numerals, and so forth). Furthermore, we would quickly discover why "prior knowledge" is prior in instructional sequences. If we attempted to teach our perfectly naive kid how to add fractions with unlike denominators, we would ultimately have to teach the various skills that should have been introduced "prior" to the introduction of this operation (basic equivalence, counting, and so forth) before we could *communicate* efficiently with the kid. If we started with the teaching of fractions with unlike denominators, our communication would obviously come across to the kid as one of the gibberish passages that Floden presents.

The central thrust of how Floden treats schemata seems to be to provide a framing that will mobilize the appropriate knowledge set and guarantee success. It won't work. Here's why: In instruction, schemata are strictly relative to what has been taught and what is to be learned. Nobody has a completely articulated "schema" for "fractions." Some mathematicians might come close, but the properties of fractions are potentially too pandemic to assume a "limit" of a lid on knowledge. Similarly, the kid in the fifth grade doesn't have a complete "schema" or even a set of complete "schemata" for fractions. The kid either has a schema that is appropriate for the applications that are to be presented next or he doesn't. If he doesn't, his "current knowledge" is either incomplete but not distorted, or distorted in some way with respect to what is to be taught next.

The three possibilities are that the kid has perfect background knowledge, the kid had incomplete background knowledge, or the kid has distorted background knowledge. Note that "perfect background" means simply that the kid has the prerequisite knowledge needed for what is to come next and that what will be presented will perforce modify the schema. (If this weren't the case, we wouldn't have to teach kids anything because they'd already know it.)

Since the kid with perfect background presents the easiest case, let's start with that kid. at some point in the teaching, this "perfect" schema will become either incomplete or possible even distorted, even if the teaching sequence is well designed. But what does schema theory tell us to do about restoring undistorted schemata that incorporate new knowledge? I'm not sure. The summary of things that Floden suggests should happen are reasonable, but the concrete descriptions of what the teacher does are unreasonable. Certainly the new teaching should be linked to the kid's knowledge base, and certainly the teaching would mobilize the appropriate framework (such as adding and subtracting fractions). Since the original schemata are now inappropriate, the kids should obviously exchange inappropriate schemata for better ones. But the kid *doesn't have access to the alternative schema* because it hasn't been taught yet.

When we start teaching the new material, we are creating some form of conceptual change. So possibly, we are supposed to engage in conceptual-change teaching, with circuitous demonstrations to create dissatisfaction and questionable verbal explanations, such as, "This will help you out later." We encounter a problem in applying conceptual-change teaching because we are unable to "help students draw on appropriate schemata." They don't have the appropriate schemata and won't have them until the successful teaching of the new operation has bee completed.

The teaching will not necessarily be successful. There are three possibilities: the teaching could be incomplete; it could create great distortion; or it could be perfect. Whatever happens to the students, however, will occur as a function of the teaching, not of any "advance organizers," explanations, or obliquely related demonstration. The framing that is presented through the examples and the tasks that are presented "cause" the schemata that kids come away with. The methods used to change them is what renders the instruction successful, partially successful, or a perfect disaster.

Diagnosis and Remedies

Consider Benny, the fifth grader with great deficits in math knowledge. Through his responses, he indicates precisely what his conceptual problems are. Indeed his description of the causes are probably quite accurate. Benny has been reinforced for winging it, making it up as he went along, and trying to psych out the various worksheets. The problem was instructional because Benny was successful, which means that the worksheets actually reinforced Benny's psyching-out behavior. To fix up Benny, however, it's quite another matter. We could make statements about what we would need to do. We need to modify his schemata. We need to show him the relationship between fractions and decimal values. We need to create a conflict, and we need to resolve it. and we need to do it efficiently.

Here's an effective way of doing it that does not involve any of the conceptual-change steps that Floden suggests; however, it will do everything Floden would like to see done. We introduce problem sets like those inFigure 1. For each row, Benny is to complete the fraction with the denominator of 100 that equals the first fraction in the row. Then Benny is to write the decimal notation. When we introduce the exercise, we may discover that Benny doesn't know how to convert the fractions in the first column into 100th fractions. So we'll teach him that. The conversion step is important because it shows Benny that the fractions are equal. They are equal because we multiply the fractions in the first column by a fraction *that equals 1* to get the equivalent fractions. Multiplying by 1 doesn't change the value you start with so the fractions must be equal. To convert the 100th fractions into decimals, Benny simply reads them: "fifty hundredths." That's exactly what he writes for the decimal number, .50.

Figure 1. From Fractions to Decimals.

Fractions	Equivalent Fractions	Decimals
$\frac{1}{2}$	$\frac{\quad}{100}$	•
$\frac{5}{4}$	$\frac{\quad}{100}$	•
$\frac{3}{4}$	$\frac{\quad}{100}$	•

As part of this exercise, we'll have Benny circle the smallest fraction and make a box around the largest *decimal* number. This part of the exercise will challenge Benny's notion that 1/2 and 1.2 are equivalent. He'll see that the "mediator" is the 100th fractions. They provide the conversion and they show that 1/2 can't equal 1.2 because 1/2 is the smallest fraction, and 1.2 is the largest decimal number.

After Benny has successfully performed on some of these tables (for more than one lesson), we introduce a variation that presents *dollar amounts* in the last column. And lo, we have given Benny a new slant on the entire operation. He now sees how decimals and percents interface and how their equivalence works (1/2 dollar is .50; 5/4 dollar is 1.25). Why not introduce the "dollar" link from the beginning, rather than having Benny work the problems "mathematically"? We want to discourage Benny form making anymore homemade interpretations. We want to make sure that he processes the full range of fractions including those like 9/5. If we give Benny the green light to think of fractions in terms of dollars, he may come up with a perfectly inappropriate strategy for working the problems.

That's the solution, very simple, very quick, and guaranteed to work. Note that the "dissatisfaction" is short circuited. We simply work with what knowledge Benny has and show him the appropriate *relationships*. We point out the relationship between dollars and decimals, but in this case, after the fact, not as a premise or rule for handling conversions, because we want to establish *the mathematical operation* as the primary one for driving this relationship. The remedy is provided with no windy explanations, no seductions, and no wasted time on activities like counting out money. Yet, when Benny completes the exercises and their extensions to "word problems" and so on, we will have greatly modified his schemata for "money" (because we have enlarged what he already knows into a greater constellation of knowledge that includes equivalent fractions), and his understand of equivalence. All these changes will come about as a function of what we do and how we do it—the details of instruction.

Furthermore, if Benny's instruction had included activities like the ones described above, Benny would not have either the knowledge deficiency of how fractions relate to decimals or the notion that the game is to psych out worksheets. The issue is one of instructional design. On issues of design, Floden says simply,

Students will understand and remember better if they use the appropriate organizing principles that they have already mastered to make sense of what they are learning. This requires subject matter knowledge of appropriate ways of organizing and interpreting content.

So what is left for "schema" theory, except to add "dissatisfaction" exercises that are perfectly unnecessary and inefficient demonstrations? Although Floden provides NO suggestions for preparing Benny, Floden does address some "distorted schemata" problems. For each problem, I'll provide a remedy that I guarantee will work. None of these remedies will resemble what Floden suggests, but I'll also guarantee that his remedies won't work.

The flat earth: From the responses of the kids, we know what kind of instruction they received, mostly rote information. What must be implanted in the kids' head, however, is a "transformation," an understanding of how to relate phenomena viewed on the earth the kids have experienced to "round earth" phenomena. Here's how we do it with *second graders:*

1. We teach major "continents" *using the globe.* As part of this teaching, we present the globe in different orientations so kids get used to identifying North America, for instance, when the globe is upside down. Kids also learn to identify where they are on the globe.
2. We present the relative notion of up and down on the globe by putting a "figure" on different parts of the globe and indicating *up* for that person and *down.* The rule we present: "Down is always toward the center of the earth. Up is always the opposite direction." (We show how a person looks with he "jumps' up from different parts of the globe.)
3. We follow with worksheets that show people on different parts of the globe. For some exercises each person would be holding a ball. For some tasks, kids would draw an arrow to show the direction the ball would move if the person dropped it. For other exercises, kids would draw an arrow to show the direction of the ball if the person threw it straight up into the air.
4. Next, kids would do tasks with the globe that involve going from "continent to continent" or to different places within a particular continent. They would move a figure on the globe, when the globe was presented in different orientations. These would point out that the orientation of globe is perfectly irrelevant to how the "figure" on the globe "looks" (upside down or right side up).
5. Extension activities involving the solar system, rotation of the earth, and so on, follow.

Note that this sequence would not be presented in a "lesson." Rather, it would be an ongoing activity that spanned possibly 12 lessons, but not requiring more than a few minutes each lesson. In the end, the kids will have an understanding of "round earth" that permits them to map what they know about flat earth on the surface of the spherical earth. Note that there would be no studies of Columbus, no looking up in the sky, nothing but a frontal attack on the various relationships (or schemata) that we wish to teach.

Photosynthesis: This example reveals the necessity of instructional design. It also illustrates how kids could have a reasonably perfect schema for instruction that precedes "photosynthesis," but how inappropriate framing and poor instruction could cause incredible problems. Floden asserts that "plants, like animals, need *food* to provide energy for growth and the operations of the systems of the organism." He asserts that "starch stored in the roots or seeds *is* food." Wrong on both counts. The starch is no more food than your muscles, fingernails, or fat are food. They may become "food" for other organisms, but certainly not for you.

Floden's experiment is a classic example of two things you should never do: (a) present an experiment that doesn't prove anything; (b) present an experiment before the fact. We have done a lot of experiments with before-the-fact (or before-instruction) experiments. The bottom line is that even the relatively short ones are a waste of time. Kids either don't remember what happened in an experiment or are unable to relate the experiment to what they learn later. (After all, they do not have the schema necessary to provide a relevant relationship. So it is difficult for them to "store the information without distortion" before they can finally use it.)

In any case, Floden's teacher grows the plant in darkness to show that a plant with plenty of water and soil will die, and die soon, according to Floden. And this experiment is supposed to demonstrate that soil and water could not be "food." Obviously, the experiment doesn't show that at all. We hope that there are not smart kids in this classroom because just one of them could raise havoc with this "demonstration." The kid brings in three dead plants. He explains, "I took the first one out of the soil and put in in distilled water, in sunlight. It died in a few hours. I used a hairdryer to dry out the soil in the second one. It put it in the sun. It died in a few hours. I took the third one, pulled it out of the soil, laid it on the dry ground, in sunlight. It died right now."

In the meantime, what is happening to the teacher's plant? It's growing like crazy in the darkness. The reason is that sunlight inhibits stalk growth. In darkness, the inhibition is removed, and the plant grows very rapidly. Does the plant die "soon?" Depending on the plant, and it's dormancy responses, it may live for six months, often for five weeks. So the experiment basically compounds the infraction of trying to teach kids something that is basically not true. The truth is shown largely by the four experiments (the teacher's and those performed by the kid). The plant NEEDS sunlight and raw materials that are provided by water and soil. The plant (or green plants) also need regular air for the carbon dioxide.

How would we do it the right way? We would do what Floden suggests won't work. We teach the kids carefully, and of course, relate what is new to what they already know.

1. We begin with a reorganization of knowledge (schemata). We indicate that all organisms need two primary things to grow and stay alive: raw materials and energy.

2. We teach kids about energy. Specifically, we teach them the major forms: mechanical, radiant, electrical, chemical, and heat. We also teach the rule that energy in one form can be converted to energy to another form. We give them lots of exercises in which they identify the form of energy that is being shown, and we present conversions from one form to another.

3. We teach basic facts about chemical reactions, illustrating them with things like "burning." The test of a chemical reaction is that you end up with chemicals different from the ones you started with.

4. We apply the rule about what all living things need to grow and stay alive (raw materials and energy) to animals, showing the kids that all the "mechanical" things the organism does use energy (just like a car using up fuel) and that the source of raw materials and *energy* is food. The major raw material that is added to the animal's "food" is oxygen. The organism extracts energy from the food through chemical reactions. The basic reaction is a form of "burning." (You're warm because there's a kind of chemical burning going on inside of you.) Burning is a simple way of saying that the game is to go from higher energy chemicals to lower energy chemicals, which are the ones you end up with when something burns.

5. Finally, we apply the basic needs, energy and raw materials, to plants. The source of energy is the sun, not food. The raw materials come from soil, air, and water. Enter photosynthesis (which simply permits the plant to convert lower energy chemicals into higher energy chemicals).

Certainly the framing is important. But it is not possible to separate the framing from the instructional design. And the design must take into account where the kids are going from here. We want to teach them always so that what they learn later can be easily related to what they already know so the new schemata do not contradict earlier-taught ones, and do not stand as islands that are unrelated to what had been taught. But the question of how to achieve these links *does not automatically spring from the diagnosis of the problem.* And the remedy is often complicated.

Remedies From Diagnostic Information

For all the examples that Floden presented, I gave instructional remedies that will work if they are developed appropriately. Would I expect a teacher to provide these or other workable remedies? No. Why not? Because I've worked with a lot of teachers, and I appreciate both their problems and their limitations. Teachers typically do not know how to *teach* "concepts," information presented by "rules," or transformations. Typically, the teacher talks *about the concept* or rule, but does not reduce it to the necessary exercises, tasks, and extensions that teach the concept or rule. Once, we presented over 50 teachers with the assignment "Teach your kids the rule that liquids and gases move from a place of high pressure to a place of low pressure." The basic teaching would involve presenting the rule, having the kids say it, then applying the rule to a series of simple examples (diagrams that show the place of high pressure, the place of low pressure), and then having the kids draw an arrow showing the direction of movement. (Other examples show the arrows indicating the direction of movement and require the kids to label the high and the low.) Not one single teacher did it or even came close. Most talked about the "water cycle" or did some whimsical experiments that did nothing but consume time. None taught the kids.

We don't have to go beyond Floden's paper, however, to discover that a mere identification of the problem does not necessarily imply that a workable remedy will follow. Floden stated the problems, but provided no remedy for Benny, none for flat earth (except to warn the teacher that even after reading about Columbus, kids may have failed to adopt the appropriate schema) and one for photosynthesis that will impart distorted schemata. So effective solutions are not glib and simple. And their complexity raises a serious question about whether teachers should spend time probing. Certainly they will discover problems, but if the identification of the problem does not guarantee an *effective* remedy, the probing may be a waste of time and a cause of the teacher actually teaching less.

Most of the instructional material the teacher uses is hopeless from the standpoint of instructional design. The checklists of "objectives" are a joke. They represent things that are presented in the program, not things that are presented in a way that could possibly lead to uniform mastery. It would be comforting to suppose that the teacher could fix up the programs, but when and how is that going to happen? Will the teacher stay up all night trying to reorganize the curricula so they have the potential to teach? And how is the teacher going to learn how to do it the right way?

Teachers have neither the time not the training to do it. They typically remain slaves to their instructional programs. In one study that we conducted, even teachers who reported that they deviate extensively from the specifications of their basal reading programs, actually followed more than 95 percent of the program specifications (for the regular part of the lessons, not the "enrichment" activities). The relationship between teacher and instructional program is a lot like that of an automobile driver and car designer. To drive the car, we don't have to know how the carburetor works or the details of the turbulence inside the combustion chambers. Those are the designer's problems. The driver should have a machine that has the potential to perform well in various driving conditions. So it is with teaching. The program designer is supposed to create a "machine" that will work well, if used appropriately.

The programs that we developed have scripted presentations, a feature that strikes traditionalists as being stultifying to the teacher's creativity and ability to interact with the kids. These criticisms are based on distorted "schemata" of teachers, their creativity, and the importance of framing concepts in a way that has the potential for creating unambiguous communication with the kids. Anyone working with teachers on *effective* teaching (a high criterion of performance) would quickly learn about the advantages of scripted presentations and of the details of an effective sequence (such as not spending an entire "lesson" on a particular idea, when information about "learning" shows that kids can't assimilate a great deal of information presented at one time and that by "spacing" the practice over a series of days, kids learn things faster).

Certainly by teaching these programs, the teacher will learn both about the content and about the kids. Warped or greatly distorted schemata will not occur in these programs, which is something the teacher may observe. And, hopefully, there will be the transfer of skills to other situations. Meanwhile, the teacher is not burdened with "probes" because they are totally unnecessary. The performance of the kids on the activities presented in the well designed program provide the teacher with all the information that is necessary to determine if there is a problem.

If the kids do the exercises without making mistakes, there's no problem. If kids make mistakes, there is a problem, but the remedy is straightforward. The teacher does not have to step outside the program, merely repeat exercises or tasks that had been missed and bring the kids to a high level of mastery. If the program is poorly designed and actually teaches something as misleading as, "plants make their own food," the teacher is out of luck. Unless the teacher reorganizes the entire "unit" and throws away the text, the kids will come away with varying degrees of distorted schemata.

Floden's remedies are based on the assumption that what the kids learn is influenced or "caused" by what the teacher does. (Otherwise, why provide the "dissatisfaction" activities, the explanations, etc.?) If this assumption is valid, then probing and after-the-fact fix ups are not the primary solution. The primary solution would be to go back and fix up the programs so they didn't convey distorted schemata and so they effectively induce the relationships and facts that would permit students to learn in an orderly and efficient way. Floden's basic assumption is correct: Kids are lawful. They learn exactly what the teacher teaches, although much of what is actually communicated to the kids is unintentional. If a remedy is effective in correcting a misconception, it should be introduced before the fact as part of the initial teaching to buttress against the misconception.

Since the problem that schema theory is supposed to address is that of organizing content so it makes sense to pupils, and since the curriculum is what determines whether it will make sense or be gibberish, the primary solution must be one of instructional design, not probing, and certainly not practices based on the assumption that the teachers who can't view instruction from the pupil's viewpoint will be able to organize the content so it does make sense to pupils.

In summary, teaching is an act that involves orchestrating many details. Some are details of content, and the content is conveyed primarily by the verbal and nonverbal applications of rules or principles, the juxtaposition of things that are done in the lesson, the amount and use of vocabulary and facts. Through these details an organization is conveyed. If the framework created by the activities is vague, abstract, or unclear, students will employ a variety of "sense-making" strategies, most of which will be inappropriate or distorted. If the design has the potential of conveying the appropriate relationships and discriminations, and if it is continuous with what the kids will learn later, the content is organized so it has the potential to make sense to any kid who is adequately prepared for the program. These design issues are not effectively handled by teachers and do not derive automatically from a description of a "distorted"-schema problem.

Even if the program is well designed and has the potential of making sense to all the students, the design represents only a potential. This potential will be realized only if the teacher is proficient at conveying the information and executing the various behaviors that are needed to make the communication real. This reality occurs only if the students are taught to a high level of mastery (so they are relatively fluent or automatic in applying the facts and relationships), are motivated to learn, and understand that they are expected to learn. The skills that this teacher must have are far from trivial. Relatively few teachers possess them; however, these skills can be taught. and teachers who possess them have a great potential to induce content so it makes sense to pupils. ◆

Reference

National Council of Teachers of English, Commission on Reading. (1987, November). *Report card on basal readers.* Paper presented at the NCTE Invitational Conference on the Basal Reader, Los Angeles.

Oak Park & River Forest High School
Oak Park, Illinois

Located nine miles west of Chicago, Oak Park ranks as one of the city's more affluent suburbs. For twelve years the community was home to Frank Lloyd Wright, a place where many of his buildings remain as area landmarks. The Oak Park and River Forest High School, now a sprawling campus with approximately 3000 students and 300 teachers, once graduated Ernest Hemmingway. There is a long history of excellence in Oak Park, and as one might expect, this extends to academics. Students' scores on the California Achievement Test (CAT) generally reach into the 80th percentile, and over 80% of the graduates attend college. In an era of commissions on excellence and hand wringing over intellectual decline, impressive performance of this kind gives more than small comfort to the district's administrators.

Successful as the typical student at Oak Park may be, there are many others—a surprising number in fact—who are less fortunate. Although a definite minority, these "at risk" students score well below their peers on the CAT. On the average, mean performance is at the 20th percentile, with grades hovering in an equally depressing zone: somewhere between Ds and Fs. Nonetheless, these students can easily hide (or can easily be hidden) in the shadows of Oak Park's more typical student.

When Dr. George Gustafson arrived at Oak Park as the district's new superintendent and high school principal three years ago, one of the first faculty concerns was the at risk population. Teachers only had a general feel for these students—who they were, how much they were failing. To better understand the problem, Gustafson suggested that the school review the first six-week report cards of the sophomore class. To the surprise of everyone, the at risk population was larger than anticipated. Of the 690 students, about 180, or 25 percent, were failing two or more of their classes. "*These* were the students who were not successfully participating in the general program at Oak Park," explained Gustufson.

Gustafson wanted something other than more basic track classes or tutorial assistance. Both of these "solutions" are common in secondary schools, and the results are often meager. Many at risk and special education students fail the basic classes. And while tutoring may provide individualized help in completing homework assignments and preparing for tests, it is more often than not a cosmetic tactic. Many students do, in fact, pass exams and even graduate from school. However, it is doubtful whether they know more after four years than when they entered. Instead, they are more likely to be ill-prepared for the demands of work following high school. The general lack of abilities among these kinds of students has fueled a growing concern in the business community over the sheer number of new applicants who thoroughly lack basic literacy skills. Gustafson, then, chose not to perpetuate a reactive, "put out the brush fires" system.

During his first year, Gustafson contracted with Dr. Mary Anne Wheeler as a consultant and teacher trainer. Wheeler, along with Dr. Maria Collins (who was to join the staff a year later) are specialists in at risk and learning disabled students. Together, they devised a comprehensive program based on SRA's Direct Instruction programs. They called it the Structured Studies Program.

The Structured Studies Program

Unlike so many high school remedial or special education programs, where students progressively disappear from the regular curriculum never to return, the Structured Studies Program attempts to provide an intensive, but concurrent basic skills program for a *limited* time. On the average, one third of a student's day is spent in the Structured Studies Program. Every effort is made to work with students on academic deficiencies and study skills and to fully return them to the regular program in no more than two years. This requires early identification, a process which now starts at the end of the eighth grade. In this way, the Structured Studies Program can work with at risk students early in their high school careers, while they are ninth and tenth graders. Entering the program depends on grades and test scores.

To qualify for the program a student must be failing two or more classes and score at less than the 40th percentile on the CAT. All who meet these criteria are given a battery of placement tests for the Direct Instruction programs. Only two to five percent of those who are given placement tests are too low for the Structured Studies Program. These students, in turn, are referred for special education placement. As a middle ground for academic remediation, the Structured Studies Program reduces the number of at risk students who may end up in resource rooms because of a lack of options.

The Structured Studies Program is a carefully designed, two-part program. Initially emphasized are reading, spelling, writing, reasoning, and mathematics. Through programs such as *Corrective Reading (Decoding and Comprehension)*, *Corrective Spelling Through Morphographs*, *Corrective Mathematics*, and *Expressive Writing*, students make rapid gains in their basic skills. For most students, this is the main thrust of their program, taking a year or more to complete. Oak Park teachers consistently note that this strand of the Structured Studies Program—the Direct Instruction programs—leads to the most visible changes in student academic performance.

Study skills, time management, and organizational strategies comprise the second phase of the program. Here, students learn how to use the library, take notes, and manage their time more effectively. Naturally, the Structured Studies teachers use Direct Instruction techniques to teach these high school survival skills.

Direct Instruction is even used to teach school rules. As Dr. Collins remarked, "Many of these kids are 'school survivors.' They know how to succeed at failing, how to avoid work and toy with expulsion. As much as academics, they also need to know the school rules and how to follow them." Students were taught school rules at the beginning of the 1989-1990 academic year, and they were systematically apprised of consequences of a wide range of deviant activities. Expulsions have dropped to one third of what they were the year before.

Results

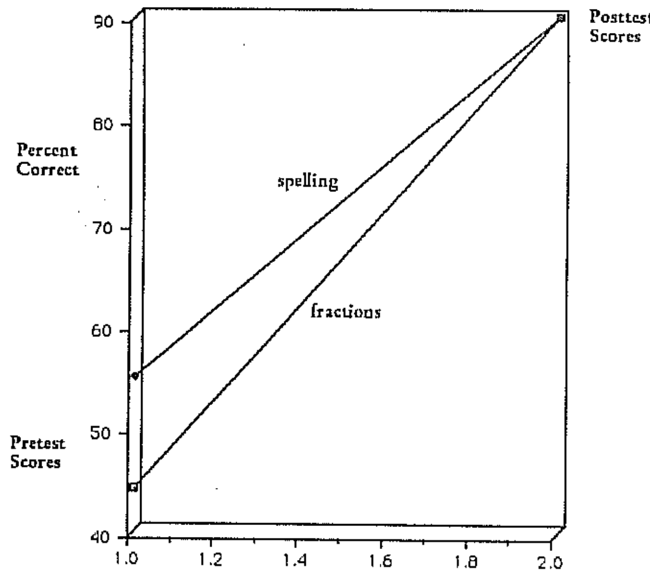
Academic gains in the basic skills have been impressive. Reading and vocabulary subtests of the Gates-MacGinite Test show dramatic improvement over a six month period. Changes on the California Achievement Test reflect comparable gains, with 10 and 16 percentile points improvement on each subtest respectively. The figure below compares traditional, expected growth for such a period with students in the Structured Studies Program.

Criterion measures in spelling and mathematics show that students are entering the programs at a low level of performance and, after one semester, showing clear signs of mastering the material. The figure below shows an unequivocal rise toward mastery in spelling and fractions, both necessary survival skills for high school.

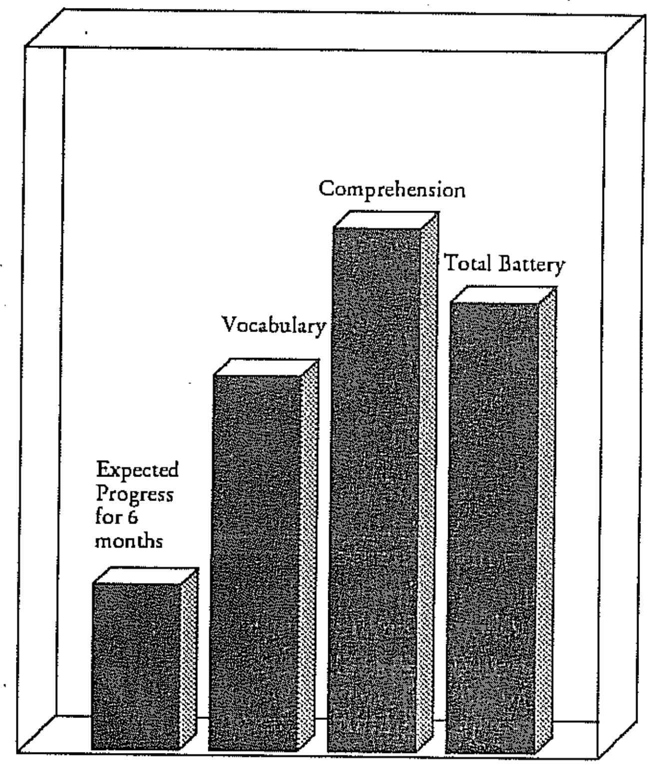
Finally, an increasing number of Structured Studies students are returning to the regular program on a full time basis within the two year goal. According to Dr. Collins, "We've been about 70 to 80 percent successful in this area. Considering that some of the students graduated before they left Structured Studies, we're pleased at this level of integration."

Reactions

Reactions across the spectrum — from skeptical teachers at Oak Park to administrators and parents — have been positive. One of the new Structured Studies teachers, Pat Graham, was very cynical about another remedial program for at risk students. After the first year, however, she has swayed. "I am now convinced that Direct Instruction gives students the skills and strategies to be successful in their other classes." The signs of success are apparent to many of Oak Park's staff. Karen Urban, an English teacher, has noticed that the students in from the Structured Studies Program, "are doing better than many of my other English students. They come to class prepared with their notebooks and begin to work right away."



Growth on the Gates-MacGinite Reading Test



Oak Park and River Forest—*Continued*

Dr. George Gustafson, Oak Park's superintendent, sees improvement not only in grades and behavior, but in his school budget. Special education referrals have dropped approximately 50 percent. According to Gustafson, "At the cost of $1,500 per student, this has resulted in over $150,000 in savings thus far." Further, the at risk students used to take the "basic" classes (like general math), where there was a 40 percent failure rate. Each class, which then has to be reoffered, costs approximately $10,000. Gustafson has been able to cut a number of these classes because of the Structured Studies Program. With the extra funds accrued from the reduced special education enrollments and the basic classes, Gustafson plans to hire three more Structured Studies teachers next year and still save money. This, he feels, is a far more efficient use of resources for the academic needs of at risk students.

Parental reaction has ranged from approval to elation. The Structured Studies Program attempts to engender involvement through joint placement decisions and regular phone or mail contacts on six week intervals while students are in the program. With secondary students who have had less than illustrious academic careers, parental enthusiasm and support is not easily won. But in so many other instances, there is a realization that things have changed. In one parent's words, "This program is exactly what my son has needed. I wish that he had had this program several years ago."

Yet nowhere are the reactions more important than the students themselves. Repeatedly these students, most of whom are frustrated and reconciled to failure, sense a definite change in their abilities. They have seen their grades go up and are much more willing to study and to participate. A former student of the program summarizes it well, "I really didn't want to talk a lot in class. I was getting Cs and Ds. Now I'm getting Bs. I'm above average now." ◆

ADI MATERIALS PRICE LIST

Direct Instruction Reading (Revised)

Douglas Carnine & Jerry Silbert

Membership Price $32.00 — List Price $40.00

Direct Instruction Mathematics (Revised)

Douglas Carnine, Marcy Stein & Jerry Silbert

Membership Price $32.00 — List Price $40.00

Teach Your Child To Read in 100 Easy Lessons

Siegfried Engelmann, P. Haddox & E. Brunner

Membership Price $12.00 — List Price $15.00

Generalized Compliance Training

Siegfried Engelmann & Geoff Colvin

Membership Price $16.00 — List Price $20.00

Structuring Classrooms for Academic Success

S. Paine, J. Radicchi, L. Rosellini, L. Deutchman, C. Darch

Membership Price $8.00 — List Price $10.00

Members of the Association for Direct Instruction may purchase copies of the materials listed above at the Membership price. Shipping charges are $1.50 per book for 1-5 books and $1.00 per book for orders of 6 or more. Orders are to be paid in U.S. Funds, in advance. Purchase orders are also accepted. Please allow 4 weeks for delivery.

ADI cannot provide copies for entire classes nor can we provide desk copies. All such requests must be made to the publisher of the specific book.

ADI presents. . .

Basic Skills in Teaching—
A Video Training Program for Effective Teaching Skills

These 3 lessons show skilled teachers demonstrating effective teaching techniques with a variety of students and a range of instructional materials. The lessons are designed for individual use by novices to Direct Instruction, but can be used by supervisors or teacher trainers to illustrate effective use of Direct Instruction techniques. Video examples demonstrate correct and incorrect use of teaching skills with small groups of low-performing students. In the workbook that accompanies the video presentations, the viewer has the opportunity to practice the skills presented. Skills are reviewed cumulatively throughout the lessons.

Overview of Lessons:

Lesson 1, *Pacing and Signaling* (25 minutes)

- Presenting scripted material with enthusiasm
- Moving quickly through lessons to cover more material and maintain student attention
- Using signals to increase teacher-student interaction rate

Lesson 2, *Motivation* (30 minutes)

- Setting clear behavioral and academic expectations
- Providing consistent feedback
- Using group management systems to increase student motivation

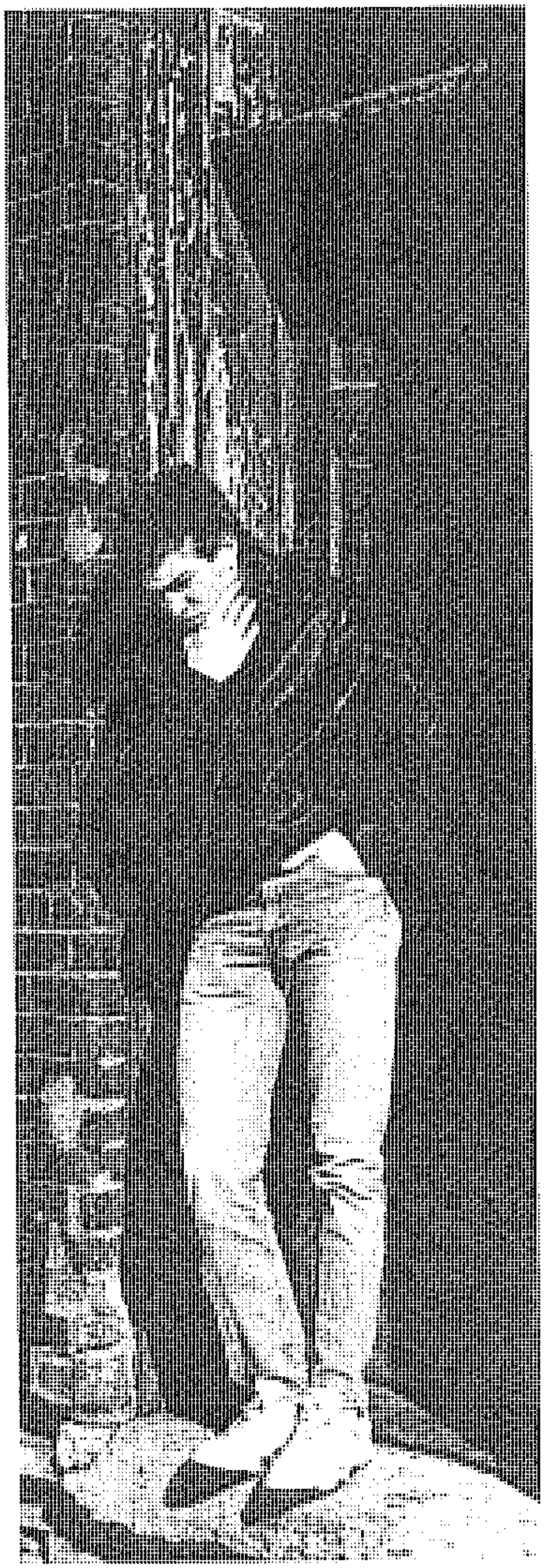
Lesson 3, *Corrections* (30 minutes)

- Correcting errors immediately and effectively
- Using a standardized correction procedure to remediate student errors, regardless of instructional materials

Cost: $75.00 per lesson (includes trainer guide and 1 workbook)
$200.00 for set of three lessons
$5.00 per extra workbook

To order, send your check or purchase order to:

Association for Direct Instruction
P.O. Box 10252
Eugene, OR. 97440
(503) 485-1293



Their last chance can be their best chance of all!

You've tried them all. And Johnny still can't read. Nor can Mary or Carlos or Elizabeth or Tim. And, they're getting older. As a concerned teacher, you're worried. Time is running out and their chances are getting slimmer. Their literacy will soon be put on the line as they are asked to compete in the modern workplace. Just what are their alternatives?

SRA has a solution—the Corrective Reading Program. Designed for students in grades 4-12 who haven't learned in other reading programs and don't learn on their own, Corrective Reading teaches both Decoding and Comprehension strategies that can enable students to meet the challenges of literacy.

For more information about the best chance for your students, fill out the response form below and mail to: SRA, 155 N. Wacker Drive, Chicago, IL 60606 or call 1-800-722-5351.

SRA

☐ Yes! Please send me more information about Corrective Reading

☐ Please have a sales representative call on me.

Name ____________

Position ____________

School ____________

Street ____________

City ____________ State ______ Zip ______

Phone # ____________ County ____________

Association for Direct Instruction
P.O. Box 10252
Eugene, OR. 97440

Non-Profit Organization
U.S. Postage Paid
Permit No. 122
Eugene, OR

Join the Association for Direct Instruction

Membership Options:

A) Regular Membership: $15.00 per year (includes one year of *DI NEWS* and a 20% discount on ADI sponsored items and events).

B) Student Membership: $7.00 per year (includes one year of *DI NEWS* and a 40% discount on ADI sponsored items and events).

C) Sustaining Membership: $30.00 or more per year (includes regular membership privileges and recognition of your support in the *DI NEWS*).

D) Institutional Membership: $50.00 per year (includes 5 subscriptions to the *DI NEWS* and membership privileges for 5 staff people).

E) *DI NEWS* Subscription only: $7.00 per year (outside North America and Hawaii $10.00 per year).

ADI sponsored products and events include books and other materials published or marketed by the Association for Direct Instruction. The ADI NEWS is published 4 times a year (Fall, Winter, Spring and Summer).

To join the Association, complete the bottom portion of this form and mail it, with your check or Purchase Order (in U.S. funds) to the Association for Direct Instruction.

Check one:
I wish to become an Association member. Please enroll me as a:

_______ Regular Member ($15.00 annually)
_______ Student Member ($7.00 annually)
_______ Sustaining Member ($30.00 or more annually)
_______ Institutional Membership ($50.00 annually)
_______ I wish to subscribe to the DI NEWS only ($7.00 annually; $10.00 outside North America & Hawaii)

Name: ______________________________

Address: ______________________________

City, State, Zip: ______________________________

Phone: ______________________________

School District or Agency: ______________________________

Position: ______________________________