ADI NEWS

VOLUME 9, NUMBER 1 THE ASSOCIATION FOR DIRECT INSTRUCTION FALL, 1989

Mark your calendar:

Eugene Direct Instruction Conference
August 6–10, 1990

Salt Lake City Institute
August 13–17, 1990

Plan Now to Attend!

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 40 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.

Editors .... Wes Becker
.... John Woodward
Associate Editors for Research .... Craig Darch
.... Russell Gersten
.... Robert Horner
.... Ed Kameenui
Departments
Dear Ziggy .... Zig Engelmann
Software Evaluation .... Douglas Carnine
Layout .... Wes Becker
Typesetting .... Bryan Wickman
Printing .... Springfield News

FROM THE EDITOR—

ADI Annual Awards Made at the Eugene Conference

Education Service Awards

Wes Becker presented the Educational Service awards to the Follow Through directors (past and present) attending the Eugene DI Conference. The following is from his presentation.

The ADI Board of Directors voted to recognize the special contributions of our Follow Through Directors to the improvement of education. Four of them are here at this Conference and I would like to present them to you.

As many of you heard yesterday at the symposium they presented, these former directors participated in the biggest educational experiment ever undertaken. They dedicated a good part of their lives to helping make schools work better for disadvantaged children.

In Uvalde, Texas, Alice Martinez became a teacher early in the program, and then became a supervisor, and then the director. She helped create a setting where Hispanics for the first time had a say in their schools. She was a strong person, a strong leader, and tonight a strong candidate for an educational service award.

In East Las Vegas, New Mexico, Margaret Aragon had been a teacher and a principal when she took over the Follow Through project. Her knowledge if instruction and the community, and her hard working ways led to an exemplary DI program with some of the strongest outcomes for any DI site. She created a new solution for our problems of transition to 4th grade by moving her 3rd grade teacher on with the children. I hear she may also have contributed to the women's lib movement in patriarchal New Mexico.

Our next award winner comes from Tupelo, Mississippi. The beginning of Follow Through was the beginning of integration in Tupleo. Four or five parents of handicapped White children allowed their children to attend a previously all Black school because Juliet Borden (Judy) convinced those parents that their kids would learn to read at the Green Street school. Judy directed a very successful program for some 7 years—years during which the disadvantaged children performed better than they ever had before. Judy was one of our great leaders.

Finally, but not least (except for size), the Board wishes to recognize the persisting contributions of Rosali Wade, Follow Through Director of the Flippin, Arkansas program. Rosali was a teacher in the program at the start, became a supervisor and then a supervisor-director. Through her efforts, Flippin continues as a demonstration site for the dissemination of the DI Follow Through Model.

Help me congratulate them all.

Margaret Aragon, Alice Martinez, & Judy Borden

Supervisor of the Year Award

The Supervisor awards were presented by Marcy Stein, from the University of Washington.

The 1989 Supervisor of the Year Award is shared by the supervisory team of Arezetta Johnson and Georgina Hosmer from the Flint, Michigan Follow Through program. Both women began as Follow Through teach-

Rosali Wade

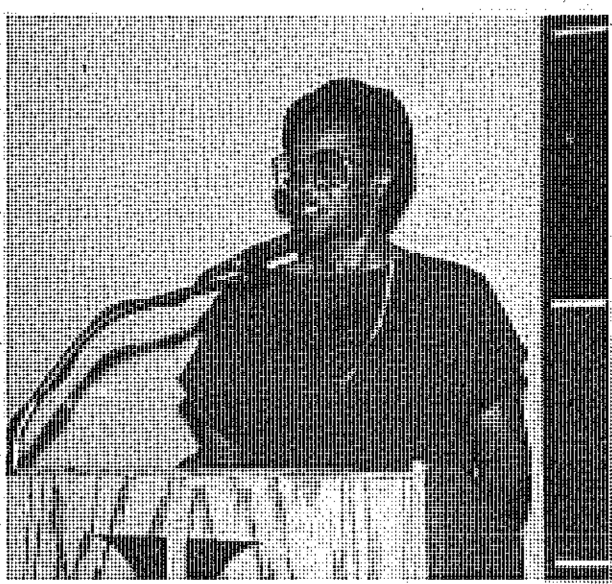
ers, shortly after the Flint Follow Through project was started in 1970. They also worked as Resource Center facilitators, presenting the Flint model of the Direct Instruction Follow Through project to teachers and administrators throughout the United States.

In 1988, when federal money was again available, for dissemination, these women reapplied to become a demonstration site. Currently they are teacher supervisors for the Flint Follow Through project, working as diligently as ever to maintain the high standards of excellence that their Follow Through project in Flint has always had.

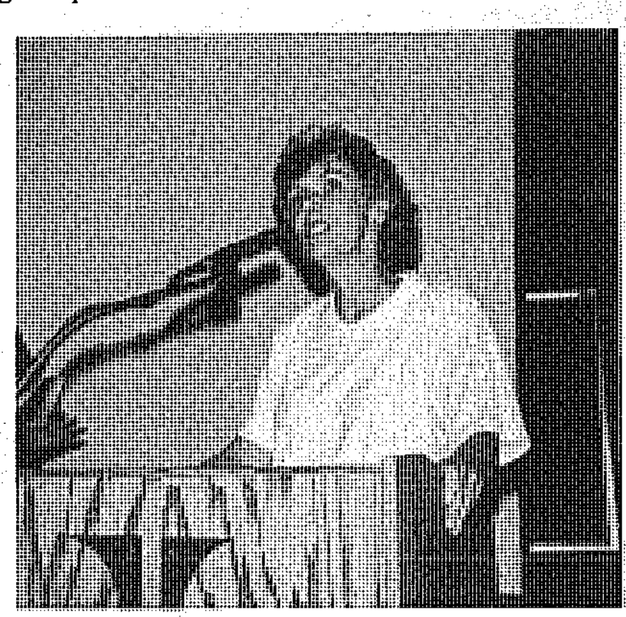
Teacher of the Year

Geoff Colvin presented that ADI Teacher of the Year award to Debra Blumberg. Debra Blumberg teaches students who are certified as seriously emotionally disturbed at Lane School. In this capacity she has demonstrated four qualities that have earned her the honor of ADI teacher of the year.

First, her delivery of instruction is exceptional. The basic skill components of pacing, teaching to criterion, corrective feedback, reinforcement, student monitoring, cumulative review, and data-based decisions for program adjustments are exemplary. Her supervisor wrote her in her evaluation, "Student teachers should be required to come and watch her teach." Second, Debra is able to motivate the "hard to teach" students. SED students are typically hard to motivate in class. These students have had many interruptions to their schooling and overall have not had success in school. In a support letter it was noted, "It truly is quite a sight to see these 'difficult' students responding in unison." Third, she epitomizes the quality Direct Instruction teacher. She demonstrates that all children can be taught and exerts a lot of time and effort trying to find ways to determine how and what to teach. She will not give up on a student and if the student is not succeed-



Georgina Hosmer



Arezetta Johnson

ing she asks, "What am I missing? What am I doing wrong?" rather than "What is wrong with this student?" Finally, she is masterful at managing behavior. She attends to detail, catches problems early, provides a high level of structure to ensure that students know what to do and can do what is required. Her timing of reinforcement, corrections, prompts and orientations for appropriate behavior are exceptional. She provides a wonderful demonstration that quality instruction is the most powerful tool we have in a classroom for managing behavior problems.

In summary, Debra is an exciting teacher and as stated in one of the support letters, "To watch Debra at work is to be entertained not because she is putting on a performance, but because she is so skillful and spontaneous. You are watching a master in action." Debra Blumberg is a truly worthy recipient of the ADI teacher of the year award. ◆

Debra Blumberg

Praise that's Good to Share

May 3, 1989

Dr. Jim Maxwell
Lane Education Service District
1200 Hwy 99N
Eugene, Oregon 97402-0374

Dear Dr. Maxwell,

I recently had the fortunate experience of spending four days at Lane School as part of my sabbatical leave to view programs of excellence that serve severely emotionally disturbed children and youth. The past semester I have had the opportunity to view 10 programs for SED children and youth and approximately 20 teachers within those programs. Of all the programs, Lane School was by far the most impressive.

I was impressed on a number of counts. First, Geoff Colvin is extremely knowledgeable and from my brief observations is highly respected by his staff. Good Leadership is always necessary for a program to operate successfully. Geoff provides that leadership. Second, the teachers at Lane School appear to be skilled in direct instruction and individual programming for SED youth. I was also extremely pleased to see that this school program is beginning to implement some of the newer methods, specifically curriculum-based assessment and data-based management of both educational and social behavioral programs. Third, utilizing a consultation model to both prevent students from being referred out of their home districts and to aid successful integration of students back into their home school districts is quite impressive.

All of the above is not only "State of the Art" in providing educational services to SED students, but is also reaching beyond the "State of the Art" by implementing many of the newer and empirically sound teaching and service into the practice of the art. I was very impressed with the total program. Lane Educational Service District can be very proud of Lane School.

Sincerely,

Richard E. Shores, Ed.D.
Professor, Special Education
Vanderbilt University
Nashville, Tennessee

Reprinted with permission of the writer and Geoff Colvin.

Treasurer's Report—

by Wes Becker

Table 1 provides a comparison of the financial status of the Association for the past four years. The 88-89 fiscal year was the second in a row in which we incurred a loss. This loss comes from a variety of sources. We tried to set up and participate in 9 conferences. Several of these were losers so that the gains made on our two large conferences (Eugene and Salt Lake) were wiped out by the losses at the smaller conferences. A number of small workshops for west coast school districts lost money ($5,701), as did our basic efforts with the *ADI News* and book sales ($4, 132). Membership income was down and book sales didn't compensate for it.

The handicapped preschool has grown and provided services to more children each year. It amounts to 3/4ths of our budget. We currently are showing a loss on the books of $5900 on the preschool operation. This loss will be charged against a preschool cash carryover of funds restricted for their use which is included in the cash balance above. The increase in administrative expenses is largely associated with the preschool.

When we break down the bottom line on our June 30, 1989 balance sheet separately for the Preschool and the rest of ADI, and include inventory and equipment which is not shown above, the total assets look like this:

	Preschool	Rest of ADI	Totals
Cash & receivables less payables	$15,437	$19,412	$34,849
Book Inventory		$6,132	$6,132
Equipment	$6,814	$5,130	$11,944
Total Assets	$22,251	$30,674	$52,925

Since June 30th, our financial picture has not improved. The Eugene Conference drew only 300 this year, versus 450 to 550 in recent years. As of October 23, 1989, the total assets of ADI without the Preschool had dropped to under $15,000 and the board has taken emergency steps to drastically reduced expenditures in order to save the organization. We have a plan in place that should get us through next summer, when we again hope to improve our financial status. Conference loses again account for our precarious position. ◆

Table 1. Treasurer's Report for Fiscal Year Ending June 30, 1989—Association for Direct Instruction

	85-86	86-87	87-88	88-89
Cash Balance (Does not include book inventory or equipment)	$41,132	$66,321	$51,783	$34,849
Gain (Loss) for year	$12,589	$25,189	($14,539)	($16,934)
Income				
Handicapped preschool	$162,417	$217,974	$245,063	$283,730
Memberships	$11,031	$13,442	$15,297	$10,628
Book Sales	$13,981	$14,318	$11,955	$21,495
Conferences	$37,004	$106,380	$97,946	$107,227
Workshops	——	——	$28,351	$16,904
Other	$21,426	$16,447	$4,700	——
Total Income	$245,860	$368,561	$403,312	$439,984
Expenses (Direct)				
Preschool	$166,270	$183,949	$212,326	$239,103
ADI News and book cost	$9,761	$31,880	$31,646	$33,418
Conferences	$42,218	$86,540	$104,239	$109,040
Workshops	——	——	$26,615	$22,606
Other –e.g. Summer School	$5,043	$7,586	——	——
Total Direct Expense	$223,292	$309,955	$374,826	$404,167
Administrative Expenses				
Preschool				$50,525
Membership, News and Books				$2,837
Total Administrative Expenses	$9,979	$33,417	$43,025	$53,362
Percent of total expenses	(4.3%)	(9.7%)	(10.3%)	(11.7%)
TOTAL EXPENSES	$233,271	$343,372	$417,851	$457,529

An Historical Perspective of the Early Days of the Follow Through in Las Vegas, New Mexico

by Margaret M. Aragon

Editor's Note. At the recent Eugene Conference, three Follow Through Program directors (see AWARDS, this issue) participated in a symposium on what they had learned from working with disadvantaged students and families in the Direct Instruction Follow Through Model. Below, one of the directors reports on her experiences.

The Follow Through Program in Las Vegas, New Mexico, began in December, 1967. The funding provided for two para-professionals in each classroom (grades 1-3), additional materials and equipment, plus money for medical, nutrition, and psychological services. A unique feature of the funding was the provision of money for parent education activities. All these funds were for the purpose of supplementing, not for replacing, local funding.

The following year, local agencies were invited to a conference to learn about several innovative models of instruction. Psychologists and Educators had applied their science to the learning process and developed programs of instruction to be considered for implementation in Follow Through Programs throughout the country. At this time, selection of a model was optional.

The Las Vegas City Schools implemented a program known then as the Engelmann-Becker Model of Instruction. It was a giant step to take! It meant close communication with the sponsor and a commitment to change—great change.

The entire Follow Through staff went to the University of Illinois (Urbana) for a summer training program. This training was followed by a pre-service workshop at the local site under the direction of a project manager trained by the sponsor. The project manager was on-site periodically, training and monitoring throughout the year.

The problems of implementing the new program were many; the biggest problem encountered was that of being accepted as a different model of instruction by non-Follow Through staff. It was difficult for some people to understand that research and development was a component of the program.

Another problem arose due to the fact that the program did not have a true scientific control group. Non-Follow Through teachers sent all children with learning problems to F.T. Classrooms; yet, at evaluation time they compared their test data with F.T. data instead of looking at gains.

A non-instructional problem emerged as a result of hiring parents for the para-professional positions. Husbands wanted their wives at home cooking supper instead of at school attending in-service meetings after school or taking evening classes at the university.

The main problem in the teaching process was developing teachers' organizational skills. Precise preparation for teaching, accurate record keeping, adherence to schedules, acceptance of supervisors and observers, changes in teaching strategies, ignoring unacceptable behavior—all these were stressful, overwhelming experiences for most staff members.

Developing a harmonious teaching team took much joint teacher-supervisor-aide planning. Often a compatible team would be broken up in order to strengthen a weak team. This created further stress.

There were many positive aspects of the implementation of the Direct Instruction Program in Follow Through. The two most important and immediately beneficial features were the sequencing of the teaching tasks and the monitoring system. Teachers knew what they needed to teach, they know whether the child had learned, and if he hadn't learned, they had a remedial procedure in place.

The children received the benefit of an efficient instructional program because there was no waste of time; yet, there was time for fun activities within the teaching process as well as through the reinforcement system.

Another positive aspect of implementation was the opportunity for local sites to make suggestions to enrich the evolving curriculum.

A component which had great impact on the program was the parent education feature. Parents had their own budget and allocated the funds towards various activities which they planned and carried out. The sponsor provided consultant services to the local parent groups and held workshops for them away from the local areas.

Parent involvement was required on the premise that parents are members of the instructional team. A Policy Advisory Committee composed of parents of Follow Through Program children screened and recommended non-certified applicants for positions in the program, assisted in developing program proposals, made suggestions for program operations, planned activities for Parent Educators to carry out, established a Career Development Committee and reported to parents on the progress of the program. Parent education activities included; sewing, upholstery, gardening, nutrition, parenting, crafts, cultural awareness, income tax preparation, Social Security and Aid to Dependent Children information meetings. Social activities included; Weekly Family Recreation Program, holiday parties, Get Acquainted Dinners, End of the Year Family Picnic, Awards Social, and Fashion Shows to display clothing produced by the mothers.

Parents participated in the classroom, observing, helping with individual and group tasks, preparing supplementary materials, conferring with teachers—all in an accepting, non-threatening atmosphere. These were new experiences for parents and most teachers.

The Follow Through Program had impact on the school system, the staff, the community, as well as on the children.

The fact that, after all these years, Follow Through is still in operation in the Las Vegas City Schools is testimony to the success of the program. It has undergone a metamorphosis, but *it is there*; the *instructional program is there.*

The administration, including the board of education, became more informed about curriculum and methodology than at any time prior to F.T. The administration was kept abreast of progress and modifications through communication with the U.S. Office of Education, the Engelmann-Becker Model Sponsors, the local F.T. Staff and the Parent Advisory Committee.

The Follow Through staff became skilled in the DISTAR Model of Instruction; teachers and aides adjusted to the constant stream of observers from all over the state and to the individual video taping and evaluation. They were very proud when the Las Vegas City Schools Program was selected to represent the model sponsors in Washington, D.C., at Ed Fair '72, a demonstration of Follow Through Models of Instruction sponsored by the U.S. Office of Education.

The greatest impact was on the para-professional staff. At least eleven aides earned Bachelor of Arts Degrees and now hold regular teaching positions. Two who did not earn degrees, respectively, have established Day Care Centers for preschool children. One aide became a Bilingual Education Coordinator Assistant and one male aide became an elementary school principal.

Three professional staff members became administrators and two served as head-teachers in their respective schools. One teacher became State Superintendent of Instruction and currently is in the same position.

The impact on the community was due mostly to the parents of F.T. children who became involved in a variety of educational and social activities. It became easier for them to express their opinions at policy council meetings and parent workshops. They learned many useful skills and the additional jobs took those employees off the welfare rolls. The business community and New Mexico Highlands University provided volunteers for parent education programs.

The real winners were the children. They became more verbal, more out-going, more questioning, and certainly seemed very happy. Observations of these children in grades 5 and 6 showed that children who had been in F.T. had word attack skills, problem solving skills, and not surprising, children who persevered—they didn't quit! They were no more dependent on help than non-F.T. children. Test data from the 1987-88 school year compared Las Vegas City Schools F.T. children in grades 3, 5, and 8 with similar groups from Northern New Mexico; data indicated that:

- F.T. Children tested higher than the comparison groups in all areas.
- F.T. children had lower drop-out rates.
- The F.T. Hispanic children's scores were closer to the state-wide non-Hispanic student scores than were the comparison groups' scores.
- Locally there was no discrepancy between Hispanic student and non-Hispanic student scores.

Follow Through was a very educational professional experience for me. It was difficult, but very rewarding work. I have been able to apply the teaching strategies and organizational skills that I learned to subsequent teaching and consultant tasks. Also, I have been able to use the skills in use of reinforcement procedures, in observation, and in supervision to continue working in various educational capacities since my retirement from the Las Vegas City Schools. My best memories of Follow Through are of the many parents who participated in many different ways to the program, the children who are doing well in the community and away from it, the dedicated people in other F.T. programs that I met during my work with F.T., and the hard-working staff with whom it was my privilege to work. ◆

Looking for Mr. Goodbooks— Reflections on Whole Language and Direct Instruction*

by George R. Paterson

Getting Back to Books

Probably the most talked-about trend in reading and language-arts instruction today is the "Whole Language" movement. Many dedicated and energetic teachers have flocked to the banner of Whole Language, which may be seen in part as an effort to restore good books to the central position they deserve in the classroom. The movement also represents a reaction against certain sterile and unproductive instructional practices of the past.

Among the things Whole Language has reacted against are the excessive atomization and isolation of individual reading skills and overeliance on worksheets, ditto masters, and similar routine formats of instruction. When such formats are allowed to replace truly enjoyable and memorable reading experiences, something is clearly amiss. Whole Language teachers contend that the magic of a good storybook and the satisfaction of tracking down wanted information in factual sources are far better motivators—and therefore more likely to produce enthusiastic readers—than time spent on content-free skills work.

Motivation from Within

Whole Language enthusiasts also stress the the child must have *personal* reasons to read, write, speak and listen if these communicative acts are to be pursued with enthusiasm. They seek to make reading, writing, speaking and listening activities central to the children's own lives and to help the children see these behaviors as ways to accomplish *their* own aims—not just ways to satisfy arbitrary classroom requirements.

In this respect, Whole Language is not so much a new idea as a rediscovery of the message that John Dewey delivered at the dawn of our century; all of us learn most willingly and best when we acquire our skills in the course of doing something that we ourselves find useful—something we *want* to do.

The Language-Rich Environment

Because language is a social behavior, the Whole Language enthusiast seeks to encourage lots of classroom talk, reading aloud, and shared activities that will bring students together in partnerships that foster social interchange. Hence the Whole Language teacher's fondness for group publications, committee projects, cooperative research, and the like.

Indeed, a cardinal tenet of the Whole Language movement is that the classroom should be a literate environment—a place so filled with good books (and magazines, signs, posters, student writing, and other communicative interchange) that the practical day-to-day utility of reading and writing will be brought home to the children inescapable.

At times the Whole Language enthusiast seems to suggest that such surrounds will, of themselves, impart reading and writing skills. An analogy is drawn to the way in which infants naturally pick up their native tongue just through daily exposure to the speech of adults and older siblings. Reading skill, it is suggested, can emerge in a similarly natural fashion: "We learn to talk by talking, and we learn to read by reading."

Other Emphases

Other matters emphasized by the movement include the integration of reading with writing, speaking, and listening; treatment of children as responsible persons who can determine and pursue their own interests—and also, incidentally, correct their own errors; tolerance for approximate responses and invented spellings (as opposed to a Grinchlike insistence on "one right way"); and empowerment of the teacher (rather than the publisher or administrator) as the final arbiter of what should take place in the classroom.

As a philosophy, Whole Language generally places greater emphasis on creating the conditions in which children can blossom and discover than it does on actively intervening to lead and direct them. Joy, naturalness, and internally derived motivation seem to be the key watchwords.

Much to Admire

There is much to admire in the Whole Language approach. In particular, the effort to restore quality literature to its rightful place of prominence in children's lives was long overdue. And the movement's many motivational teaching practices are often exciting and rewarding. No child can fail to benefit from a language-rich environment that generates lots of personal reasons to read and write. And no one would dispute that the aim should be to produce citizens who

*From S.R.A. Pergamon, *Perspectives*, 1,(No 1), 1989.

are enthusiastic, lifelong readers of books and other useful print—not citizens who are worksheet experts.

Some Causes for Concern

But the rejectionist aspects of Whole Language give pause to many teachers and parents. No revolution, it seems, is ever without its excesses. Under the banner of Whole Language, some educators seem prepared to throw out everything that isn't unstructured, child-generated, and spontaneous.

Persons claiming to speak from a Whole Language perspective have at one time or another attacked and rejected all of the following: systematic phonics instruction; predetermined learning objectives; directed practice on individual skills; the idea that there can be *any* "right answers" or "correct spellings"; objective testing and evaluation measures; and any learning materials that are controlled in their language difficulty or structured to illustrate particular concepts.

At the extreme, we seem to be hearing that "if children are enjoying themselves, then learning is taking place." In such a philosophy, structure becomes the enemy, and structured learning materials come under attack for not being "real books" reflecting the "real language" found in the "real life" reading experiences of the "real world."

But is the classroom to be *only* a mirror of the real world? If so, it seems fair to ask why the classroom is needed at all, since the real world is just outside out door. Unless the classroom offers considerably *more* than unstructured contacts with the wonderful world of literacy, one may argue that it is doing less than its job. Besides being a place to motivate and enchant students (excellent aims, to be sure), the classroom also should be the place where their encounters with language are sufficiently *organized, structured and directed* to produce the maximum learning benefits with the least amount of error, frustration, and wasted effort. It should be the place where children are assured of incremental successes, where error and confusion are minimized, and where children are permitted the satisfaction—which is surely their right of knowing exactly what is expected of them, how they can achieve it, and when they have succeeded.

Direct Instruction and the Educator's Responsibility

Teachers who use Direct Instruction methods certainly have no quarrel with the aims of creating a literate environment, exposing children to the finest literature, creating conditions in which the will *want* to read and write, and promoting the inter-student exchange that builds language fluency. Every teacher should be encouraged to implement these goals throughout the school day.

But the Direct Instruction proponent believes that more is required. From a Direct Instruction perspective, we run too great a risk when we assume that a literate, supportive environment and good motivation are all that any child requires. While some children may learn surprisingly well just by rubbing up against such an environment (particularly if they are also supported by highly verbal and book-filled home lives), the critical question is: how many will not? Regardless of their capabilities, children have varying learning styles. In a structure-free program, how many will learn poorly, or partially, or with a generous amount of mislearning that must then be unlearned? Even the brightest children are capable of wrong conclusions when adequate guidance is lacking. While some may effectively correct their own errors over time, how many will not? How many approximate understandings will pass for complete understandings and remain permanently half-correct? And at what loss of time, efficiency, and self-confidence will even the successes be achieved?

Reading Mastery, SRA's Direct Instruction reading program, assumes that the teacher has an *active* responsibility to prevent such casualties. Beyond just encouraging learning to happen, there is also an obligation to see that it *does* happen with reliable and predictable certainty. In addition to a positive and supportive environment, there must also be sequential and meaningful instruction together with effective measurement techniques. The *Reading Mastery* teacher assumes responsibility for seeing that learning takes place, rather than turning that responsibility over to the child.

Minimizing Error and Confusion

Features of *Reading Mastery* aimed at minimizing error and actively producing successful learning include the following:

1. systematic phonics training
2. direct teaching of comprehension and metacognative strategies
3. modelling of precise responses
4. prompt feedback and correction to minimize errors
5. cumulative program design
6. activation of background knowledge
7. use of classics and "real books" when appropriate
8. effective measurement and management techniques

(1) In some Whole Language classrooms, *phonics* is

"something we only use if the child needs it." In Reading Mastery, phonics is much more, and for good reason. The authors of *Becoming a Nation of Readers* state without equivocation:

> *Phonics instruction improves children's ability to identify words. Useful phonics strategies include teaching children the sounds of letters in isolation and in words, and teaching them to blend the sounds of letters together to produce approximate pronunciations of words... Phonics instruction should go hand in hand with opportunities to identify words in meaningful sentences and stories. Phonics should be taught early and kept simple.*

Reading Mastery makes systematic phonics training a part of every child's early instruction, thereby building children's confidence. The code system that underlies written language need never be a mystery or a guessing game for learners. It is a more-or-less rational system that they can master with confidence at an early stage, after which they can give their total attention to meaning. Accuracy, fluency, and automaticity—the benefits conferred by systematic phonics work—are generally agreed to be necessary preconditions for effective comprehension.

If a teacher encourages "look-say, " "discover-it-for-yourself," and guesswork until some problem becomes apparent, more is lost than just efficiency. By the time it's discovered that the child really needs phonics after all, the child's misunderstandings are apt to be entrenched and resistant to correction. Early phonics training keeps this from happening.

(2) *Comprehension strategies* and *metacognitive techniques* are taught directly. Again we cite the authors of *Becoming a Nation of Readers*, who say:

> *Teachers need to teach comprehension strategies directly. Teachers should devote more time to teaching strategies for understanding not only stories but also social studies and science texts.*

Reading Mastery is not content merely to get a good conversation going about a good book and then accept all spontaneous comments as evidence of understanding. Conversations about books and spontaneous student reactions certainly have their place; but teachers also need to help students see that *some* questions really *do* have one best answer—and that there are reliable ways of determining what it is. By directly teaching comprehension strategies. *Reading Mastery* accepts the responsibility of communicating this to students.

Further, students practice metacognitive techniques for monitoring and correcting their own comprehension processes. They develop the habit of self-questioning as they read, to anticipate the comprehension questions they may be asked. Thus, they practice a model of the self-monitoring (metacognition) that research has shown to be characteristic of good readers.

In presenting these strategies, *Reading Mastery* uses a judicious balance of reading material that includes not only fiction and poetry, but also science, social studies, and other kinds of nonfiction Students learn to comprehend the full range of written material. We can predict that informational reading will be fully as important as recreational reading throughout their lives, and it is therefore appropriate to work with such materials from the beginning.

(3) and (4) *Modeling of precise responses* and *prompt feedback and correction* are techniques that show children what an accurate response looks or sounds like so that they always know what is expected, when they are right, and when they are going astray. As a result, learning is not haphazard or unpredictable. Mislearning is prevented; errors are flagged before they have a chance to become ingrained practices; and the desired results are obtained much more rapidly and efficiently than would be the case if they were merely left up to the hope of self-discovery and self-correction.

(5) The *cumulative program design* of *Reading Mastery* ensures that concepts once presented are never simply dropped thereafter. Nor are they just spiralled back again for a quick review each year, as in some programs. In a cumulative design, basic concepts such as understanding main idea, perceiving contrasts, recognizing the author's purpose, and so forth, become integrated into the lesson material from the moment of their introduction. Thereafter, student's are repeatedly called upon to apply these understandings in new contexts, with changing subject matter, and at increasing levels of challenge.

(6) *Background knowledge* is increasingly seen as a critical contributor to reading comprehension, as reading specialists have demonstrated in their studies of schema theory. *Reading Mastery* was one of the earliest programs to help children activate the necessary factual background before they begin reading a text, so that their confusions are minimized and they can fully appreciate all the implications of what they read. Contrast this with letting a child roam freely through the "wonderful world of books" and expecting learning to happen. Much incidental learning probably *will* happen; but there will also be plentiful occasions when the child attempts books for which he or she lacks the necessary background, and the frustration that results

can damage the child's self-confidence and motivation. With such an approach, there can be no expectation of systematic successes.

(7) For similar reasons, *Reading Mastery* introduces classic texts and *"real books" with "real language"* as they become appropriate—not indiscriminately from the very beginning. Many of the great children's classics were never intended for independent reading by beginners, but are best appreciate when read aloud by adults. And while children's love of a good story may motivate them to read such works, that motivation will quickly dry up if problems of decoding, vocabulary, idiom, and syntax frustrate the child's efforts. The classic tale of *Peter Rabbit* illustrates the point. It is a wonderful story for first-graders to hear; but the following thirty-two word sentence shows some of the decoding and comprehension difficulties it presents to the beginning reader: *"Peter gave himself up for lost, and shed big tears; but his sobs were overheard by some friendly sparrows, who flew to him in great excitement and implored him to exert himself."*

In its beginning levels, *Reading Mastery* seeks to prevent the frustration of overchallenge by presenting texts containing only words that students have been taught to decode. But in the upper levels, when students are ready for them, classics and "real" works of fiction are included, along with poems, plays, biographies, and expository nonfiction. The authors include Mark Twain, Eleanor Clymer, Langston Hughes, Jack London, and others.

(8) Finally *effective measurement and management techniques* are needed in order for the teacher to know how well his or her active responsibility for the child's learning is being fulfilled. To many a firmly committed Whole Language enthusiast, there is no place for objective testing measures referenced to predetermined criteria. The preference is for informal "kidwatching" and for self-evaluations by the children themselves. What the children do for purposes of evaluation, it is said, must always be something that interests them and has a clear purpose *other than* evaluation; it must never look like a check-out or a test. The idealism of this approach is attractive; but unless class sizes are quite small and the teacher is an unusually practiced and gifted observer of subtle clues, the results can be impressionistic and imprecise, leaving entirely too much to chance. The measurement procedures of *Reading Mastery*, by contrast, are designed to ensure that *no* child will be left behind or allowed to fall through the cracks.

The Importance of a Track Record

Many positive and joyful things go on in Whole Language classrooms, reflecting the energy and creativity of the most gifted and insightful Whole Language teachers. The best of these practices deserve widespread celebration and emulation. But Whole Language still lacks a clear outline. At present it is not a unitary methodology, or even a fixed set of practices; it is a general point of view under which many highly varied practices and experiments have tended to gather. Only time will tell which of these practices can help give children the full measure of competence and confidence they deserve from their schooling.

Because Whole Language is still in flux and means different things to different people, there is no reliable way of assessing its track record with students. Indeed, there is no such thing today as "the" Whole Language classroom—only a lot of different Whole-Language-inspired classrooms. Eventually, when the good and the bad are sorted out, the best Whole Language techniques can be expected to enter the mainstream of instruction; those practices (and omissions) that are thoughtless, ineffective, or actively harmful will be thrown out. But until the dust settles, proven methods offer children the best hope of success.

Direct Instruction *does* have a clear outline. It is a specific method of proven effectiveness. *Reading Mastery*, with a firmly established track record going back to the 1960s, has been used successfully with millions of American schoolchildren. Its innovations—in phonics instruction, in the teaching of critical thinking skills, in its use of both nonfiction and literary classics—have earned it the respect of the educational community. It has helped countless students to become active, accurate, independent readers with a strong and enduring love of reading. And that is the end result by which every approach to reading instruction must finally stand or fall. ◆

Attitudes Toward Direct Instruction*

by Thomas J. Proctor
Baylor University
Waco, Texas

The term *direct instruction* usually can be counted on to generate disagreement and debate among educators. In research on effective teaching, this term is used to describe techniques that emphasize the teacher's role in maximizing the time students are actually engaged in learning and therefore result in higher student achievement (e.g., Rosenshine & Stevens, 1984). However, use of "direct instruction" to define effective teaching is strongly objected to by some (e.g., Peterson, 1979); they argue that this teacher-directed approach ignores individual differences among students.

The term *Direct Instruction* (with initial capital letters) has been used to refer specifically to the University of Oregon Direct Instruction Model (Becker, 1977; Brent, DiObilda, & Gavin, 1986; Carnine, Zoref, & Cronin, 1986; Mathes & Proctor, 1988). This model combines specific teaching techniques with a curriculum carefully sequenced into scripted lessons that teachers follow in exact detail. Although a considerable amount of research has given evidence for the effectiveness of this model with disadvantaged and disabled learners (see Mathes & Proctor, 1988, for a brief review), there are those who oppose Direct Instruction (DI) on philosophical grounds (see Tarver, 1986). For example, the "preprogrammed" instruction in DI is seen as being unresponsive to the learner and to individual differences (Poplin, 1984).

Because DI requires many changes in traditional classroom practices (Gage, 1985), teachers may initially experience it as being in opposition to their own philosophy of teaching (Becker, 1984). Therefore, when teachers are asked to implement DI without being involved in the choice, strong negative attitudes can result (Gersten et al., 1986). In one study of a large-scale implementation of DI, at least half of the teachers experienced a philosophical conflict with the highly structured, scripted lessons, which many though were "overly mechanical" (Gersten at al., 1986, p. 268). However, the same study also found that the use of DI over a period of time produced significant change in the teachers' attitudes. According to Becker (1984), key factors in the change to a more positive attitude toward DI seem to be increased competence in using the materials and progress of the students.

Attitudes of teachers asked to implement DI programs are relevant to teacher-training programs that emphasize the DI model. Students in these programs may also be confronted with a model that they have not specifically chosen and that may seem at odds with their previously conceived beliefs about teaching. The experience with inservice teachers reported above suggests that beginning experience with DI may produce negative attitudes.

The question addressed in this study is whether the training and experience in DI as part of a teacher education program is sufficient to overcome any initial negative attitudes. Thus, the purpose of this study was to investigate attitudes toward DI at different stages in a teacher education program and following graduation. Specifically the study investigated two questions: (1) For undergraduate students in a special education teacher education program, what is the relationship between the amount of training and experience in DI and attitudes towards DI? (2) How do attitudes toward DI by graduates of the teacher education program compare with those of current students?

Program Description

The undergraduate program in generic special education at Baylor University uses the Direct Instruction model as the basis for methods and practicum courses. Students are introduced to the Direct Instruction model in the course "Mathematics for Learners with Special Needs" during the first semester of their junior year. The text (Silbert, Carnine, & Stein, 1981) provides an extensive application of the DI model to the teaching of mathematics. In addition, demonstration, guided practice, and role playing are used with a commercial DI math program. Students then use the program to teach in a resource room for approximately 40 hours of supervised practice in groupings of one-to-one or one-to-two.

The DI math course is followed by a 6-hour combined methods and practicum. The DI model is applied to reading, oral and written language, and behavior management. Practicum students receive approximately 100 hours of daily supervised experience in using DI with learning disabled children in one-to-one and small-group situations.

The methods-practicum course is followed by student teaching for a full semester—half in a regular classroom and half in a special education classroom. In some cases the special education classrooms use the DI programs extensively, while in others DI is not used at all.

Method

Subjects

Subjects were 41 students currently enrolled in the

*Reprinted from *Teacher Education and Special Education*, 1989 12(1-2) 40-45, with permission of the publisher and author. Copyrighted 1989.

undergraduate generic special education program at Baylor University, Waco, Texas, and 19 recent (1 to 3 years) graduates of the program. The 41 current students represented three classes. Two of the classes included students taking the math methods course in two consecutive semesters. These will be designated Math 1 ($n = 8$) and Math 2 ($n = 25$). (These classes each included one additional student whose results had to be dropped from the study because of incomplete data.) The third group of students was taking the combined methods-practicum and will be labeled Practicum ($n = 8$).

Instrument

The instrument used in this study is an attitude scale adapted from Bursuck and Dudzinski (1987). In completing the survey, subjects are asked to use a 5-point Likert-type scale to indicate the extent to which they agree or disagree with statements such as "Direct Instruction creates a positive attitude in the classroom" or "Direct Instruction is boring." The choices are "Strongly agree," "Agree," "Not sure," "Disagree," and "Strongly disagree." (A list of all items is included in Table 1.)

Items were the same for current students and graduates with the following exceptions. (1) Verbs were changed on some items to be appropriate to students or graduates, e.g., "I (plan to) use DI when I teach." (2) Two questions regarding student teaching plans were omitted from the graduates' survey; as a result, the student version of the survey contained 30 items (compared to 28 for the graduate version).

Procedure

Undergraduate students completed the survey during the last week of the semester. Surveys were completed anonymously and required only an "x" for a response. A total of 43 students completed the survey, but 2 were incomplete and not included in the analyses.

The survey was mailed to 59 of the 64 students who had graduated from the teacher education program between the spring of 1985 and spring, 1987. (Current addresses of the other 5 graduates could not be located.) Of the 59 surveys, 24 (41%) were returned. Three of the graduates were not teaching and returned blank forms, and 2 of the surveys were were incomplete, resulting in 19 included in the analyses.

Analyses

The percentage of subjects who "Agreed" or "Strongly Agreed" with positively stated items, e.g., "I am glad DI is emphasized at Baylor" and the percentages who "Disagreed" or "Strongly Disagreed" with negatively stated items, e.g., "DI is too mechanistic" were calculated for each item to provide descriptive information regarding the DI model.

To evaluate the effect of training on attitudes toward DI, comparisons were made on the four groups of subjects for each survey item and the overall attitude rating. For this analysis the attitude survey was scored by assigning a value of 1 for "Strongly Disagree" to 5 for "Strongly Agree." Values for "negatively" stated items were assigned so that high values indicated a favorable attitude toward Direct Instruction. For example, if a subject marked "Disagree" for the item "Direct Instruction is boring," the score of 2 was converted to a 4. The effect of the different groups (Math 1, Math 2, Practicum, Graduates) on the rating of each survey item and on the overall DI attitude were tested by means of the non-parametric Kruskal-Wallis one-way ANOVA.

Results

Percentages of subjects agreeing/disagreeing with each item are presented in Table 1. For positively stated items, agreement ranged from 47% to 97%; for negatively stated items disagreement ranged from 33% to 97%.

The four groups of subjects were compared on the average overall attitude score on each of the items. (Comparisons of two items, "I hope I do not have to use Direct Instruction during student teaching" and "I am looking forward to using Direct Instruction during student teaching" include only the three student groups.) The Kruskal-Wallis ANOVA resulted in a significant effect for the overall attitude rating ($X^2 = 10.54$, df = 3, $p < .05$). In addition, significant effects were obtained for 6 of the 28 items involving all four groups and for one of the items including only the three student groups. (See Table 2.)

For the overall attitude rating and the seven items with significant effects, the Mann-Whitney U Test was completed on selected pairwise comparisons between the groups. The comparisons of interest were the two math groups vs. the practicum, and the practicum vs. the graduates. The results are presented in Table 3.

Discussion

Agreement/Disagreement with DI by All Subjects

In general the results indicate that the majority of subjects had a favorable attitude toward DI; there were only four items on which less than 50% of subjects either agreed with a positively stated or disagreed with a negatively stated item. (See Table 1.) The

Table 1. Survey Results—All Subjects

Positively Stated Items	% Agree/ Strongly Agree
Direct Instruction aids learning.	97
I feel well prepared to use Direct Instruction.	94
Student improvement is worth the extra effort of using Direct Instruction.	91
Regular use of Direct Instruction with students had increased my appreciation of it.	89
Direct Instruction creates a positive attitude in the classroom.	89
There would be more support for Direct Instruction if people knew more about it.	87
I am glad Direct Instruction is emphasized at Baylor.	84
Direct Instruction helps students cope with academics.	84
Direct Instruction meets my students academic needs	78
Direct Instruction improves overall classroom condition.	70
I will use Direct Instruction techniques even if materials are not available.	67
I am looking forward to using Direct Instruction during student teaching.	63*
Direct Instruction has unlimited possibilities.	58
More money should be spent on Direct Instruction programs.	48
Direct Instruction can be used in all subject areas.	47
Negatively Stated Items	**% Disagree/ Strongly Disagree**
All teachers should be prohibited from using Direct Instruction.	97
Direct Instruction places too much emphasis on academics.	91
I hope I do not have to use Direct Instruction during student teaching.	88*
Direct Instruction is excessively slow-paced.	82
Direct Instruction is too teacher-centered.	80
Direct Instruction is unable to meet the complex demands of the classroom.	77
Direct Instruction does not carry over into the regular classroom.	75
I do not plan to use Direct Instruction when I teach.	73
Direct Instruction is too mechanistic.	70
The benefits of Direct Instruction have been exaggerated.	64
Direct Instruction is boring.	64
There is too much emphasis on Direct Instruction in teacher training at Baylor.	61
Direct Instruction makes students too dependent on the teacher.	59
Direct Instruction cannot be used with all children.	38
Direct Instruction is primarily beneficial in 1:1 and small groups.	33

*Includes only the three student groups

Table 3. Results of Selected Pairwise Comparisons Using the Mann-Whitney U Test

Groups	Variable	X^2
Math 1-practicum	DI can be used in all subject areas.	-3.07
Math 2-practicum	DI cannot be used with all children.	-4.15
	DI is primarily beneficial in 1:1 and small groups.	-3.23
	DI can be used in all subject areas.	-3.33
	I do not plan to use DI techniques even if materials are not available.	-2.72
	Overall attitude toward DI.	-3.23
Practicum-grads.	DI is primarily beneficial in 1:1 and small groups.	-2.65
	Regular use of DI has increased my appreciation of it.	-3.13

* All $p < .05$ level. Critical z value = 2.64.

Table 2. Results of Kruskal-Wallis ANOVA

Survey Item	X^{2*}	df
DI cannot be used with all children.	20.27	3
DI is primarily beneficial in 1:1 and small groups.	12.05	3
DI cannot be used in all subject areas.	15.11	3
I do not plan to use DI when I teach.	17.83	3
I will use DI techniques even if materials are not available.	11.71	3
Regular use of DI has increased my appreciation of it.	11.74+	3
I hope I do not have to use DI during student teaching.	7.01	2

* All $p < .05$.
+ Includes only the three student groups.

highest percentage of agreement was on "DI aids learning" (97%). In addition 87% or more agreed that student achievement made DI worth the effort, that DI creates a positive attitude in the classroom, and that there would be more support for DI if people knew more about it. It seems clear that, as a group, the subjects supported the effectiveness of DI.

In contrast to the high percentage of subjects who agreed with the effectiveness of DI, only 67% said they used or planned to use DI techniques when they teach. Apparently recognizing the effectiveness of DI is not a sufficient condition for wanting to use it. However, 89% did agree that regular use of DI with students had increased their appreciation of it.

In regard to training, 94% agreed that they felt well prepared to use DI, and 84% said they were glad that DI is emphasized at Baylor. However, only 61% disagreed with the statement that there was too much emphasis on DI at Baylor.

Thus it seems that, in general, subjects have learned to appreciate the effectiveness of DI, feel prepared for its use, and are glad they have learned it; however, they are less sure about wanting to use it and the amount of emphasis it receives.

Comparisons Between Math 1 and 2 and Practicum

The comparison between the math classes and the practicum tests the relationship between the amount of supervised experience with DI and attitudes towards it—the math classes had just completed a semester of training and approximately 40 hours of experience with DI in one subject area while the practicum students had completed an additional semester of training and approximately 100 hours experience with DI in three or more subject areas.

As can be seen from Table 3, one item produced a significant difference between Math 1 and Practicum, while five items produced significant differences between Math 2 and Practicum. The one item that resulted in significant differences between both math groups and Practicum was "DI can be used in all subject areas." Practicum students agreed with this item to a greater extent than did the math students. This is a reasonable finding in that the math students had been exposed to DI in only one subject area. This result shows that the practicum students who used DI in several subject areas were more confident of its use in all subjects. This logical outcome lends support to the validity of the measurement procedures employed in the study.

Four items resulted in significant differences between Practicum and Math 2 only. In addition the comparison between these two groups is the only one that produced a significant difference for the overall attitudes toward DI. In each case the more favorable attitude toward DI was shown by the practicum students (See Table 3). Two of the four items producing significant differences were "DI cannot be used with all children" and "DI is primarily beneficial in 1:1 and small groups" that involve the generalizability of DI; the other two items were "I do not plan to use DI when I teach" and "I will use DI techniques even if the materials are not available," which both involve personal commitment to the DI approach.

It is notable that the results for Math 2 showed several differences with Practicum that were not obtained for Math 1. Students in Math 1 and Math 2 were presented with generally the same content and experiences, but with some important exceptions due to class size. Both classes received approximately 40 hours of experience in the same resource room with supervision provided by two university instructors and the resource room teacher. However, in the case of Math 1, which had 9 students, this meant a supervisor-student ratio of 1:3, compared to a ratio of approximately 1:9 in Math 2, which had 26 students. In addition, class size in Math 2 decreased the amount of actual instruction; Math 1 students taught 1 to 3 students twice a week during two class periods, while Math 2 students taught 1 to 2 students, twice a week during just one class period. (In Math 2, students worked in pairs and observed their partner during the second class period.) Finally, students in Math 1 received one opportunity to teach an entire class of 14 to 16 students, but this was not possible for students in Math 2.

It seems likely that these differences in the amount of experience actually teaching with DI and in the amount of supervision received resulted in Math 2 showing greater differences with practicum students than did Math 1 students. Although Math 1 and Math 2 students ostensibly took the same course, in actuality these groups differed substantially in regard to supervised practice with DI. On the attitude survey, Math 1 students differed from Practicum only in regard to beliefs about the use of DI in all subject areas. Therefore the obtained differences between Practicum and Math 2 in overall attitude toward DI, in beliefs about the genralizability of DI to all children/larger groups, and in personal commitment to the use of DI may reflect training differences primarily related to the amount of supervised experience in actually using DI.

Furthermore, the fact that Math 1 and Practicum, which were both small groups and equivalent in supervisor-student ratio, differed only on the one item regarding subject matter suggests that the amount of supervision is more important than the amount and type of experience.

Comparisons between Practicum and Graduates

The comparison between practicum students and program graduates contrasts students who were just completing intensive training in DI with those who completed this training 1 1/2 to 4 years earlier. Two items resulted in statistically significant differences between practicum students and graduates: "DI is primarily beneficial in 1:1 and small groups" and "Regular use of DI has increased my appreciation of it." (See Table 3.) In both cases the practicum students gave a rating more favorable toward DI.

In discussing these results it is interesting to note, first of all, that the differences between practicum students and graduates is minimal. The teaching experience of the graduates and those just completing their DI training is not correlated with different attitudes towards DI.

The fact that the graduates reported less confidence than the practicum students in the fact that DI is beneficial to larger groups may reflect a change in the practicum. For several years the practicum has included only 1:1 instruction as the basis for learning DI techniques. During the past year (including the semester that the survey was completed,) group teaching experiences have been emphasized in addition to the 1:1.

The finding that graduates agreed with the item "Regular use of DI with students has increased my appreciation of it" to a lesser degree than the practicum students may simply reflect a difference between the training situation and the real world. Practicum students were just completing intensive training in the use of DI in "ideal" situations—prescheduled, homogeneous grouping, available materials, ample feedback—where the success of the child is generally assured. Graduates, on the other hand, must contend with scheduling problems, heterogeneous groupings, a lack of materials, and little feedback. The message to be received from this result may be to do a better job of including sufficient reality in the training situation that transfer of training is more likely to occur.

Conclusions

In agreement with previous reports (Gersten et al., 1986; Becker, 1984), the results of this study support the fact that supervised experience in the use of DI increases positive attitudes toward it. Eighty-nine percent of all subjects (students and graduates) agreed that regular use of DI with students had increased their appreciation of it. In addition, the relationship between the amount of supervised experience and positive attitudes toward DI. It was found that increased class size, which resulted in less supervision and less practice, was associated with less favorable attitudes toward DI. Finally, this study provides evidence that attitudes toward DI acquired in this teacher education program are not greatly affected by experiences following graduation. ◆

References

Becker, W.C. (1977). Teaching reading and language to the disadvantaged. What we have learned from field research. *Harvard Educational Review*. *47*, 518-542.

Becker, W.C. (1984). *Direct Instruction—A twenty-year review*. Paper presented at the Annual Banff International Conference on Behavioral Science.

Brent, G., DiObilda, N., & Gavin, F. (186). Camden Direct Instruction project, 1984-1985. *Urban Education*, *21*, 138-148.

Bursuck, W.D., & Dudzinski, M. (1987 November). *The transfer of training from special education coursework to fieldwork: A program analysis*. Paper presented at the tenth annual conference of the Teacher Education Division, Council for Exceptional Children.

Gage, N.L. (1985). Hard gains in the soft sciences: The case of pedagogy. *Phi Delta Kappan*.

Gersten, R., Carnine, D., Zoref, L. & Cronin, D. (1986). A multifaceted study of change in seven inner-city schools. *The Elementary School Journal*, *86*, 257-276.

Mathes, P.G. & Proctor, T.J. (1988). Direct instruction for teaching "hard to teach" students. *Reading Improvement*, *25*, 92-97.

Peterson, P.L. (1979). Direct instruction reconsidered. In P.L. Peterson & H.J. Walberg, (Eds.), *Research on teaching: Concepts, findings and implications*, pp. 57-69. Berkeley, CA: McCutchan Publishing.

Poplin, M. (1984). Toward a holistic view of persons with learning disabilities. *Learning Disabilities Quarterly*, *7*, 290-294.

Rosenshine, B. & Stevens, R. (1984). Classroom instruction in reading. In D Pearson(Ed.), *Handbook of reading research* (pp. 745-798). New York: Longman.

Silbert, J., Carnine, D., & Stein, M. (1981). *Direct Instruction mathematics*. Columbus, OH: Charles E. Merrill.

Tarver, S.G. (1986). Cognitive behavior modification, Direct Instruction and holistic approaches to the education of students with learning disabilities. *Journal of Learning Disabilities*, *19*, 368-375.

New Research on the Brain—
Implications for Instruction*

by Doug Carnine
University of Oregon

The dominant view of perception, recognition, memory, and by default, learning, originated with Plato—the brain is a block of wax and the world a signet ring. This interpretation has gained credence from neurological discoveries beginning in the late nineteenth century, suggesting that the brain consists of a collection of highly specialized functional regions. The doctrine of localization of function has strongly influenced many educators, as evidenced by the learning styles movement. These brain locations are associated with various functions—auditory, visual, tactile, and so forth—which are thought to be areas of "strength" or "weakness," depending on the individual. Once an individual's functional strengths have been identified, instructional methods that emphasize those functions are selected. With reading styles, for example, language experience emphasizes visual and tactile functions and so would be appropriate for a child with visual and tactile strengths (Carbo, 1987).

More recent research on the brain by Gerald Edelman, director of the Neurosciences Institute at the Rockefeller University and winner of a Nobel Prize, challenges localization (Edelman, 1987). Rosenfield (1988) describes Edelman's new view of the brain:

> *What look like localizations are different ways of grouping stimuli—parts of a process of creating possible appropriate combinations and orderings of stimuli . . . The "specialized centers" are just part of the larger combinatory tactic (the procedures) of the brain* (p. 10).

The central procedures in Edelman's scheme are *categorization* and *recategorization* in:

a. perception (Rosenfield, 1988, p. 112),

> *How we perceive stimuli depends on how they are categorized, how they are organized in terms of other stimuli, not on their absolute structure...*

b. recognition (Rosenfield, 1988, p. 189),

> *Recognition of an object requires its categorization. And categories are created by coupling, or correlating different samplings of the stimuli.*

c. memory (Rosenfield, 1988, p. 192),

> *We do not simply store images or bits but become more richly endowed with the capacity to categorize in connected ways.*

Categorization and recategorization might be viewed as an overriding activity of the brain, serving as the basic mechanism for the various brain functions. A cornerstone of the "capacity to categorize" is the learners capacity to note samenesses. Understanding the role of noting samenesses in learning has important implications for instruction.

At first glance, categorization might appear mundane, e.g., membership in a category requires a shared sameness—all vehicles share certain characteristics. Noting samenesses can be far more creative than classifying objects as vehicles, however. In the early 1900's, a physician was vacationing in Egypt was asked to treat a boy who'd been bitten by a cobra. When asking how the incident occurred, the physician found the boy's father was bitten first, yet lacked the ominous symptoms present in his son. The father said he had been bitten on two previous occasions, with the severity of the symptoms diminishing on each occasion. Upon return to Germany, the physician hypothesized that the same process might be applicable to diphtheria, which was ravaging his homeland at the time. He injected horses with increasingly potent doses of the diphtheria until they developed antibodies against the disease. The serum from the horses led to a vaccine that immunized children against diphtheria. The physician's discovery, based on noting samenesses, is, of course, a dramatic example.

On the other extreme are cases where the samenesses that are noted are not only commonplace but are also incorrect! As Rosenfield noted, the mind is not a block of wax. Learners are active, categorizing and recategorizing.

> *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).

Why Mistakes Make Sense

There is no way to "make" the learner select the combination of stimuli (i.e., note the sameness) the teacher wants to teach. By learning the unintended sameness the student will make mistakes of a trivial or significant nature. The way in which students mislearn by noting unintended samenesses illustrates the

*Forthcoming in the *Phi Delta Kappan*. Reprinted with permission of the author and the *Kappan*.

educational relevance of this basic brain activity. The examples begin with preschoolers and continue through the elementary grades. In the latter part of this article some of the educational implications of this process are illustrated with examples from the secondary grades.

Very young children know that the name of an object stays the same after the object's orientation changes. For example, when a chair is flipped to face the opposite direction, it's still a chair. Consequently in preschool, when a **b** is flipped to face the opposite direction, children assume it still has the same name, "b." This error doesn't necessarily imply that the student's visual brain function is weak and would benefit from a kinesthetic approach. Extensive research has shown that students are more likely to confuse objects and symbols that share visual and/or auditory samenesses such as **b** and d (e.g. Carnine, 1980).

For problems such as:

$$\begin{array}{r} 24 \\ \underline{+\ 23} \end{array}$$

first graders 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 from the larger:

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

The next example of learning an unintended sameness comes from spelling in the second grade. Primary-grade Hispanic students were doing very well in a basal spelling program. Words such as *site, kite, bite, high, sigh, tight,* and *eye* were introduced on Monday and practiced in the same order until they were tested on Friday. A consultant noted that the students scored very well on the Friday test; the class average was over 80%. He suspected the students had learned a sameness not intended by the publisher or teacher—for the first three words, the students wrote the letter for the first sound, then *ite;* for the next three words, they wrote the letter for the first sound then *igh;* for *eye,* they had to remember how to spell it. To test for this unintended sameness, the consultant had the teacher present the same seven words again, but in a different order. The class average fell to below 40%. The word spelled correctly most often was *eye,* the odd word the students had to remember how to spell because it didn't fit a pattern—no sameness.

A reading example. Many basal readers control vocabulary during grades one and two by restricting it to a few hundred words and emphasize reading for meaning, using context and pictures. The sameness students learn from these stories is to memorize a few hundred words, relying on pictures and context. In most third grade basals, there are few pictures and many, many more words, to many lower performing students to memorize. The inappropriate sameness learned by these students to memorize. The inappropriate samenesses learned by these students isn't revealed until third grade, when they "blossom" into remedial readers.

A fourth grade example. This student's strategy for solving word problems is based on the samenesses found in the word problems she'd encountered. This is her description of the rules she'd learned: "If there is lots of numbers, I add. If there are only two numbers with lots of parts, I subtract. But if there is just two numbers, and one 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."

A study skills example. The student who learns to find a word in a glossary by going page by page from the first page quickly gives up on the dictionary. Treating a dictionary the same as a glossary, turning page by page from the beginning, is too slow, particularly to find a word such as zenith.

The previous examples from elementary school can be difficult to appreciate, because the "samenesses" are all familiar. In the next example, you are the learner, looking for the samenesses. The concept is Zug. Study examples *a* and *b*, then answer *c* and *d*.

a. Zug	b. Zug	c. Zug	d. Zug
20	24	21	8
15	18	7	2
5	6		

If you answered 14 and 6, you noted and "incorrect" sameness. Zug does not mean: "Find the difference between these numbers." We'll return to Zug later.

Inducing Intended Samenesses

The brain's search for samenesses has little regard for the intentions of educators. The previous examples have illustrated 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 more effective curricular activities. The goal is to develop activities that help students learn important samenesses. The activities should also exhibit a minimum number of inappropriate samenesses and call attention to unintended samenesses that students are likely to learn.

To reduce b d confusions, the curriculum designer can separate their introduction over time (Carnine, 1976, 1980b) and when **d** is introduced later, emphasize how **b** and **d** are not the same, with visual discrimination tasks (e.g., have students cross out the letters that are not b: b d g b p d b) before introducing auditory tasks (Carnine, 1981).

In preparing students to borrow, for example, the curriculum designer emphasizes how borrowing problems are *not* the same as previous types of addition problems. To highlight this difference, the designer might present a series of simple problems, such as:

1	7	5	2
<u>−7</u>	<u>−1</u>	<u>−2</u>	<u>−5</u>

students would be told that for subtraction they had to subtract the *bottom* number from the *top* number. The students would then cross out problems they couldn't work and write the answers to the problems they could work. This activity reduces the sameness between addition and subtraction by sensitizing students to the consequences of having the smaller number on top.

Let's revisit Zug. Study examples e through j of Zug. Then try c and d of the previous examples of Zug.

e. 25	f. 25	g. 20	h. 20	i. 6	j. 16
<u>15</u>	<u>10</u>	<u>10</u>	<u>8</u>	<u>2</u>	<u>8</u>
5	5	10	4	2	8

The correct answers for *c* and *d* are 7 and 2. Zug means: "Find the largest number that you can multiply by to reach both numbers, i.e., the greatest common factor." The preceding set of examples (*e-j*) is preferable because it was constructed following research-based guidelines for using examples to teach samenesses.

Selecting and sequencing examples. Guidelines for selecting and sequencing examples, such as those for Zug, include:

1. Selecting examples that preclude unintended samenesses (Carnine, 1980a). In examples *e* and *f* and *g* and *h* the answers do not equal the number that results from subtracting the two numbers. The unintended sameness (subtraction) is precluded, at least logically.
2. Presenting minimally different examples to highlight unintended samenesses that students need to reject (Carnine, 1980b; Granzin & Carnine, 1977). In example pair *e* and the top numbers are the same, 25. Also the answers are the same, 5. But the answers do not result from subtracting. Minimally different examples are relatively easy to compare, making it easier to identify how the examples are the same and how they are different.

These principles will be illustrated with a study that compared a fractions curriculum designed according to the research-based guidelines (Systems Impact, 1985) with the best basal math program that could be identified (Kelly, Carnine, Gersten & Grossen, 1986).

The first step is to select a full range of examples to eliminate unintended samenesses. Basals introduce fractions as a part of a pie—1/3, 2/3, 1/4, 2/4, etc. The following year's text introduces mixed numbers, but the fraction is still less than one, that is, part of a pie. Thus, students have at least two years to become convinced that a fraction always represents a portion of pie; all fractions are the same in that they represent part of a whole. In the third year students encounter a fraction 4/3, causing bewilderment for low-performing students. To deal with this seeming violation of the sameness they learned, many of these students apply what they learned previously—a fraction is part of a pie. They draw a pie with 4 parts and shade 3 parts.

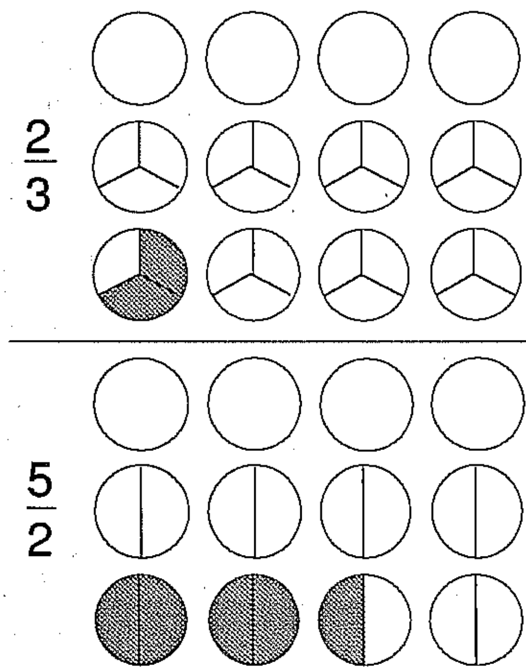
This confusion was reduced in the research-based curriculum by presenting a full range of examples (2/3 and 5/2 on the first lesson. Students were given this rule to explain how all fractions are the same:

> *The number on the bottom of the fraction tells how many parts are in each group. The top number tells how many parts we have.*

This rule applies equally well to improper (5/2) and proper fractions (2/3). (See Figure 1.)

The second step is to sequence minimally different examples to alert learners to unintended samenesses. The National Assessment of Educational Progress (Carpenter, Coburn, Reyes & Wilson, 1976) found many students had learned an unintended sameness about denominators in addition problems, i. e., do what the sign says. This sameness comes from the

Figure 1.



students' experiences with whole numbers and even with multiplying fractions. When students multiply 1/3 x 1/2, the denominators are multiplied. When students apply this sameness to addition (1/3 + 1/2), they add the denominators to get 2/5.

The basal program avoided dealing with this unintended sameness. It teaches adding and subtracting fractions in one unit and multiplying and dividing fractions in another. Students don't receive instruction and guided practice in distinguishing fraction addition from fraction multiplication.

The research-based curriculum directly addresses this unintended sameness. Students are told that when they add or subtract, they just copy the denominator in the answer. Adding 2/3 and 1/3 is like adding 2 apples and 1 apple. The answer when adding two-thirds and one-third is 3 *thirds;* the answer when adding 2 apples and 1 apple is three *apples.* The research-based curriculum presents minimally different examples 2/3 + 1/3 is transformed through animation into 2/3 x 1/3 by rotating the + sign to make a x sign. By encountering minimally different problems, students have opportunities to decide what to do when they add and what to do when they multiply.

The guidelines for selecting and sequencing examples are important tools for educators, but hardly sufficient. More sophisticated tools are also needed, such as multi-step procedures and unifying principles, particularly at the secondary level.

Multistep procedures. A multistep procedure requires students to carry out the same sequence of actions on a variety of problems. The explicit procedure prompts students that the problems are the same because they can be worked by following the same steps.

A multi-step procedure can be illustrated with research on story grammar (Carnine & Kinder, 1985). Many short stories adhere to a set structure: A major character encounters a problem, acts to overcome that problem, and experiences some ultimate resolution. Students can first learn to identify the main character, then the problem, then the actions taken to resolve the problem, and finally the ultimate resolution. Students learn that because many stories follow this structure the story grammar questions are useful in "making sense" out of the stories.

The need to teach students an explicit multistep procedure for comprehending even simple stories was driven home as I observed a first-grade teacher with a reading group. She asked a hodge podge of literal and inferential comprehension questions as students read "The Boy Who Cried Wolf." The sameness the students were learning was that the purpose of reading was to remember isolated facts about the passage. If the students had learned a multistep procedure based on story grammar, they could have identified the boy's problem as boredom; his solution to cry wolf, which did relieve his boredom; and the resolution being that no one came to help him when he cried "wolf" for real. With this type of summary, the students could then have intelligently discussed the theme of the story. Of more importance, the students could apply the same procedure to many other stories. A more sophisticated story grammar that incorporates story "twists," character clues, etc., has also been taught successfully to high school students (Gersten & Dimino, in press).

Unifying principle. A unifying principle is another way of showing how things are the same, The purpose of identifying unifying principles is particularly important 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 concepts as the American Foreign Language Association recommends when introducing new labels for familiar concepts. Most students try to remember some of the vocabulary, at least until they take the next test.

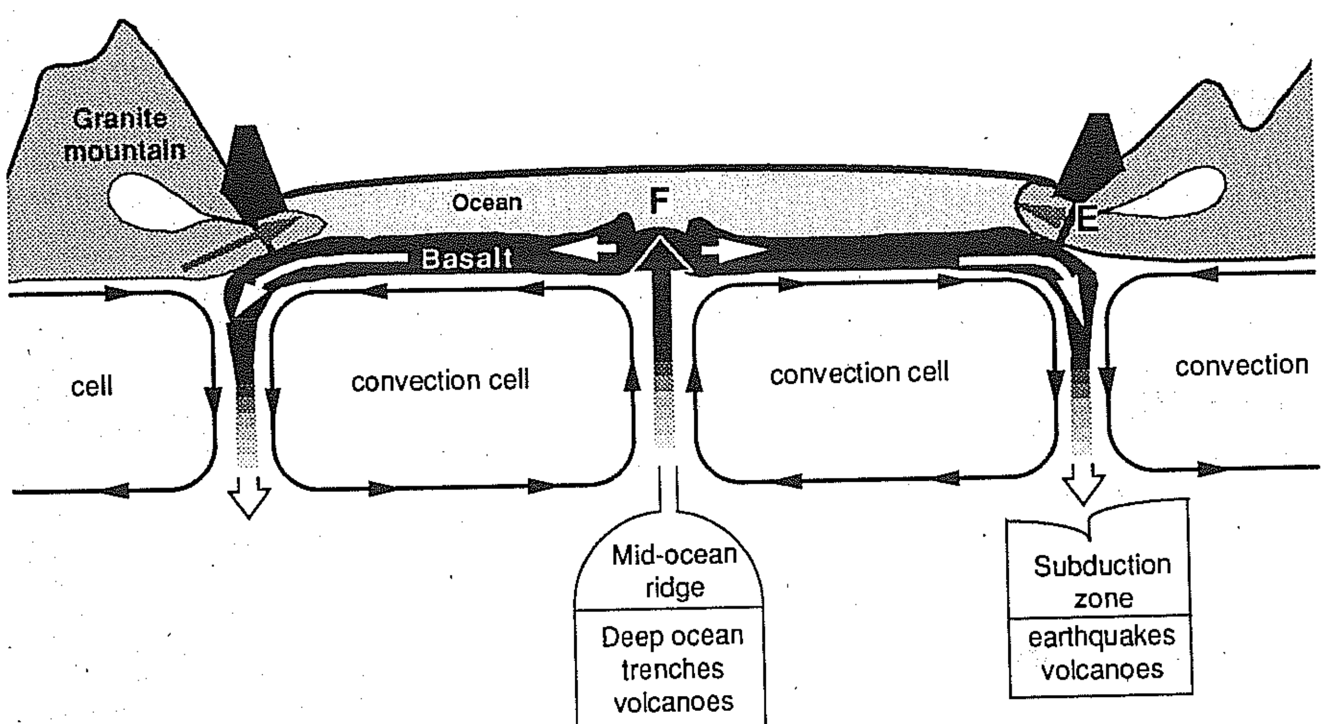
One way of handling this information overload and the attendant misconceptions about the nature of science is to first identify underlying principles of a discipline. In the research by Hofmeister, Engelmann, and Carnine (in press) the concepts necessary to understand the underlying principles can be taught, followed by instruction on the unifying principles themselves. Finally, the concepts that can be explained by the underlying principles are presented. For example, earth science covers a wide variety of phenomena in the solid earth, oceans, and atmosphere. Yet textbooks do not emphasize the underlying principle of convection. To understand convection—the circular motion of a substance in a medium caused by heat—requires knowledge of many prerequisite concepts: heating and cooling and the implications for expanding and contracting, which lead to rising and sinking, and finally high and low pressure areas.

After the concept of convection is taught, it is used to explain large scale ocean currents, air currents, and many other phenomena in the solid earth. These phenomena are the same in that they are caused, at least in part, by convection. Figure 2, for example, graphically depicts convection cells in the solid earth and how they account for granite mountains, vulcanoes, earthquakes, mid-ocean trenches, and plate tectonics. The crust of the earth actually rides on top of the convection cells illustrated in Figure 2. At point E in Figure 2, the crusts come together at a subduction zone, where the ocean crust goes under the continental crust, causing earthquakes and vulcanoes. At point F in Figure 2, the ocean crust is pulled apart by two convection cells, causing deep ocean trenches and vulcanoes. The large sections of earth's crust that ride on these convection cells form the "plates" referred to in plate tectonics. The unifying principle of convection reveals a fundamental sameness of many phenomena in the ocean, atmosphere and solid earth.

Practice and Review

Learning the appropriate samenesses, though critical for acquisition of new content, does not touch on many other important aspects of learning. For example, if students are to retain newly acquired samenesses, they should receive practice until they consistently respond correctly (Darch, Carnine & Gersten, 1984). In the basal math program critiqued earlier, the skill of finding the lowest common multiple was introduced in one lesson, disappeared for seven lessons, was reviewed on one lesson, disappeared again for six lessons and then appeared in the context of adding and subtracting fractions with unlike denominators. Two

Figure 2.



exposures over 15 lessons is not sufficient for even average ability students. The research-based curriculum introduced this skill and gave students practice on 8 consecutive lessons and then, on the next lesson had the students apply the skill in problems with unlike denominators.

Conclusion

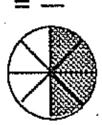
Learning and remembering are important goals. Deciding how to react to the conundrum that results from individual differences in learning and remembering has haunted educators for decades. As new theories from other disciplines make their way into education, they often play a part in the evaluation and creation of various educational responses to the challenge of individual differences in learning. Edelman's work (1987) on the brains's *overarching capacity to categorize in connected ways* has direct implications for educators, as illustrated earlier in the article.

This capacity may also be a key variable in understanding individual differences. Brighter, intuitive learners may be capable of categorizing and recategorizing 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. These students can "figure out" important samenesses without getting seriously mislead. Consider this example of teaching the rewriting of fractions by beginning with semi-concrete representations, such as this one:

$$\frac{1}{4} = \frac{?}{8}$$

The pictures are assumed to develop the concept that 1/4 can also be written as 2/8, because the same area is shaded in both fractions. The inappropriate sameness exhibited by problems of this type is that the answer can be determined by counting the shaded parts, ignoring everything else. This misconception can be easily demonstrated be giving students a problem such as the one below that does not require looking at the equivalent fraction on the lect side of the equal:

$$= \frac{?}{\;}$$



Students can respond correctly by applying this unintended sameness: Count the shaded parts. They then write 4 as the answer. Soon thereafter students are asked to solve a problem such as:

$$\left(\frac{2}{3}\right) = \left(\frac{?}{6}\right)$$

The students do not have shaded parts to count.

The intuitive learner, left without parts to count, will look for other samenesses that will yield an answer, similar to what you did after reading that Zug did not mean subtract. Knowing when to search for new samenesses, how to generate alternative samenesses and how to evaluate those samenesses are the hallmarks of an intuitive learner.

The challenge for educators is quite different with lower performing students. One aspect is to design activities to help those students become more "intuitive." This should only be one tactic, in part because educator's documented successes in this area are rare. The other tactic was illustrated earlier in the article—design the learning environment to maximize the likelihood that students will learn important samenesses. In teaching lower-performing students to rewrite fractions, for example, one important sameness can be expressed as a rule: "Multiplying the side of an equation by one or by a fraction equal to one does not change the value on that side." Thus, when students encounter

$$\left(\frac{2}{3}\right)\left(\frac{\;}{\;}\right) = \frac{\;}{15}$$

they will understand that the fraction that goes inside the parentheses must equal one or else the equality relationship will be destroyed. The rule about multiplying by one reinforces one of mathematics great unifying principles—equality.

A different type of equality underlies educators' interest in individual differences—not equal treatment, not even equal outcomes, but equal opportunity to learn and flourish in school. Determining the nature of those opportunities in education is its shibboleth. Differing theories of the brain can be interpreted as supporting different instructional approaches. As much as possible, decisions among those approaches should be based on their effects on students.

This seeming truism is actually very difficult to carry out (Carnine, 1988). For example, the notion of learning styles based on relative strengths and weaknesses of brain functions was very popular in special education in the 60's and 70's. However, numerous research studies have documented several seemingly insurmountable flaws in special education's "learning styles" (e. g., see Kavalle, 1987 for a review): (a) measures for identifying students' learning styles were *not reliable* (e. g., a student might have a visual strength when tested on one day, but a visual weakness when tested on a different day), (b) *relationships* between learning style strength and academic performance *were weak* (e. g., the correlation of students' scores on special education learning styles tests with reading tests and math computation tests!), (c) instruction matched to students' learning styles had relatively weak effects on academic performance (e. g., instruction to improve the visual functioning didn't appreciably improve reading performance). As noted in a recent *Phi Delta Kappan* article, the research base outside special education is also open to question (Stahl, 1989).

The educational principles outlined in this article have also been subjected to large scale evaluations in elementary reading and mathematics (Stebbins et al., 1976) and small-scale research studies at the University of Oregon in various secondary topics. These studies cover physical science, (Hofmeister, Engelmann & Carnine, in press), law (Fielding & Gersten, 1986), critical reading (Patching, Kameenui, Carnine, Gersten & Colvin, 1983), syllogistic reasoning (Collins & Carnine, 1988), math word problems (Darch, Carnine & Gersten, 1984), problem solving (Woodward, Carnine & Gersten, 1988), and literature analysis (Gersten & Dimino, in press). The point is that arguing by analogy from brain research to education provides only a rationale for an approach. The crucial factor is the effect of the approach on students. The new research on the brain by Edelman provides a strong rationale for the analysis of sameness, which has extensive research support. ◆

References

Carbo, M. (1987). Reading styles research "What works" isn't always phonics. *Phi Delta Kappan* (Feb.), 431-434.

Carnine, D., & Kinder, D. (1985). Teaching low-performing students to apply generative and schema strategies to narrative and expository material. *Remedial and Special Education*, 6 (1), 20-30.

Carnine, D. W., (1976). Similar sound separation and cumulative introduction in learning letter-sound correspondences. *Journal of Educational Research*, 69, 368-372.

Carnine, D. W., (1980a). Two letter discrimination sequences: High confusion alternatives first versus low-confusion alternative first. *Journal of Reading Behavior*, 12 (1), 29-40.

Carnine, D. W., (1980b). Relationships between stimulus variation and the formation of misconceptions. *Journal of Educational Research*, 74, 106-110.

Carnine, D. W., (1980c). Three procedures for presenting minimally different positive and negative instances. *Journal of Educational Psychology*, 72, 452-456.

Carnine, D. W., (1981). Reducing training problems associated with visually and auditorily similar correspondence. *Journal of Learning Disabilities*, 14, 276-279.

Carnine, D. W., (1988). Overcoming barriers to student achievement. In S.J. Samuels & P.D. Pearson (Eds), *Changing School Reading Programs* (pp. 59-91). Newark, DE: International Reading Association.

Carpenter, T. P., Coburn, T. G., Reyes, R. E., & Wilson, J. W., (1976). Notes from national assessment: addition and multiplication with fractions. *The Arithmetic Teacher*, 23 (6), 137-142.

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.

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

Edelman, G. (9187). *Neural Darwinism: The theory of neuronal group selection*. New York: Basic Books.

Fielding, G., Kameenui, E., & Gersten, R. (9183). A comparison of an inquiry-oriented and a direct instruction approach to teaching legal problem solving to secondary school students. *Journal of Educational Research*, 76, 287-293.

Gersten, R. & Dimino, J. (1989). Story grammar and scaffolded instruction: Teaching literature to "at-risk" students. *Educational Leadership*, 46 (5), 53-57.

Granzin, A.C., & Carnine, D. (1977). Child performance on discrimination tasks: Effects of amount of stimulus variation. *Journal of Experimental Child Psychology*, 24, 332-342.

Hofmeister, A., Engelmann, S., Carnine, D. (in press). Technology and teacher enhancement: A videodisc alternative. *Technology in Education*, Alexandria, VA: ASCD.

Kavale, K. & Forness, S. (1987). Substance over style: Assessing the efficacy of modality testing and teaching, *Exceptional Children*, 54 (3), 228-239.

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 (4), 5-17.

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

Rosenfield, I. (1988). *The Invention of Memory*, Basic Books, Inc., Publishers, New York, New York.

Stahl, S.A. (1988). Is there evidence to support matching reading styles and initial reading methods? *Phi Delta Kappan* (Dec.), 317-322.

Stebbins, L., St. Pierre, R., Proper, E., Anderson R., & Cerva, T. (1977). *Education as experimentation: A planned variation model.* (Vols. IV a-d). Cambridge, MA: Abt Associates.

Systems Impact, Inc. (1985). *Mastering Fractions*. Washington, D.C.: Systems Impact, Inc. 4400 MacArthur Blvd. NW.

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

Woodward, J., *Developing Schema in Earth Science*, Technical Report, 89-3, Eugene, OR: University of Oregon.

Teaching Absolute Pitch

by Paul Williams
Siegfried Engelmann

Learning highly unfamiliar skills is a topic that is important to understanding human growth and development, but something that has not been studied extensively. Unlike the learning of familiar skills, learning unfamiliar skills requires much, much practice. This study was done as part of a series of investigations involving highly unfamiliar skills. The objective was to teach first graders, most of whom could not sing on pitch, to develop "absolute" pitch—the ability to identify notes played on a piano or sung.

The incidence of absolute pitch is not precisely estimated and apparently has not been studied to a great extent. Wynn (1971) has noted the relationship between absolute pitch (AP) and other "rhythmic bodily functions" such as menstrual cycles and androgen cycles.

Brady (1970) and Wynn (1971) suggest (and other investigators aver) that AP is probably instilled very early in life. At least one investigator (Brady, 1970) tried to train himself in absolute pitch at the age of 32. He improved considerably over the estimated eight months of training and testing. Wynn (1971) reports that Brady was the only known adult to achieve substantial gains in AP.

The question of what constitutes AP is not answered precisely by the literature. Perhaps the most detailed classification is offered by Bachem (1937), who identifies three main levels, each with subcategories. The highest level is called Genuine AP and is characterized by, at most, an occasional half-tone or octave error. Another characteristic of Genuine AP is short latency (one or two seconds). The middle level, quasi AP is characterized by the subject's apparent use of an internal standard, typically, humming a note of known pitch and then "figuring out" the note that had been presented for identification. Bachem's third level, pseudo AP, is characterized by very long latency ("tens of seconds") and by relatively poor accuracy (judgments that may be inaccurate by as much as four and one-half notes).

Brady (1970) and Cuddy (1968) state that positive effects in AP training are dependent upon the subject's relative-pitch performance. The literature is quite vague on the incidence of genuine AP, although all investigators apparently agree that it is quite rare.

The present study was designed to teach absolute pitch of the genuine AP type using effective DI strategies. The experiment involved subjects who : (a) had very little previous experience, (b) had poor relative pitch, and (c) were past the age of infancy, but not yet to the age when estrogen and androgen cycles would potentially interfere with their performance in pitch discrimination (if such really happens).

The investigators' interest was not in AP *per se*, but in AP as an example of highly unfamiliar learning. The investigators had done studies to show that hearing subjects could learn to identify tactually presented words and sentences (Williams, Granzin, Engelmann, and Becker, 1979). The learning was characterized by no initial acuity by the subjects, hundreds of trials to achieve apparently simple discriminations, and an acceleration of learning that is at least partially controlled by the sequence of examples presented to the learner and the practice provided. In brief, the investigators assumed that the learning of AP should follow the same general pattern as learning tactually presented words. The initial performance should be characterized by many mistakes, however, over time, there should be a definite growth pattern toward the AP type of performance.

Method

Subjects

Subjects for the experiment were first-grade students in a semi-rural, near-average performing, elementary school. Initially, investigators asked for the higher-performing students in the school's only first grade classroom; however, all 18 students were initially placed in the program. Students dropped from participation if they seemed to have trouble attending to the presentation or had extreme difficulty responding. By the 6th week of instruction, 12 students remained in the program. All but one of these students remained until the end of the program.

Control subjects were high-school-age volunteers from a music theory class being conducted during the summer session at the Music Department of the University of Oregon for high school music students. Subjects reported that they had studied music, voice and/or a a specific instrument for from 4 to 11 years.

Procedure

The same investigator taught the experimental students on a nearly daily basis. The students who were tested received a total of 152 teaching sessions from October 23 through May 15. Each session lasted for about 20 minutes and consisted of activities involving perception of tones and production of tones. During the first few months, over 70 percent of the periods was devoted to relative-pitch production—e.g., singing simple phrases and songs.

Notes were introduced so that the children discriminated each note from other notes and sang each note–in isolation and as part of "songs." The order and date of each note introduction is indicated in Table 1.

Table 1. Dates of Note Introduction.

Date	Note
October 23	C
October 25	F
November 1	A
November 20	D
November 24	Octave Discrimination
February 14	B
March 5	G
April 2	E

During each lesson, each student responded an average of 15 times to pitch-production and pitch-discrimination tasks. Approximately 33% of the responses were production tasks (requiring the students to sing notes that are identified by letter name) and the remaining 67% of the responses required the students to discriminate between notes.

The production tasks required students to:

a. Sing isolated notes.
b. Sing songs composed of familiar notes.
c. Sing the scale, starting with middle C.

The following is one of the songs that was introduced after the notes C, A, F, and D had been introduced: SEE, DEE, EFF, AAE, SEE, DEE, EFF, AAE; SEE, DEE, EFF, AAE; SEE, SEE, EFF. The investigator would sing the song with the students, direct the students as they sang it by themselves, call on individual children to sing the song, and call on subgroups to sing it (all the boys, all the girls, all children in front rows, etc.). For most discrimination exercises, the investigator played the note on the piano or played a group of notes on the piano (out of student view). The students identified what the investigator had played.

The rate of introduction for the notes was determined partly by the performance of target students in the group and partly by the need to reduce the possibility of students getting the right answer by guessing. When only three notes had been introduced, the strategy of guessing about the name of a single note that had been played led to correct responses one third of the time. A fourth note was introduced quickly (before students had reached a very high criterion of discrimination performance with C, A and F) to reduce the students' odds. Also, at this time, the single-note identification tasks were replaced by three note identifications. The investigator played three notes on the piano (which was still shielded from the students' view), repeated the three notes, then called on an individual or on the group to identify the notes. After January 15, virtually all perception or discrimination tasks involved three-note identifications.

To make the identifications relatively easier for the students, three-note phrases were taken from the songs. The phrasing used in the songs was not used in the three-note sequences, which were played about 47% of each session. For instance, the notes CCF appear in the song "CDFA" above. Typically, after students sang two or three songs, they would do discrimination exercises. One group of notes selected from "CDFA" was "CFF" (i.e., SEE, SEE, EFF). This group was presented during discrimination exercises approximately 19%.

The following is a list of the three-note sequences taken from the various songs that were introduced. Each three note sequence was presented at least 200 times.

AFA CCF CFA AFC FAC CAA CDC CDF
AFC CCF CDA CFA ADD DFA FCC DCD

For the reinforcers, the investigators used praise, stickers, and during one period of training, old buffalo-head nickels. The investigator had never taught early elementary children, had never taught in the public schools, and had taught academic-type skills for only one quarter in a practicum prior to the experiment. The investigator taped some sessions, which were critiqued. Judgment of the investigator's presentation skills was that they were quite good, perfectly capable of inducing the desired learning.

Student Assessment

At the end of the training period, students were assessed on: (a) discriminating notes and (b) producing notes. These tests were not administered at the same time and were administered at least 5 days after the last instructional session had been completed. Each student was presented with fifteen, three-note sequences. Each sequence was played twice in succession on the piano. The student was then asked to identify three notes. No feedback was given about the correctness of the identifications. All fifteen sequences were composed of notes the students had been taught; C D E F G A B. Seven three-note sequences were sequences from songs that had been sung and practiced as discrimination sequences. Eight three-note sequences were generated from a table of random numbers by assigning a number value to each note and then generating the random numbers.

The following is a list of discrimination test items:

1. CFA	5. CCF	9. EGB	13. ABD
2. FAF	6. FAD	10. CCA	14. CBF
3. CDC	7. FGA	11. CEB	15. FAB
4. DFA	8. DED	12. BAG	

Production Assessment

The production test was administered at least 48 hours from the time the discrimination test had been given.

The production test consisted of three tasks:

1. "Sing the note C."
2. "Sing the note A."
3. "Sing the note F."

To score each subject's response, productions were recorded and then played by judges who demonstrated virtual absolute pitch. Each subject's production was judged on three occasions. If a judge was in doubt about the note produced by the subject, the judge could compare the recorded production with the output of a Wavetek Signal Generator. The judge's reliability was 87.2%. If judgments varied across the three separate occasions that the tones were evaluated, the modal judgment was taken as the scorable response.

Students in the comparison group were tested about a week after the experimental students had been tested. The procedure for testing the comparison subjects was basically the same as the procedure for the experimental subjects; however, comparison subjects were practicing musical skills at the time testing occurred.

Results

The discrimination of the two groups was assessed by adding the number of notes identified correctly plus one-half the number of notes missed by only one full note. This scoring procedure allowed each subject to have a familiar-sequence score and unfamiliar-sequence score that included weighted correct responses (X=1.0) and near-misses (X=.50). Table 2 summarizes the discrimination performance by subject. Maximum mean score for the three-member sets was, of course, three.

Production comparisons of the two groups take into account each subject's ability to approximate the correct response. For each note judged to be "right on," the subjects received one point. For each production that was not exact, but that was no more than one note above or one note below the appropriate note, subjects received one-half point. Production performance of experimental and comparison groups is summarized in Table 3.

Discussion

Typically, tone acuity is assessed by such instruments as the Seashore Measures of Musical Talents (1939). Test items require the student to either distinguish the higher of two notes or to name the ordinal position of a note that is changed from one passage to another. The first subtest assess the students' ability to make relative, not absolute pitch judgment and the second subtest is seriously confounded by student memory and ability to accurately count notes. The results of this test imply that very, very few subjects in an opera company had absolute pitch, only 0.8% of conservatory students had absolute pitch and only 2% of the performers in a philharmonic orchestra had absolute pitch.

In the present study, 2 of 15 *comparison subjects* had perfect scores on unfamiliar sets, which is 13%. Another subject had a nearly perfect score, (missing only 1 of 45 notes). Possibly, the three-note sequences provide a more valid test of production skill. Probably the incidence of the skill is far, far more prevalent than one would gather from the scant literature on the subject.

Amenability of Absolute Pitch Instruction

Although no experimental subject performed perfectly on either the discrimination or production exercises, it was apparent that their performance had been affected by training. The seven-year old experimental subjects had better overall ability to "approximate" the

Table 3. Production Performance by Subject.

Experimental Subjects	Production Means	Control Subjects	Production Means
1	.167	1	0.000
2	.833	2	.500
3	.333	3	.167
4	.167	4	1.000
5	.500	5	1.000
6	.333	6	.833
7	.500	7	1.000
8	.167	8	1.000
9	.500	9	1.000
10	.500	10	1.000
11	.667	11	0.000
		12	1.000
		13	0.000
		14	.167
		15	0.000
Mean	.424	Mean	.578
SD	.22	SD	.46

notes than the comparison subjects and even though the comparison group contained three subjects with virtually perfect scores, the experimental group out performed them.

The ultimate conclusion is that the learning of absolute pitch follows the same pattern of learning observed with other highly unfamiliar content. The initial slow learning is expected, but this does not imply that the learning is impossible. Once the students learn the "game," their performance improves. They learn "benchmarks" or reference points for new learning. The performance of the students in this study would have been even more impressive if they had reliable relative pitch at the beginning (the ability to carry a tune). The results, however, demonstrate that even though initial learning is very slow, the use of reinforcement, models, and basic instructional techniques are effective in teaching the skill. The study has implications for slow learners in academic skills and for remedial learners, whose performance is much like that of the subject learning something that is highly unfamiliar. The message is that the slow initial learning is not an indication of either what the student is capable of learning or of the learning rate that will occur after the initial learning has occurred. ◆

References

Bachem 1937 (Complete reference not available at press time.)
Brady 1970 (Complete reference not available at press time.)
Cuddy, L. L. (1968). Practice effects in the absolute judgment of pitch. *Journal of Acoustical Society of America. XLIII/5*, 69-76.
Williams, P., Granzin, A., Engelmann, S., & Becker, W. (1979). Teaching language to the truly naive learner–An analog study using a tactual vocoder. *Journal of Special Education Technology*, 2, 5-15.
Wynn 1971 (Complete reference not available at press time.)

Table 2. Discrimination Performance by Subject.

Experimental Subjects	Means of Familiar Sets 1-7	Means of Unfamiliar Sets 8-15	Combined Means Sets 1-15
1	2.78	2.06	2.40
2	1.14	1.25	1.20
3	1.00	1.38	1.20
4	.93	.87	.90
5	2.50	1.94	2.20
6	2.50	1.56	2.00
7	2.07	1.81	1.93
8	3.00	2.44	2.70
9	2.64	1.81	2.20
10	2.93	2.99	2.80
11	2.64	1.88	2.23
Mean	2.19	1.7	1.98 (SD = .63)

Control Subjects	Means of Familiar Sets 1-7	Means of Unfamiliar Sets 8-15	Combined Means Sets 1-15
1	1.50	1.19	1.33
2	1.50	1.25	1.37
3	.71	2.13	1.47
4	3.00	3.00	3.00
5	3.00	3.00	3.00
6	.07	.97	.97
7	.93	1.50	1.50
8	1.14	1.53	1.53
9	2.43	2.37	2.37
10	3.00	2.97	2.97
11	.71	.97	.97
12	.14	.70	.70
13	1.50	1.07	1.07
14	.50	1.03	1.03
15	.57	.43	.43
Mean	1.38	1.76	1.58 (SD = .85)

Individual Differences and the Form and Function of Instruction

by Alan M. Hofmeister
Utah State University

In individualized instruction, individual student needs drive the selection and modification of instructional experiences. We create a major problem if we use the term individualized instruction as an antonym for group teaching. Such interpretation implies that individual needs cannot be met by group teaching. The mastery of certain social skills, or the preparation of a student for declassification as a special education student may demand group teaching as the only vehicle for meeting important individual needs.

Instead of asking, "What learning experiences are needed to generate the required individual student outcomes?" and then structuring the most cost-effective environment, or combination of environments to deliver the needed learning experiences, we sometimes reverse the process, select the setting first, and then try to create the needed range of learning experiences within the selected setting. An even more undesirable possibility would be the selection or rejection of a setting on the assumption that what occurred in that setting would be consistently effective or ineffective.

In the following discussion, two approaches to meeting the individual needs of students with mild handicaps will be discussed in relation to the research literature of effective teaching practices. One approach is the "typical" individual programming found in many resource rooms, and the other approach addresses "individualization" through the use of technology.

Understanding Instructional Elements

Leinhardt (1977), in discussing approaches to research and evaluation on effects of instructional programs, warned of the lack of value associated with "black box contrasts," because they serve to disguise more important variables. Many of the comparisons of group and individual instructional settings are confounded by such powerful variables as mastery learning (Kulik & Kulik, 1987). Given that mastery learning can be implemented in a range of group and individual settings (Kulik & Kulik, 1987), it makes little sense to claim an advantage for a setting when mastery learning is present in that setting and not in the comparison setting. It would be far more helpful to claim an advantage for the specific instructional practices responsible for the difference in impact between the settings being compared.

Epps and Tindal (9187) made the following observation on the issue of relevant variables and instructional settings.

> *Furthermore, education setting, as a global unit is not the salient variable that determines the success of instruction. Rather, certain features of educational interventions systematically affect outcomes, but are not unique to one setting in particular* (p. 227).

What Are Salient Variables?

While special education was occupied with research on the efficacy of different treatment settings (Carlberg & Kavale, 1980), regular education was conducting an intensive programmatic line of research searching for those instructional practices that served to discriminate between effective and less effective teaching. This "effective teaching" literature documented relationships among teacher performance, student learning experiences, and pupil outcomes (Capie & Tobin, 1981; Medley, Soar & Soar, 1975).

Some of the elements consistently associated with effective instruction in regular education included: (1) a concern for the use of teacher and student time; (2) an emphasis on the curriculum; (3) the planned introduction of new material in small steps, integrated with guided practice, and followed by carefully managed independent practice; (4) the careful monitoring of individual student progress with coordinated reteaching based on student performance; (5) attention to the mastery of prerequisite skills and frequent reviewing to ensure that new content was successfully introduced and consolidated, and (6) a set of classroom management skills that depended on a strong instructional program and active, positive, teacher involvement with all students in all phases of the instructional process (Brophy & Good, 1986; Hofmeister & Lubke, 1990; Rosenshine & Stevens, 1986). These characteristics of effective instruction also apply to the instruction of students with mildly handicaps (Bickel & Bickel, 1986; Christenson, Ysseldyke, & Thurlow, 1989; Larrivee, 1985).

While these effective teaching characteristics appear to be common denominators in a wide range of instructional settings, one should not assume that such characteristics make up the total act of teaching. As researchers continue to accumulate knowledge on effective teaching procedures, the teacher's approach to specific curriculum content is receiving more attention (Kelly, Gersten, & Carnine, in press; Moore & Carnine, 1989). Porter and Brophy (1988) noted that there is a growing interest in instructional skills related to the organization, sequencing and presentation of content to ensure "meaningful understanding." They noted, for example, that "Effective teachers not only know the subject manner they intend their students to learn, but also know the misconceptions their students bring to the classroom that will interfere with their learning of that subject matter" (pp. 79-80). The effective teaching research is still evolving and continues to consolidate the more general principals, while producing complementary findings related to the structure and presentation of specific curriculum content.

In the process of generating the effective teaching literature, researchers progressed through years of correlational research to identify promising variables which then had to be validated by experimental research. In the process of trying to identify effective practices, researchers also made observation about some of the less productive practices. In an observation that questions some prevalent practices in programs for mildly handicapped students, Brophy (1986) observed, "Research has turned up very little evidence suggesting the need for qualitatively different forms of instruction for students who differ in aptitude, achievement level, sociometric status, ethnicity, or learning style" (p. VI-122).

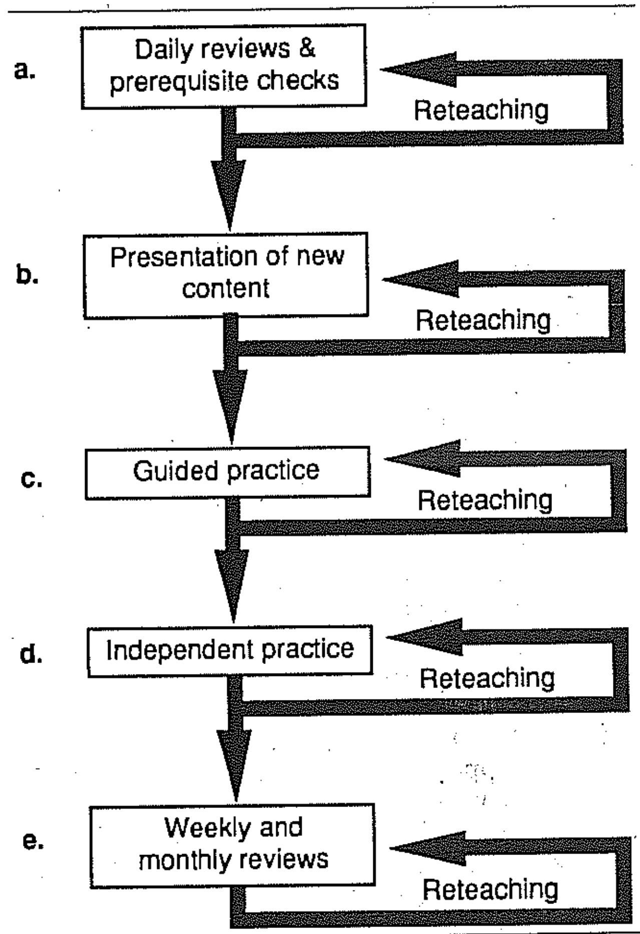
In special education, a professional concern for individual differences often generates a less professional reaction in which students are subjected to a host of unvalidated treatments designed to accommodate a wide range of static individual differences in personality and learning style. In many cases, neither the assessment procedures to prescribe the individual interventions nor the associated treatments have been validated (Fuchs & Fuchs, 1986; Gallery & Hofmeister, 1978). A related problem appears to be the lack of appreciation for the complexity and costs involved in implementing even a few accommodations for *proven* instructionally relevant individual differences. It is probable that a poorly planned accommodation to meet an additional individual difference of questionable relevance may defeat an existing accommodation for a more salient variable.

Accommodating Differences in Content Mastery and Needed Learning Experiences

In synthesizing some of the effective teaching research literature, Hofmeister and Lubke (1990) noted that the more effective teachers provided the sequence of student learning experiences listed in Table 1. They also noted that all teachers at some time provided these experiences; however, the effective teachers provided the appropriate experiences in the correct amount at the right time in response to student needs. One example of differences between effective and less effective teachers relates to the relative emphasis placed on guided and independent practice. The typical less effective teacher placed an overemphasis on independent practice at the expense of guided practice, while the more effective teacher preceded independent practice with extensive guided practice. This effective teacher also monitored student performance to ensure that students were not placed in independent practice prematurely (Anderson, Evertson & Brophy, 1979; Good & Grouws, 1979; Rosenshine & Stevens, 1986).

Haynes and Jenkins (1989), in a comparison of regular classroom and resource room practices, noted that the students were on-task more in the regular classroom than in the resource room. More importantly, they noted that the "individualized" teaching in the majority of resource rooms resulted in more than half of the instructional time being spent in independent

Table 1. Major Teaching Functions



practice. In their efforts to individualize on the basis of curriculum content, the resource room teachers were not able to supply the needed guided practice. Individual needs for large amounts of guided practice could not be met because the teacher could not supply such experiences on a one-to-one basis, even with a seven-to-one pupil-teacher ratio.

The large investment in individual programming and advantageous pupil-teacher ratios resulted in a profile of guided and independent practice distribution typical of an ineffective regular classroom. Haynes and Jenkins (1989) were able to identify a subset of resource rooms in which the profile of effective teaching characteristics was much more consistent with effective regular classrooms. This subset used teaching methods emphasizing highly targeted direct instruction delivered to small groups. The researchers concluded that the extreme variations in instructional practices present in the resource rooms prevented the resource room from being considered a standardized intervention.

Technology and Individual Differences

Interactive video. In many educational applications of technology, there is a strong tendency to place form before function. In many school districts, computer hardware is purchased with little planning regarding the function of the hardware (Hofmeister, 1984). One of the most highly regarded technology-based delivery systems is the interactive videodisc learning station. In these individual learning stations a computer and a videodisc player combine to present still or motion audio and visual stimuli. The student responds via keyboard or touch screen, and the system adjusts the instruction based on individual student responses.

As researchers worked on the development and validation of a range of interactive programs in math, language arts, and social skills for different special education populations, a clear trend emerged (Hofmeister, 1989; Thorkildsen, 1986). While these programs often achieved the instructional objectives set for the programs, the comparative advantages over other forms of instruction in public schools disappeared when the student gains were weighed against the costs of implementation and the lack of flexibility associated with the delivery system.

In an effort to identify more cost effective delivery systems, the researchers decided to focus on the needed instructional functions first and then design a delivery system to support the functions. In this redesigned delivery system a teacher controlled a videodisc player through a remote control, and most of the instruction was provided in group settings, although the program was validated for use in both group and individual settings. The instructional methodology was based on the findings of the effective teaching and direct instruction literature (Engelmann & Carnine, 1982), and programs were successively refined based on a series of field tests and consultant reviews. These math and science programs, directed at Grades 5 to 8, consistently achieved their objectives with special education and regular education populations, and were delivered at one-tenth of the cost of the interactive video, individual, learning station (Hasselbring, Sherwood, Bransford, Fleenor, Griffith & Goin, 1987; Hofmeister, Engelmann & Carnine, 1985; Hofmeister, Engelmann & Carnine, 1989; Miller & Cooke, 1989). In a series of studies comparing the same videodisc content used in group and individual learning station settings, no achievement or cost advantage was found for the individual learning station setting (Thorkildsen, 1986).

Some of the highly touted attributes of interactive videodisc learning stations, such as self-pacing and rapid, frequent branching, turned out to be more of a problem than an advantage. The self-pacing of many special education students is often an attribute to modify rather than an attribute to be accepted and accommodated. Our observations, as well as those of others (Havita, 1988), suggested that the individual learning station may accentuate differences rather than facilitate inclusion in the mainstream. The facility for extensive, rapid branching, present in the interactive, computer based, learning station, may be overkill. Extensive branching is usually associated with a high error rate. It appeared to be far better to prevent errors by providing the necessary emphasis on prerequisite skills, systematic review, and guided practice in small steps.

Computer-assisted instruction. In a discussion of the comparative value of computer-assisted instruction (CAI), Walberg and Wang (1987) questioned the value of present forms of computer-assisted instruction as a comprehensive form of instructional delivery. The research on the cost effectiveness of this form of individualized instruction has generated an inconsistent set of findings that have disappointed those advocating this delivery system on the basis of setting characteristics (Bracey, 1988; Knoppel & Edelson, 1989).

The contradictory nature of the research on CAI is typical of most of the research comparing mediated instructional settings against other mediated and non-mediated settings. Clark (1983) conducted a review of the research literature concerned with the comparative value of different media-based delivery systems, including CAI. He concluded his review as follows:

> *The point is made, therefore, that all current reviews of media comparison studies suggest that we will not find learning differences that can be unambiguously attributed to any medium of instruction. . . Future research should therefore focus on necessary characteristics of*

> *instructional methods and other variables (task, learner aptitude, and attributions), which are more fruitful sources for understanding achievement increases* (p. 457).

Clark's conclusions were exemplified by the findings of Ragosta (1983), when she provided an explanation for one of the most comprehensive and successful CAI studies. In her conclusions she gave no credit to unique characteristics of the CAI medium and stated:

> *The success of CAI in this study may be related to the successful practices identified in other effectiveness studies: Mastery learning, high academic learning time, direct instruction, adaptability and consistency of instruction, an orderly atmosphere with expectation of success in basic skills, the use of drill, and equal opportunity for responses from all students with a high probability of success in responding* (p. 124).

One of the problems associated with an overemphasis on a particular setting or technology-based delivery system is the lack of flexibility in alternatives generated by this partnership. As we (Hofmeister, Engelmann, & Carnine, 1985) searched for ways to implement the effective teaching research, we ended up with combinations of settings. One arrangement that has proven very effective in accommodating a range of individual differences is listed in Table 2. In this arrangement the needed learner experiences provided the basis for selecting the lesson and classroom structures. During the first two segments, the teacher spent virtually all the time moving among the students, while using the remote control to direct videodisc presentations. During group instruction, imbedded testing and decision points required at least 80% of students to be at mastery to allow the group to move ahead. During the last segment, which was more individualized, the average and above average students received independent practice, while the teacher provided additional guided practice to low achievers identified in earlier lesson segments. In this last segment, at least one-third of each lesson was set aside and systematically planned as a "safety net" for low achievers. This daily safety net was complemented with a weekly safety net. In this weekly safety net, every fifth lesson was a review lesson initiated by a diagnostic test of individual student mastery, followed by the reteaching generated by the results of the test of student mastery. Lesson structures of the type just described reflected a clear concern for students as individuals without having all instruction delivered through individual teaching (Hofmeister & Lubke, 1990).

Conclusions

We have made major advances in our understanding of the characteristics of effective instruction, and there appears to be no support for emphasizing such global descriptors as "group teaching" or "individual teaching" to describe the salient aspects of an instructional treatment. What is even more incomprehensible is the practice of advocating treatments that carry considerable organizational, fiscal, and even ethical costs, without a serious analysis of the important instructional variables that operate in that setting. We can no longer accept the assumption that the presence of group teaching means the absence of individualized instruction or that the presence of individualized teaching means that individual needs are being met.

Those special educators who respond to IEP requirements to identify interventions with statements such as "Two hours per day in the resource room" have not defined an instructional intervention; they have only defined a location for instruction. Those vendors of computer hardware, who stridently advocate CAI because of its media attributes, do both the technology and the instructional process a considerable disservice. The value of a technological intervention will depend on the quality of the instructional methodology and the curricular organization prompted, carried, or supported by the technology.

Technological teaching tools can make a substantive difference in the quality of education if they serve to capture, crystallize, and disseminate the essence of the teaching profession, namely, the practices of effec-

Table 2. Example of a Lesson Schedule

Lesson Segment	Time	Instructional Setting	Learner Experiences
1	5-10 minutes	Group/Videodisc	Review and check on prerequisites.
2	20-25 minutes	Group/videodisc	Presentation of new content integrated with guided practice.
3	20-25 minutes	Individual with workbooks	Independent practice for average and above average students. Additional guided practice for low achievers.

tive teachers. Likewise, interventions in special education will provide much more value and much more relevant instructional information for program improvement when the salient variables in the instructional process are the center of attention.

Research concerned with the conceptualization of individual differences in terns of entering static personal characteristics and learning styles has not yet generated the practical returns hoped for by advocates of such approaches. In contrast, the effective teaching research literature has provided a source of individual differences with instructional relevance. Examples of such relevant, individual differences would include: (1) the degree if mastery of prerequisite skills brought to, and new content taught in specific lessons, (2) the amount of guided practice needed before independent practice can be initiated, and (3) the amount and nature of feedback needed to ensure effective reteaching rather than just error recognition. Because these individual differences are dynamic and often directly related to the nature and quality of instruction, the total instructional process has to be driven by the constant monitoring of individuals and the associated adaption of instructional experiences supplied in group and individual teaching settings. ◆

References

Anderson, L. M., Evertson, C. M., & Brophy, J. E. (1979). An experimental study of effective teaching in first-grade reading groups. *The Elementary School Journal, 79*(4), 194-234.

Bickel, W. E., & Bickel, D. D. (1986). Effective schools, classrooms, and instruction: Implications for special education. *Exceptional Children, 52*, 489-500.

Bracey, G. (1988). Computers and learning: The research jury is still out. *Electronic Learning, 8*(2), 28-30.

Brophy, J., & Good, T. (1986). Teacher behavior and student achievement. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd Edition) (pp. 328-375). New York: MacMillan Publishing Company.

Brophy, J. (1986, April). *Teacher effects research and teacher quality.* Paper presented at the annual meeting of the American Education Research Association, San Francisco, CA.

Capie, W., & Tobin, K. G. (1981). Pupil engagement in learning tasks: A fertile area for research in science teaching. *Journal of Research in Science Teaching, 18*(5), 409-417.

Carlberg, C., Kavale, K. (1980). The efficacy of special versus regular class placement for exceptional children: A meta-analysis. *The Journal of Special Education, 14*, 295-309.

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

Clark, R. E. (1983). Reconsidering research on learning from media. *Review of Educational Research, 53*(4), 445-459.

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

Epps, S., & Tindal, G. (1987). The effectiveness of differential programming in serving students with mild handicaps: Placement options and instructional programming. In M. C. Wang, M. C. Reynolds, and H. J. Walberg (Eds.), *Handbook of special education: Research and practice, Volume 1, Learner characteristics and adaptive education* (pp. 213-248). New York: Pergamon Press.

Fuchs, L. S., & Fuchs, D. (1986). Effects of systematic formative evaluation: A meta-analysis. *Exceptional Children, 53*(3), 199-208.

Gallery, M., & Hofmeister, A. M. (1978). A method for assessing the treatment validity of tests in special education. *The exceptional Child, 25*(2), 105-113.

Good, T. L., & Grouws, D. A. (1979). The Missouri Mathematics Effectiveness Project. *Journal of Educational Psychology, 71*, 355-362.

Hasselbring, T., Sherwood, B., Bransford, J., Fleenor, K., Griffith, D. & Goin, L. (1987). An evaluation of a level-one instructional videodisc program. *Journal of Educational Technology Systems, 16*(2), 151-169.

Havita, N. (1988). Computer-based drill and practice in arithmetic: Widening the gap between high- and low-achieving students. *American Educational Research Journal, 25*(3), 366-398.

Haynes, M. C., & Jenkins, J. R. (1989). Reading instruction in special education resource rooms. *American Educational Research Journal*, 23 161-190.

Hofmeister, A. M. (1989). *Effective videodisc instruction in core mathematics concepts.* Approved Program Effectiveness Panel (PEP) submission, U.S. Department of Education.

Hofmeister, A. M. (1984). *Microcomputer applications in the classroom.* New York: Holt, Rinehart & Winston.

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

Hofmeister, A., & Lubke, M. (1989). *Implementing effective teaching research.* Needham Heights, MA: Allyn & Bacon.

Kelly, B., Gersten, R., & Carnine, D. (in press). Student error patterns as a function of curriculum design: Teaching fractions to learning disabled and remedial high school. *Journal of Learning Disabilities.*

Knoppel, C., & Edelson, S. (1989). Teachers and technology. *Instruction Delivery Systems, 3*(1), 6-9.

Kulik, C. C., & Kulik, J. A. (1987). Mastery testing and student learning: A meta-analysis. *Journal of Educational Technology Systems, 15* 325-345.

Larrivee, B. (1985). *Effective teaching for successful mainstreaming.* New York: Longman.

Leinhardt, G. (1977). Program evaluation: An empirical study of individualized instruction. *American Educational Research Journal, 14*, 277-293.

Medley, D. M., Soar, R. S., & Soar, R. (1975): *Assessment and research in teacher education: Focus on PBTE.* Washington, DC: American Association of Colleges for Teacher Education.

Miller, S. C., & Cook, N. S. (1989). Mainstreaming students with learning disabilities for videodisc math instruction. *Teaching Exceptional Children, 21*(3), 57-60.

Moore, L. J., & Carnine, D. (1989). Evaluating curriculum design in the context of active teaching. *Remedial and Special Education, 10*(4), 28-37.

Porter, A. C., & Brophy, J. (1988). Synthesis of research on good teaching: Insights from the work of the institute for Research on Teaching. *Educational Leadership, 45*(9), 74-85.

Ragosta, M. (1983). Computer-assisted instruction and compensatory education: A longitudinal analysis. *Machine-mediated Learning, 1*(1), 97-127.

Rosenshine, B., & Stevens, R. (1986). Teaching functions. In M. D. Wittrock (Eds.), *Handbook of research on teaching* (3rd Edition). New York: MacMillan.

Thorkildsen, R. (1986). *Development and testing of videodisc systems for mainstreaming* (Grant No. G008402242). Final Report to U.S. Department of Education, Office of Special Education Programs. Logan, UT: Utah State University, Developmental Center for Handicapped Persons.

Walberg, H. J., & Wang, M. C. (1987). Effective educational practices and provisions for individual differences. In M. C. Wang, M. C. Reynolds, & H. J. Walberg (Eds.), *Handbook of special education: Research and Practice, Volume 1, Learner characteristics and adaptive education* (pp. 113-128). New York: Pergamon Press.

The Courseware Designer's Toolkit—
A First Step Toward an Integrated Environment for Courseware Designers*

by John S. Sfondilias
Intelligent Tutoring Systems Consultants
Donald P. Bailey
Gary D. Brewington
United States Air Force

Infotec Development, Inc. (IDI) in Colorado Springs, CO is currently working on a $15 million computer-based training project for the US Air Force. Over 150 personnel are involved in converting nearly 2000 hours of space operations courseware to computer-based training (CBT). Few of these personnel have significant experience in CBT or instructional design. The existing courseware, which is used to train Air Force mission control personnel, teaches complex satellite operations.

A CBT project of this magnitude and complexity poses unique problems. Staffing the project with qualified, affordable personnel can be difficult. Finding personnel skilled in both space operations and CBT is nearly impossible. The best use must be made of those who are hired. It is imperative that inexperienced personnel become productive quickly. These personnel must produce CBT courseware that effectively and reliably trains Air Force mission control personnel in satellite operations.

To address these problems, we are developing a *Courseware Designer's Toolkit*, which is a collection of instructional design tools that can allow even inexperienced personnel to produce sophisticated, effective CBT. The Toolkit is based on an instructional design theory called Direct Instruction (Engelmann & Carnine, 1982), which has been applied in numerous educational programs across the nation and is gaining increasing recognition around the world (Kelly, Gersten, & Woodward, 1988; Lockery & Maggs, 1982; Nikiforuk, 1982). The Toolkit specifically addresses the needs and characteristics of space operations training at the Consolidated Space Operations Center (CSOC) in Colorado Springs.

Each tool in our Toolkit implements, or augments, a specific Direct Instruction paradigm. The tools address the instructional design component of CBT. A integrated environment for courseware designers would provide tools for programming, graphics, word processing, and computer-managed instruction (CMI) as well as instructional design. The *Courseware Designer's Toolkit* is a first step toward this environment.

We believe this to be an important step, since the effect of good (or bad) instructional design is becoming increasingly clear. Recent research demonstrates that it is design, not media, that determines the effectiveness of lessons. The data indicate that lessons developed for both live instruction (lecture method) and CBT produce equivalent learning outcomes when designed by the same design team (Clark, 1988). Many of our intuitive notions regarding education (e.g., color is better than monochrome, or discovery learning is better than programmed) are not supported by research data. Therefore, it is imperative that the instructional strategies we employ be research-based rather than intuitive.

To complicate matters, a computer cannot compensate in real-time for a poorly-designed lesson. An instructor can (and often does). Computers cannot see confused looks on student faces or answer unanticipated questions. Therefore, instructional design for CBT must be effective, complete, and as faultless as possible.

The authoring system we use provides some level of productivity enhancement. However, it cannot guarantee that the lessons produced are instructionally sound, or even well-programmed. Authoring systems generally facilitate programming, not instructional design. The tools in our Toolkit provide templates and models for implementing CBT with effective instructional strategies.

In our Toolkit, we provide tools for implementing effective drills and progress tests, and for teaching systems and procedures. These tools address our immediate training needs at CSOC. With a minimum of direction, inexperienced personnel can use these tools to produce efficient and effective courseware.

Space Operations Training

We address two basic types of training at CSOC: systems and procedures. In satellite training, we often teach students about a particular satellite subsystem, then teach them the procedure, or procedures, associated with that subsystem. Direct Instruction theory provides us with rules and strategies for teaching this kind of content. Students are expected to achieve mastery of both satellite systems and operations, and we can create mastery-based instruction with Direct Instruction.

*The views, opinions, and/or findings contained in this paper are those of the authors and should not be construed as an official Department of the Air Force position, policy, or decision, unless so designated by other documentation.

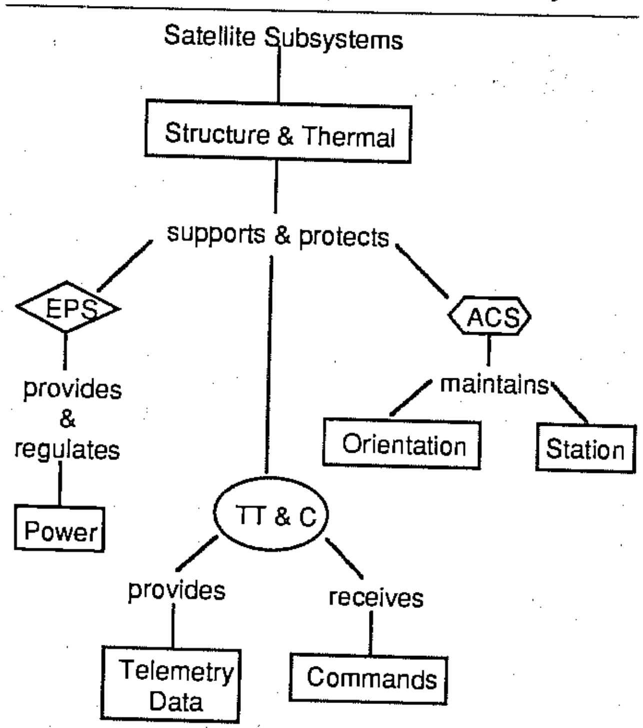
A Direct Instruction analysis of cognitive knowledge also provides a taxonomy that matches cognitive knowledge structures with optimal communication rules for each knowledge structure. This taxonomy allows us to break a lesson down into basic knowledge types. These types correspond to the tools in the *Courseware Designer's Toolkit*. The Toolkit addresses two knowledge types in particular: *fact systems* (e.g., satellite subsystems) and *cognitive routines* (e.g., satellite command procedures).

A fact system is a set of elements and the relationships among them that create a "unique whole." For example, the elements and relationships of a satellite subsystem (see Figure 1) comprise a fact system.

We teach fact systems systematically, beginning with the high-level view, then progressing to greater and greater detail. We want satellite mission control personnel to have a mental map of the systems in a satellite, know how they work and how they interact. By using the Direct Instruction approach to teaching fact systems, we can build this understanding.

A cognitive routine is a step-by-step procedure for performing a task. Figure 2 illustrates a cognitive routine that is used to perform a satellite command procedure. Cognitive routines and fact systems go hand-in-glove. Fact systems allow mission control personnel to envision satellite subsystems; cognitive routines enable them to command them.

Figure 1. Fact system for the subsystems of a satellite (Acronym definitions: EPS - Electrical Power Subsystem; TT&C - Telemetry, Tracking and Commanding Subsystem; ACS - Attitude Control Subsystem).



We teach cognitive routines in a step-by-step fashion, ensuring that the learner masters each step before moving on to the next. The student is required to make an overt response on each step so that we can diagnose and remediate problems immediately. When a student completes such training, we can be assured that the material has been mastered.

To implement the instructional strategies faithfully, pre-designed models or templates are used. These formats underlie the instructional basis for the development of our Toolkit.

The Toolkit

Each tool in our Toolkit is based on easily-used templates. Authors "fill in" the templates with lesson's specific content. The templates are then compiled along with the tool's driver logic to produce a complete lesson.

The Fact System Tool

The Fact System Tool is used to teach satellite subsystems. The product of this tool is a lesson that gradually builds a visual model of a satellite subsystem by questioning and interacting with the student at each step. The purpose of the questioning is to assure that the student is attending to the critical components of the subsystem. Building a visual model allows the student to envision and understand what can be very complex systems.

The Fact System Tool provides all the necessary logic and program code (minus the specific content)

Figure 2. Cognitive routine for arming the Apogee Kick Motor (AKM).

STEP 1: Does satellite indicate ready to receive command?
YES Initiate AKM ARM routine; proceed to step 2.
NO Initiate TT&C anomaly resolution; end of procedure.

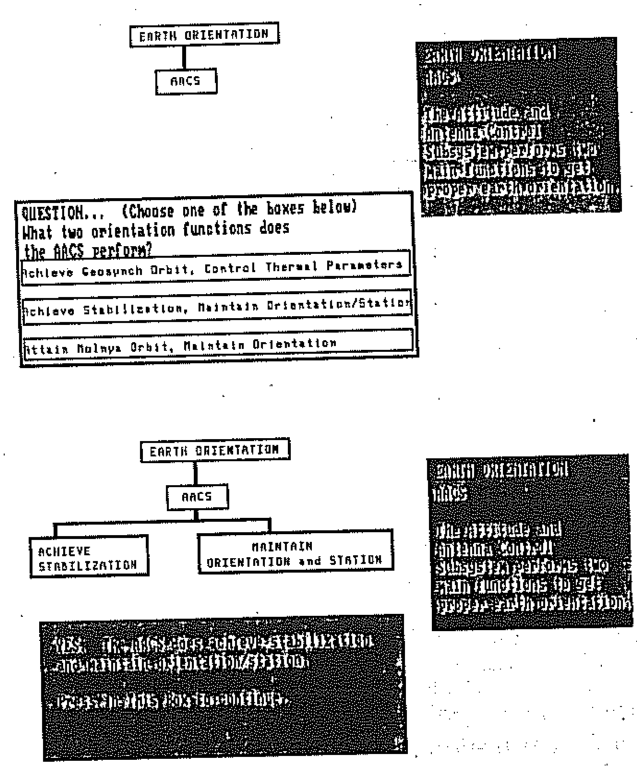
STEP 2: Has satellite stored AKM ARM command?
YES Initiate AKM FIRE routine; proceed to step 3.
NO Initiate TT&C anomaly resolution; end of procedure.

STEP 3: Does satellite indicate successful AKM fire?
YES Initite AKM SAFE routine; end of procedure.
NO Initiate ACS anomaly resolution; end of procedure.

Figure 3. Templates from the Fact System Tool. The author fills in the specific content for the question context, stem and distractors.

```
**************** Context Statement *****************************************
*
                                      $$ Replace the ?? with the fact number
case   ??
.      write   xxxxxxxxxxxxxxxxxxxxxx $$ Do one context statement
.              xxxxxxxxxxxxxxxxxxxxxx $$ for each fact.
.              xxxxxxxxxxxxxxxxxxxxxx
.              xxxxxxxxxxxxxxxxxxxxxx $$ To do this, just make a copy of
.              xxxxxxxxxxxxxxxxxxxxxx $$ this section for each fact in the
.              xxxxxxxxxxxxxxxxxxxxxx $$ lesson.
.              xxxxxxxxxxxxxxxxxxxxxx $$ Then fill in each context statement.
.              xxxxxxxxxxxxxxxxxxxxxx $$ where the x's are.  Context
.              xxxxxxxxxxxxxxxxxxxxxx $$ is limited to 9 lines, each
*                                     $$ 22 characters long.
*

**************** Question Stems *************************************
*
case   ??           $$ Replace "??" at left with appropriate fact number.
.      write   xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
.              xxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxxx
*                   $$ Question stems are limited to 2 lines, each
*                   $$ 47 characters long.
*                   $$ Make a copy of this section for each fact and
*                   $$ fill in the x's with the appropriate question stem
*                   $$ for each fact.

************************* Distractors *********************************
*
case   ??           $$ Replace "??" at left with appropriate fact number.
.      write   xxxxxxxxxxxxxx distractor a xxxxxxxxxxxxxxxxxx
.
.              xxxxxxxxxxxxxx distractor b xxxxxxxxxxxxxxxxxx
.
.              xxxxxxxxxxxxxx distractor c xxxxxxxxxxxxxxxxxx
.
.              xxxxxxxxxxxxxx distractor d xxxxxxxxxxxxxxxxxx
.
*
*      $$ Each distractor is limited to 1 line, 47 characters long.
*      $$ You are limited to four distractors per question.
*      $$ Make one copy of this section for each fact in the lesson.
```

Figure 4. Screen prints from an actual lesson produced with the Fact System Tool. In the upper frame, the student is asked a question. The student answers correctly; the lower frame shows the fact system being built.



for a complete lesson. The author fills in the specific content as indicated in templates illustrated in Figure 3.

The resulting lightpen-driven lesson (see Figure 4) provides *a high level of user interactivity*. It builds the visual model of the particular satellite subsystem, and supplies relevant information for each element in the subsystem. By building the visual model and questioning frequently, we can achieve high levels of student learning and retention.

The CFP Tool

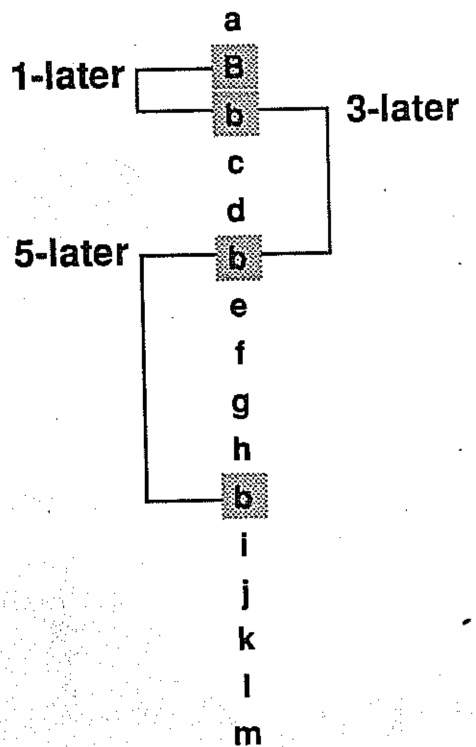
The CFP Tool is based on the Corrective Feedback Paradigm (Siegel & Misselt, 1984). The CFP Tool provides a practice paradigm for the frequent feedback and remediation that the Direct Instruction mastery-learning model requires. It provides extra practice on those elements of a fact system, or those steps in a cognitive routine, that a student finds difficult.

For example, in a 1-later, 3-later, 5-later review schedule (see Figure 5), a missed item appears immediately after it is missed. Then, if the student is successful, it appears again three items later. If the student is successful again, it appears five items later. If the student misses any of the review items, the 1-3-5 later review begins again, at that point.

The Corrective Feedback Paradigm has been used successfully in a number of instructional design projects (Alessi, Siegel, & Silver, 1982; Sfondilias, 1986; Sfondilias & Siegel, 1987; Siegel, 1983) and is an integral part of a comprehensive computer-based tutorial model developed by Dixon and Clapp (1983).

The CFP Tool is similar to the Fact System Tool in that it provides all necessary logic and program code. The author simply specifies the desired review schedule, then enters the drill questions in the template (see Figure 6). Questions can be generalized so that they

Figure 5. Increasing ratio review for a missed item in a CFP drill. The upper-case "B" is the missed item. Each lower-case "b" is a correct response to the 1-3-5 review schedule.



reappear in varied formats when brought back for review. The resulting drills can incorporate graphics (see Figure 7). Because a student cannot complete a CFP drill without answering all items correctly (some multiple times, depending on increasing ratio review), a high level of mastery is assured.

The Progress Test Tool

The Progress Test Tool is used to develop the test required by the Air Force for the end of each module. These progress tests were previously administered as paper-based tests. On a paper-based test, a student can skip around and change answers until time is up. We designed the Progress Test Tool to preserve these characteristics.

Progress tests are developed by creating a file of test questions (usually on a word processor) following a simple format (see Figure 8). The Progress Test Tool driver presents these questions in the format indicated in Figure 9. The student can touch the lightpen to the bar on the right of the screen to move to a different question. Students can move about the test and change

Figure 6. Templates from the CFP Tool. The author fills in the review schedule (in this case, 1-3-5 review) and enters the drill questions. Alternatively, questions could be executed from other files, allowing a multiplicity of question types.

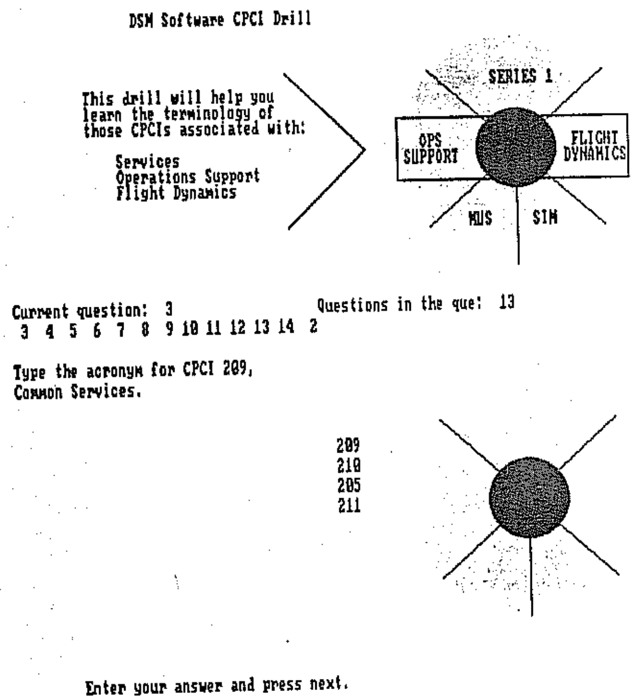
```
*   User supplied values are entered here.
locdef  questions = 14
*
        review.posns = 3
*
        review.spot1 = 1
        review.spot2 = 3
        review.spot3 = 5
*
        retire.crit = 2
*


*
* User supplied questions go here.
**
do      services
at      4|2
*       |-------------------------------35
write   Type the acronym for CPCI 209,
at      5|2
write   Common Services.
at      5|2
if      version = 0
color   8
write   C       S  v c s
color   6
endif
*
arrow   zrow+2|zleftmargin
specs   bumpshift,nookno
answer  csvcs
.       at      zrow-1|4
.       write   Correct
no
.       at      zrow-1|4
.       write   No, CSVCS is correct.
.       calc    judgement _ false
.       judge   okquit
endarrow
**
```

answers until they indicate they are finished.

The Cognitive Routine Tool

We are currently designing the Cognitive Routine Tool. There are substantial differences among cognitive routines (e.g., the command procedure in Figure 2 vs. the procedure for decrypting an encoded satellite transmission). However, by definition, all cognitive

Figure 7. Screen prints from an actual CFP drill. The upper frame introduces the drill and shows a completed "Services" acronym diagram. The lower frame presents the third question in the drill. (Note: "Current question," "Questions in the que" and the actual queue numbers appear for lesson developers, only).



routines are step-by-step procedures that may require extra practice on any given step. Therefore, we anticipate that the Cognitive Routine Tool will incorporate logic from the CFP Tool to provide the practice paradigm as well as logic from our other tools that will allow authors to specify procedures easily.

Conclusion

Our Courseware Designer's Toolkit addresses *our specific training* needs at the Consolidated Space Operations Center. It allows inexperienced personnel to produce effective and engaging space operations courseware. It also frees more experienced personnel to pursue analysis and supervisory tasks.

We based our Toolkit on Direct Instruction theory. Future research could explore the efficacy of other instructional theories. We anticipate extending and improving the Toolkit throughout the duration of this CBT project. In the future, we envision an integrated environment for courseware designers, including programming, graphics, word processing, CMI and instructional design tools. ◆

Figure 8. Question template from the Progress Test Tool. Test developers create question files with a word-processor using this format.

case 1
write 1. The redundancy of most components provides a workaround solution to most anomalies on orbit.

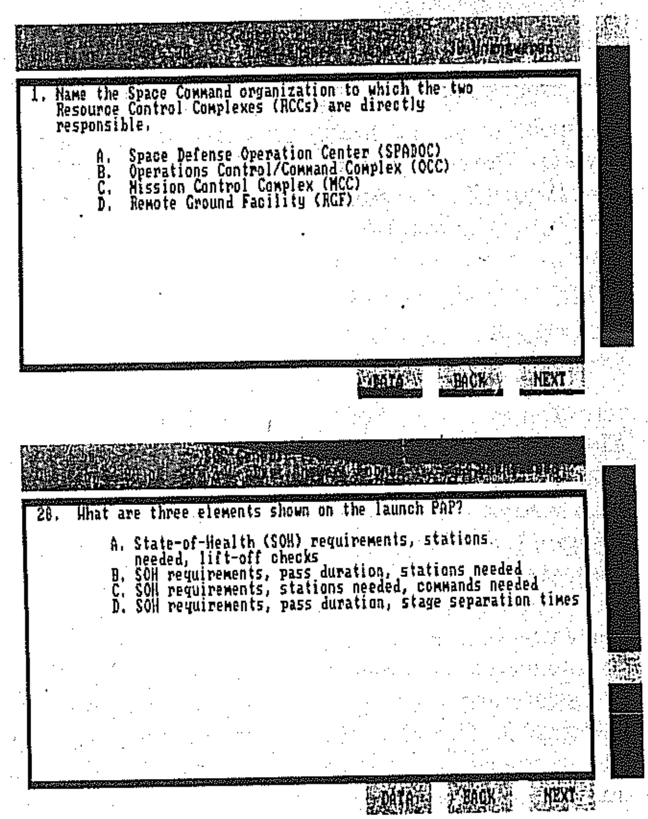
a. True
b. False

case 2
write 2. Which component decrypts the 63-bit command?

a. DCD
b. Receiver
c. RF Assembly

endcase $$ This line goes after the last question

Figure 9. Screen prints from an actual progress test. The bar on the right is lightpen sensitive and allows students to select questions anywhere in the test. In this case, the student skipped from question 1 to question 28.



Author's Note: Requests for reprints should be sent to John Sfondilias, Intelligent Tutoring Systems Consultants, 604 Healey, Champaign, IL 61820.

References

Alessi, S. M., Siegel, M.A., & Silver, D. Z. (1982). Effectiveness of a computer-based reading comprehension program for adults. *Journal of Educational Technology Systems, 11*(1), 43-57.

Clark, R. (1988, April). Effective design: guidelines from cognitive psychology. *Proceedings of the 6th Annual Computer-based Training Conference & Exposition*, session # 306.

Dixon, R. C., & Clapp, E. J. (1983). *A theory-based computer tutorial model* (CERL Report E-26). Urbana, IL: University of Illinois, Computer-based Education Research Laboratory.

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

Kelly, B., Gersten, R., & Woodward, J. (1988, Spring). Research on mastering fractions - an interactive videodisc program. *ADI News*, pp. 1, 7, 10, 11.

Lockery, M. & Maggs, A. (1982). Direct Instruction research in Australia: a ten-year analysis. *Educational Psychology*, 2 (Nos. 3-4).

Nikiforuk, A. (1982, September). Why kids can't read. *QUEST—Canada's Urban Magazine.*

Sfondilias, J. S. (1986). *The effects of combining a cognitive routine strategy and the corrective feedback paradigm in a computer-based lesson.* Doctoral thesis, University of Illinois, Urbana, IL.

Sfondilias, J. S. & Siegel, M. A. (1987, April). The instructional calculus and direct instruction in intelligent tutoring systems. *Proceedings of the Training Applications Using Expert Systems Conference*, National Science Center For Communications and Electronics, Augusta, Georgia.

Siegel, M. A. (1983). PLATO education group: *Summary of activities 1982-83* (CERL Report E-24). Urbana, IL: University of Illinois, Computer-based Education Research Laboratory.

Siegel, M. A., & Misselt, A. L. (1984). Adaptive feedback and review paradigm for computer-based drills. *Journal of Educational Psychology, 76*(2), 310-317.