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Transition First Grade
- a Success Story-

by Ed Schaefer
and Patrice Riggin
Lewes, Delaware

Once there were sixteen children who had just completed kindergarten and would soon enter first grade. For these children kindergarten had been a very trying experience. They were not being "promoted" to first grade, but rather "administratively assigned" to grade 1. However, the expectations for these children in first grade were not very exciting. Given their performance in kindergarten, it was expected that these children would find first grade as difficult and frustrating as kindergarten, and that they would almost certainly repeat first grade.

It was not that these children were handicapped. They did not qualify for classification and placement in special education. Nor were these children part of an atypical low functioning class, for every year there were 15 to 30 such children in the same predicament. Nor was this school a "bad" school; rather, standardized test scores indicated that the "average" student in this school was 10 or more points above the national average.

Why, then, were these children having such difficulty in school? A number of rather typical explanations were offered:

1. they were "slow learners" (IQ scores for the 16 children ranged from 77 to 100, with a mean and median of 90);
2. their home environments were "inadequate";
3. the children were simply not yet "ready" for formal academic instruction.

The authors favored the alternative explanation that these children simply had not been provided with the quantity and quality of instruction that was necessary. For these children, and for this reason, the Transition First Grade program was created in June of 1985. The transition class was designed to serve the children with a lower student-teacher ratio (16-1), a full-time instructional aide, and a radically different approach to curriculum and instruction. In the transition class the authors decided that both the teacher and the aide would use the DISTAR reading, language, and mathematics programs exclusively until the students mastered level 1 of each program. Thereafter, the "regular" reading, math, and language programs would be introduced as the students continued through level 2 of the DISTAR programs. Each of the "regular" first grade classes had a student-teacher ratio of 22/23-1, a half-time instructional aide, and followed one of the popular, traditional basal programs for reading, language, and math instruction.

Students were chosen for the transition class by the principal and kindergarten teachers who based their decisions on the students' records of performance in the regular kindergarten program and on the results of the Comprehensive Test of Basic Skills (CTBS - Level A) administered at the end of the kindergarten year. Essentially, the 16 lowest performing or most at-risk students from the entire class of about 125 kindergartners were chosen for the transition class; the authors had no voice in the selection of students for the transition class.

Procedures

Initially students were given the placement tests for DISTAR *Language I* and *Reading Mastery I* and were grouped accordingly. The top group (6 students) was placed in *Reading Mastery-Fast Cycle I* and DISTAR *Language I* - Lesson 31. The middle group (5 students) was placed in *Reading Mastery I* - Lesson 11 and DISTAR *Language I* - Lesson 21. The third group (5 students) began *Reading Mastery I* at Lesson 1 and *DISTAR Language I* at Lesson 11. Some regrouping occurred during October and November, and by the end of the year there were 7 students in the top group, 6 in the middle group, and 3 in the third group. Arithmetic instruction began at Lesson 21 of DISTAR *Arithmetic I* as a whole class activity, but three weeks into the school year the class was split into two groups, the higher group with 9 stu-

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Special Education
A DI Meta-Analysis

by W.A.T. White
University of Oregon

This analysis is based on studies that compared the effectiveness of direct instruction intervention with that of one or more comparison interventions. Only studies with students experiencing some form of learning handicap (e.g., learning disability, trainable mental retardation, reading disability) were included. Studies with students considered "at-risk" for learning problems did not qualify.

For a study to be included in the meta-analysis, the assignment of subjects to experimental and comparison groups must have taken place *prior* to intervention. Studies with noncomparable experimental and comparison groups, established by statistically significant differences on pretest scores or by acknowledgment of an author in a report, were excluded.

A study was considered to contain a Direct Instruction treatment group if the author of the report considered one of the groups to be such. Studies were included if a treatment group was based on the Engelmann and Carnine (1982) model of Direct Instruction, or if a group utilized instructional materials developed by Engelmann and associates (e.g., Dixon & Engelmann, 1979; Engelmann, Carnine, & Johnson, 1978; Engelmann & Osborn, 1977).

Literature Search

Studies were gathered from research previously known to the reviewer or to the reviewer's colleagues, from reports referenced in such research, and from research listed in a computer literature search conducted on April 30, 1986 using data compiled by the Educational Resources Information Center (ERIC). Descriptors used in the search were: direct instruction; direct teaching; directed instruction; directed teaching; DISTAR; direct verbal instruction; active teaching; and active-teaching.

The 25 studies in the meta-analysis for which treatment lasted for over a week are listed in Table 1. Also listed for each study are the skill area in which treatment was delivered; whether subjects were mildly handicapped or moderately/severely handicapped; and whether the research design was experimental (E) (involving random assignment of subjects to treatments) or quasi-experimental (Q) (equivalent groups, but without random assignment).

Some of the studies require explanation about the manner in which they were analyzed for the meta-analysis. The intervention in the Branwhite (1983) study consisted of two phases, only the first of which was included in the meta-analysis. During the second phase, both the experimental and comparison groups received the same Direct Instruction treatment. Thus, data from the second phase are clearly of no relevance. In the Hursh (1979) report, comparisons involved both mildly handicapped students and nonhandicapped students. Only effect sizes based on the comparisons involving the mildly handicapped students were included in the meta-analysis. The Lloyd, Epstein, and Cullinan (1981) and Lloyd, Cullinan, Heins, and Epstein (1980) reports described the same study, but included different dependent measures. In the meta-analysis, the two reports were considered as one study. The Walker, McConnell, and Clark (1983) report described two studies, but the first study had already been included in the meta-analysis from a separate report (Walker, McConnell, Walker, Clark, Todis, Cohen, & Rankin, 1983). Thus, for the purposes of this meta-analysis, citations of Walker, McConnell, and Clark (1983) refer only to the second study in that report. Finally, C. Walker's (1980) master's thesis was coded not from the complete original report, but rather from Lewis' (1982) description of the study, and from photocopies of tables from C. Walker's (1980) results section sent to the reviewer from England.

Coding Study Characteristics

Studies in the meta-analysis were coded on a number of study characteristics or po-

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In this Issue- **Information on DI Summer Conferences & Institutes**

The Midwest Direct Instruction Institute
July 8-10, 1987
Hyatt Regency Milwaukee
Milwaukee, Wisconsin

The Third Atlantic Coast Conference on Effective Teaching & Direct Instruction
July 13-16, 1987
Delaware Technical & Community College
Lewes, Delaware

13th Annual Eugene Summer Conference
August 3-7, 1987
Eugene Hilton Hotel & Convention Center
Eugene, Oregon

2nd Annual Salt Lake City Direct Instruction Institute
August 10-14, 1987
Salt Lake City Marriott Hotel
Salt Lake City, Utah

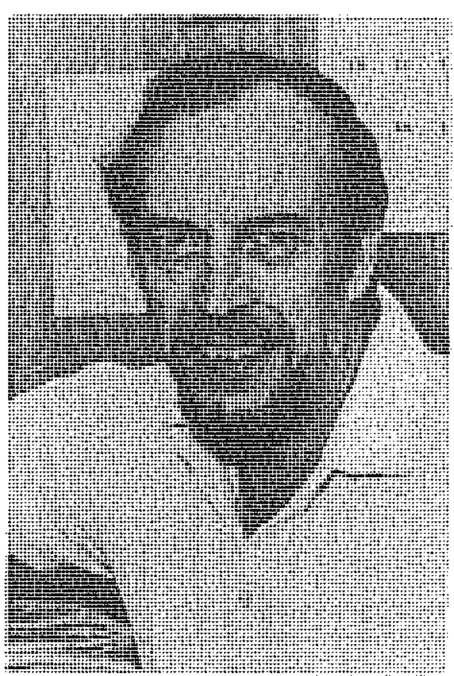
Newport Beach Direct Instruction Institute
August 17-21, 1987
Newport Beach Marriott Hotel
Newport Beach, California

Ziggy Awarded Honorary Ph.D.

Siegfried "Zig" Engelmann flew to Kalamazoo, Michigan, on April 24 to accept an honorary Doctor of Education degree from Western Michigan University. This is the third time that the Psychology Department has nominated a person for an honorary doctorate. The other two recipients are B.F. Skinner and Fred Keller.

Many people mistakenly believe that Engelmann already has a Ph.D., when in fact the highest degree he has earned for his coursework is a BA in philosophy from the University of Illinois.

The ADI Board and Members congratulate Zig on this much deserved honor.



Dr. "Zig" Engelmann

DEAR ZIGGY

Here's an excerpt from a letter I received:

Dear Ziggy:

We begin using *Reading Mastery I* in kindergarten and move students as they meet mastery criteria, and see that we are in a critical situation of providing a suitable continuation of scholarly curriculum if we rely upon what was suitable material in our recently past thinking. The crunch is evident in the sixth grade this year, the second year we have used *Reading Mastery* in our school, but we have documentation that we will be feeling it in the fourth and fifth next year, and forever, if our success continues as it is now. Our first class to have been taught *Reading Mastery* since kindergarten are now third graders. They are nearly all well into level *IV* at this time.

We realize that levels *VII* and *VIII* are still not at the publication point, so we need some coaching to ensure continuation of a viable, substantial program for our older students.

What has been successfully used by others as they have reached this point?

What do we do with these kids?

Elizabeth Jensen,
Gunnison Valley Elem. School
Gunnison, Utah

Dear Elizabeth,

It is a nice problem to have. Keep your data and share it with us. We'll pass it on to others, through the DI News.

The simplest procedure is to assign the students to read novels that are appropriate for their reading level and possibly non-fiction books that are *interesting*. The value of reading longer works is that longer works do a better job of developing the author's viewpoint and arguments. Shorter selections do not pull in as much information and therefore do not do as good a job. Good novels are fairly easy to find.

The procedure for introducing them would be the same as those novels presented in levels *V* and *VI*. First, divide the book into sections- possibly four of them. Next, identify vocabulary that would probably give the students problems and pre-teach it. Also, give students a list of study questions, or things that they should find out when reading the section. At the end of the section, ask them questions about the information presented in the section. Don't hold them responsible for the most detailed information, just important things that happened.

The procedure for non-fiction books is a little different. Instead of assigning the work for independent study, present it through lessons, using the same procedures in *Reading Mastery V and VI*. The procedure would be for the students to go over the new vocabulary words, and take turns reading the selection aloud. Following the oral work, they would independently read to the end of the chapter, and then answer question.

The best material for this structured work is interesting non-fiction- biographies of interesting people (Madam Curie, Henry Ford, etc.) or the kind of non-fiction that holds together. Books like Rachael Carson's *The Sea Around Us* are written on an adult level; however, if the key vocabulary is pre-taught, they work well for these lessons. And they teach students a heck of a lot.

The big trick to making the instruction work is to use good books. I wouldn't go by what people say is "appropriate for sixth graders". I would go by what adults find interesting. The kids who complete level 6 have the skills necessary to go through these books, if given a little structure and help on some vocabulary.

But do solve the problem. Too often school districts (and schools) put a crimp on student learning. They insist that a program has a number 4 associated with it in some way, it is appropriate for students in grade four and for no others (unless they are "remedial"). In fact, the 4 means that the program is appropriate for any student who has mastered 3. That student may be in the first grade, the second grade or the sixth.

So good for you. Show just how far kids can go if they receive good, continuous instruction through the sixth grade.

Ziggy

SRA Obtains More DI Products

C.C. Publications was recently purchased by Science Research Associates (SRA). This means that all materials previously obtained from C.C. (*Expressive Writing*, *World of Facts*, *Cursive Writing*, etc.) should be ordered from SRA.

SRA has indicated that a catalog listing all of the new programs will be available by October. Until that time, continue using C.C.'s pricing and order numbers, and mail your oders to:

S.R.A.
155 North Wacker Drive
Chicago, IL. 60606

TEACHERS
Send us your questions and write us about your DI experiences.

The **Direct Instruction News** is published Fall, Winter, Spring and Summer, and is distributed by mail to members of the Association for Direct Instruction. 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.

Preschool for the Disadvantaged-DISTAR *Language I* Tested in South Africa

by Miss A. Muthukrishna
University of Durban-Westville
and
Miss K. Naidoo, Teacher
Westcliffe Nursery School
Westcliffe, Chatsworth

The purpose of this study was to evaluate the effectiveness of DISTAR *Language I* with preschool disadvantaged Indian students. The language performance of children using DISTAR was compared with other preprimary children receiving the current language development program. The current program is a semi- structured program designed by the teacher to develop cognitive and linguistic skills of the children.

Method

The nursery school is a community project run by a group of parents and voluntary workers who began the project out of a sense of need for such a service in the particular area. At the commencement of the study, there were 30 pupils between the ages of 3 to 5 years attending the school, which was staffed by a teacher who has a two-year diploma in preschool education, and a teacher aide. Parents were encouraged to spend time at the school on a rotating basis to assist in the management of pupils and to acquaint themselves with activities undertaken by their children. The roll at the school gradually increased to about 50 children at the conclusion of the study. The school is situated in an economically deprived area--families live in subeconomic flats developed by the government.

Subjects

Fourteen children were selected whose ages ranged from 4 to 5 years. Seven children, 3 boys and 4 girls, were selected for the experimental group, initially on the basis of sex, and then, individual children were chosen by lot drawing. The remaining 7 children, 3 boys and 4 girls, made up the comparison group.

DISTAR *Language I* was used with the experimental group every day for 30-35 minutes. The children sat in a semicircle around the teacher, with the weakest children at arms length in the middle.

The comparison group received a semi-structured program every day for about 30-35 minutes. This was designed by the class teacher and included activities such as story-time, vocabulary, building or enrichment, show and tell lessons, counting, picture discussion, concept formation (color, shape, size, etc.), environmental studies, and other activities which the teacher termed 'school readiness.' Other 4 and 5 year old pupils in the school joined in with the comparison group for this program.

Both groups received some general language work, such as, daily news, morning conversation, weather, and conversation during all activities.

The arrangement was that when the experimental group was being exposed to DISTAR, the comparison group would engage in free-play under the supervision of the teacher aide and parents present for the day. The reverse would apply when the comparison group received the teacher-designed language program.

During the course of the study, certain practical difficulties were experienced. The study suffered a loss of 4 children. The family of Child 7 in the experimental group moved to another suburb. Child 6 and Child 7 in the comparison group experienced problems of adjustment and poor health; parents decided to have the children remain at home for the year. Child 5 in the comparison group left to attend a preschool attached to a regular primary school which was situated nearer her home. However, Child 5 was followed-up in the posttesting period and remained part of the study. The program and activities at this preschool were designed and supervised by the staff of the primary school to which it was attached. The teacher was not a qualified nursery/preschool teacher, but had years of experience in the field.

Tests

Pretest measures, administered by the first author, were taken between the end of August and October, 1984. Posttest measures were carried out in October-November, 1985. The following tests were administered:

1. Reynell Developmental Language Scales (Revised)
2. The Peabody Picture Vocabulary Test
3. The Stanford-Binet Intelligence Scale (to test for generalization of language learned)

In addition, Expressive Language Samples of 1 hour were taken from each child during a play situation. It was hoped that the Lee (1974) Developmental Sentence Analysis procedure would be used to analyze the utterances. However, the first author was forced to abandon the idea because of certain practical problems experienced.

Results

Results demonstrated that although both groups improved in expressive and receptive language, vocabulary, and intelligence, the experimental group obtained higher gains on each of the tests administered.

The Stanford-Binet results (Table 1) were very encouraging. The experimental group mean gain was 15.3 months Mental Age. The comparison group mean gain was 11 months. The comparison group also showed a 5-point drop in IQ, while the experimental group gained 3 points.

These results are very similar to those obtained by Gregory, Richards, and Hadley (1982) in which children with language disorders on the average gained 11.8 months on the Stanford-Binet in 12 months of teaching.

Similarly, Maggs and Morath (1976) quoted by Maggs (1980) administered DISTAR Language to severely mentally handicapped pupils and on the average results indicated 22.5 Mental Age months in 24 months of teaching, and the control group gained only 7.5 Mental Age months.

The gains by the experimental group on the Reynell Developmental Language Scale are equally impressive (Table 2). The experimental group gained 22.2 months in comprehension whereas the comparison group grained 11.4 months. On the Reynell Expression Scale, the experimental group gained 18.9 months and the comparison group gained 11.7 months.

The results of the Peabody Picture Vocabulary Test demonstrated similar findings. The mean gains in vocabulary age for the experimental group was indicated as 2 years 2 months, 7 months more than the gain demonstrated by the comparison group. (See table 3.)

Table 1. Stanford-Binet Gains by Group

Experimental Group	Pretest MA	Pretest IQ	Posttest MA	Posttest IQ	Gain in years & months
Student 1	4-11	104	5-10	102	0-11
Student 2	4-10	94	6-0	94	1-2
Student 3	4-5	107	5-8	109	1-3
Student 4	4-8	92	6-0	96	1-4
Student 5	4-2	95	5-10	107	1-8
Student 6	4-8	94	6-0	99	1-4
Mean	4-7.3	98	5-10.6	101	1-3.3
Comparison Group					
Student 1	4-7	109	5-8	107	1-1
Student 2	4-6	105	5-5	98	0-11
Student 3	4-8	103	5-10	103	1-2
Student 4	4-7	94	5-2	83	0-7
Student 5	4-10	107	5-8	103	0-10
Mean	4-8	104	5-7	99	0-11

Table 2. Reynell Developmental Scales Gains by Group

	Reynell LDS Comprehension			Reynell LDS Expression		
Experimental Group	Pre-test	Post-test	Gain in months	Pre-test	Post-test	Gain in months
Student 1	4-0	6-2.5	26.5	4-1	5-4	15
Student 2	4-5	6-2.5	21.5	3-8.5	4-10.5	14
Student 3	4-0	5-1	13	3-8.5	5-1	16.5
Student 4	4-6.5	6-2.5	20	3-11.5	4-10.5	11
Student 5	3-8	5-7	23	2-6	5-1	31
Student 6	4-3	6-8	29	3-11.5	6-1.5	26
Mean	4-1.8	5-11.9	22.2	3-7.8	5-2.8	18.9
Comparison Group						
Student 1	4-0	5-3	15	4-8.5	6-2.5	18
Student 2	4-3	5-7	16	3-11.5	4-8.5	9
Student 3	3-10	4-8.5	10.5	3-1	4-10.5	21.5
Student 4	3-8	4-1.5	5.5	3-8.5	4-2.5	6
Student 5	4-3	5-1	10	4-2.5	4-6.5	4
Mean	4-0	4-11.4	11.4	3-11.2	4-10.9	11.7

Table 3. Peabody Picture Vocabulary Test Gains by Groups

Experimental Group	Pretest MA	Pretest IQ	Posttest MA	Posttest IQ	MA Gains in years & months
Student 1	3-3	78	6-8	107	3-5
Student 2	3-3	68	6-6	105	3-3
Student 3	3-4	88	4-8	94	1-4
Student 4	3-9	79	5-5	93	1-8
Student 5	2-10	66	5-1	89	2-3
Student 6	4-3	87	5-7	95	1-4
Mean	3-6	78	5-8	97	2-2
Comparison Group					
Student 1	4-3	103	5-11	109	1-8
Student 2	2-11	78	4-11	98	2-0
Student 3	2-6	69	3-5	59	0-11
Student 4	3-0	71	4-8	83	1-8
Student 5	3-8	87	5-2	91	1-6
Mean	3-3	82	4-10	88	1-7

Discussion

The discussion will focus on a more qualitative interpretation of results and will outline some of the practical problems experienced.

During the instruction, both the teacher and the researcher found the program highly motivating to pupils. Pupils looked forward to the lessons, and on occasions when the program had to be interrupted owing to practical difficulties in the school day, pupils expressed their disappointment.

It must be mentioned that initially the researcher did have certain reservations regarding the fact that the program was developed in the U.S.A. and that certain "Americanisms" might confuse the pupils. However, it was found that this did not present a problem and no major changes were made to the content of the original scripted lessons. It was found that pupils were exposed to some of the

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Transition from First Grade- Continued from Page 1

dents, and the second group with 7 students.

In the mornings the students spent 40 minutes in a reading group with the teacher, 40 minutes in a language group with the aide, and 40 minutes doing independent seatwork. Independent seatwork consisted of the worksheets ("take-homes") from the DISTAR reading and language programs, supplemental *Reading Mastery Seatwork*, and materials from the DISTAR *Reading I Activity Kit*. Later in the year, additional supplemental materials were used to increase practice in comprehension activities. The schedule was arranged so that the top group did independent work, then language group followed by reading group. The middle group met first with the teacher for reading, then did their independent work, and then worked with the aide in language group. The third group did language first, then reading, and then independent work.

After lunch, the students had a 15-minute recess followed by spelling instruction in small groups. Initially, the students utilized the spelling program from *Reading Mastery I* and eventually, the *Spelling Mastery Program* Level A. Arithmetic followed spelling, then reading reinforcement activities, handwriting, and if time permitted some science or social skills instruction. Reading reinforcement activities consisted of sound reviews, additional practice in sounding out words and group reading of the stories in the DISTAR *Library Kit*. Beginning in late November with the top group and in January with the others, this also consisted of reading the stories in the basal reading program used in the regular first grade classrooms (*Keys to Reading*, 1986 edition-The Economy Co.). Reading vocabulary was pretaught on charts, with words introduced two days before they appeared in the story. On the chart each word was printed in the DISTAR orthography and also in regular orthography as it appeared in the Economy reader. The students were directed to sound out the first word (utilizing the DISTAR orthography), and then told that the second word said the same thing as the first word. When the words were reviewed, students were directed to read each word the "fast way"; the sounding out procedure was used only as a correction at that point. The format for irregular words used in *Reading Mastery I* ("that's how we sound out the word, this is how we say the word") was used for any word for which the students did not have the necessary phonetic skills or which could not be decoded phonetically. After orally reading the story in the group, the comprehension/vocabulary worksheets were done.

A similar procedure was used in teaching the vocabulary in those materials later used for additional supplemental comprehension practice.

Initial handwriting activities referred to letters only as sounds and followed the presentation sequence of *Reading Mastery I*, in order to reinforce reading skills and minimize confusions. Words practiced were those which had been introduced in reading vocabulary activities; sentences were taken from the stories. Capitals were introduced after lower case letters, and prior to their introduction in *Reading Mastery II*, but in the same sequence of "easy capitals" and then "hard capitals."

Results

The results clearly exceeded our highest expectations. All 16 children mastered at least 90% of the objectives in Level I of all three DISTAR programs. Seven of the 16 children also mastered at least 90% of the objectives in Level II of the DISTAR *Reading Mastery* program. Ten of the children mastered at least 85% of the objectives in the *Riverside Mathematics* and the *Economy Reading* programs used in the regular first grade classrooms. This last statistic is very critical because it meant that *10 of the transition students had met all the criteria for promotion to the second grade*, and in fact, were promoted to regular second grade classes in June of 1986. Of the remaining 6 students, 5 were assigned to regular first grade classes, and one was eventually diagnosed as "learning disabled/emotionally disturbed" and placed in a special education setting. Follow-up of these students during the first half of the 86-87 school year indicates that *all the transition students are performing at satisfactory or outstanding levels of achievement in all subject areas.* (Report cards for grades 1 & 2 indicate three levels of performance: unsatisfactory, satisfactory, outstanding, rather than letter grades.)

Another interesting pattern of information about these 16 students becomes apparent when one compares their IQ scores with the results of the Woodcock Reading Mastery Test administered late in the second half of the 85-86 school year (see Table I). As mentioned above, the average IQ of the transition student was 90. Using the same standard metric where the mean is 100 and standard deviation is 15, and converting the standard scores from the IQ test into expected grade equivalents on the WRMT, yielded a class average grade equivalent of 1.6 GE. Actual, average grade equivalent scores from the WRMT yielded a class average of 2.3 GE, or an average standard score of 112. Taken as a group, these 16 children had exceeded their measured ability level by almost a full year in grade equivalent terms, and by a whopping 1 1/2 standard deviation units.

How is such overachievement possible? John Carroll answered this question convincingly in 1963 when he stated that overachievement is a function of "high perseverance, instruction of high quality, and ample opportunity for learning." These are exactly the conditions that prevailed in the transition first grade classroom when a first rate teacher skillfully used high quality Direct Instruction programs. She was able to maximize time allocated to instruction, motivate exceptionally high rates of student engagement with instructional tasks, and produce average student success rates almost 1 1/2 standard deviation units higher than expectations.

Obviously these children were not slow learners. Two-thirds of the transition students met the standard school criteria for promotion to second grade. Obviously socio-economic and family circumstances were not preventing these children from learning. The 4 children who made the most significant gains were all low-income minority students. (See students AZ, ZA, PP, and DK in Table I.) Obviously these children were more than "ready" to learn. Fourteen of the 16 children in the transition class made progress that far surpassed expectations.

The conclusion seems inescapable: Effective education is a matter of *good teaching of good programs*. We already know enough to do both, right now, should we choose to do so.

Table 1. Performance on the Woodcock Reading Mastery Test (WRMT).

Student	IQ	Actual WRMT SS	Difference SD Units	Projected WRMT GE	Actual WRMT GE
AZ	85	128	2.86	1.4	2.6
ZA	84	119	2.33	1.4	2.3
LA	88	112	1.60	1.4	2.1
PP	84	127	2.86	1.4	2.6
AA	90	112	1.46	1.6	2.3
GF	89	118	1.93	1.5	2.4
BT	92	116	1.60	1.6	2.3
MT	87	115	1.86	1.5	2.3
TN	97	119	1.46	1.7	2.5
JN	98	119	1.40	1.8	2.6
DK	90	131	2.73	1.6	3.0
RH	77	103	1.73	1.3	2.0
CA	90	104	0.93	1.6	2.0
WM	86	88	0.13	1.6	1.6
JA	96	112	1.06	1.8	2.3
FK**	100	68	-2.13	1.9	1.2
Class Average	90	112	1.46	1.6	2.3

IQ- (Mean=100; SD=15)
SS- Standard Score (Mean=100; SD=15)
SD- Standard Deviation
GE- Grade Equivalent (Instructional Level)
**- Student diagnosed as LD/ED and placed in special education program for 86-87 school year

South African Preschool-

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"Americanisms" through the media (television). Sensitive teaching also helped overcome the problem. However, the teacher, in such circumstances, did have to deviate from the strictly laid-down verbal instructions in the presentation books and explain to children the alternate word normally used (e.g., wrench = spanner; wagon = cart).

The results showed that pupils in the experimental group demonstrated a significantly higher number of verbal concepts than the comparison group and the very aspects that were taught generalized to significant improvement on the Stanford-Binet Intelligence Scale. It was found that pupils in the experimental group could classify and categorize objects up to the 7-year level. These findings concur with those of Maggs and Morath (1976), quoted by Maggs (1980).

During the Pretesting, it was found that Child 5 in the experimental group had a developmental-lag in her language ability and an added speech defect (a stammer). She proved distractible and had a short attention span. In spite of this, it was decided to include her in the study.

Results demonstrated that this pupil made very encouraging gains in all areas tested. On the Reynell Language Developmental Scale, comprehension gains were 23 months and expressive language gains were 31 months. It was also found that qualitatively her speech improved markedly. This was substantiated by the child's mother.

On the Stanford-Binet Intelligence Scale, gains in IQ points were 12 points and in Mental Age 20 months. Gains on the Peabody Picture Vocabulary Test were 27 months in vocabulary age. Although initially the teacher indicated that the presence of this pupil slowed down the group, it was found that within approximately two months the pupil was able to keep pace. According to the teacher and from observations by the researcher, her attention and concentration span improved markedly.

One has to be cautious in the interpretation of the progress made by Child 5 in view of the fact that the comparison group did not include a child with similar language problems. It does, however, suggest that it would be worthwhile to investigate the effects of DISTAR Language I on children with language disorders.

It must be mentioned that the researcher experienced certain drawbacks in the implementation of the study. Firstly, there was a change in teachers at the school a month after the study began. Then, there was an interruption in the program for 2 weeks before the new teacher could be trained in the use of procedures involved. Secondly, the study suffered a loss of 4 children for reasons already explained. Thirdly, it was found that on occasions when the teacher aide was absent, the program could not be implemented, since there was the practical problem of management of the rest of the pupils.

Conclusion

As with other research groups mentioned, DISTAR instruction has once again achieved positive and encouraging results. The results of this present study suggested that it would be worthwhile testing and following up the implementation of the DISTAR Language program in other preschools in South Africa.

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DI Meta-Analysis- Continued from Page 1

tential moderator variables, which are listed in Table 2. Treatment length was coded as persisting either for one day, for two to five days, for six days to a month, for over a month to a year, or for over a year. Fidelity of treatment was coded as "high" if the research report mentioned that: (a) teachers using direct instruction methods were periodically observed for the quality with which they were implementing the treatment; and (b) observation indicated that the level of implementation was adequate. If either of these criteria were lacking, fidelity was coded as "low." The teacher category was coded according to whether students were taught during treatment by their regular teacher (i.e., an interventionist from the school district who worked with the students even after the study), or an experimental teacher (i.e., a professional brought in from outside the district for the duration of the study only).

Students with labels of reading disabled, learning disabled, emotionally disabled, and educably mentally retarded were considered mildly handicapped individuals. Individuals with greater learning handicaps were considered moderately to severely handicapped. Age range was divided into categories of school grades that students were in, or would have been in had they progressed academically at the same rate as their age group peers. Grade categories were prekindergarten, kindergarten through third grade, fourth through sixth grade, junior to senior high school, and after high school. Whether a study was coded as experimental or quasi-experimental in design was determined by whether assignment of individual subjects to groups was done randomly. Random assignment of entire classes to treatment groups was considered quasi-experimental in design, since all research reports used in the meta-analysis provided outcome means for individuals rather than for classes.

Outcome measures used in the studies fell into three categories. Norm-referenced measures consisted of standardized tests available to school districts. Another category was criterion-referenced tests. Experimenter- developed tests and tests designed for use with a particular curriculum fell into this category. Tests that could not be positivelydeterminedascriterion-referenced from a reading of the research report were placed in the category of norm- referenced measures. Observational measures, student data from school files, and all other measures fell into the category of "other" measures.

Effect Sizes

An effect size was calculated for each dependent measure on which the experimental and treatment groups were compared. The effect size was computed by dividing the difference between the means of the experimental and comparison groups by the pooled standard deviation, as advocated by Wolf (1986). Effect sizes favoring Direct Instruction groups were assigned positive values; those favoring comparison groups were assigned negative values.

When the necessary figures for effect size computation (i.e., means, standard deviations, and sample sizes) were not available in a report, estimates of the effect size were calculated from proportions, t values, or F values where possible, based on available formulas (Cooper, 1984; Glass, McGaw, & Smith, 1981; Holmes, 1984; Rosenthal, 1984; Wolf, 1986). However, effect sizes were not estimated from p values for a number of reasons.

In synthesizing the effect sizes across the studies in the meta-analysis, the individual study rather than the individual outcome measure was used as the unit of analysis. Thus, for synthesis on overall effect size of Direct Instruction, the Maggs and Morath (1976) study contributed an effect size (ES) of 1.93, which was the mean of the six ESs from its individual measures. For synthesis on effect size of Direct Instruction on measures of *intellectual ability* (only), the Maggs and Morath (1976) study contributed an ES of 2.57, which was the ES of its only measure of intellectual ability.

A study-weighted "vote count" was also conducted for synthesizing the research results. Computed for each study was the proportion of its measures for which there was a statistically significant difference favoring the experimental group, and the proportion significantly favoring the comparison group. The mean of the individual studies' proportions represents a study-weighted proportion of significant outcomes.

Results

The effect sizes for 25 studies that compare the outcomes for DI groups of handicapped students with the outcomes for comparison groups are listed in Table 3. The first column lists for each study the overall ES in pooled standard deviation units, which compares DI with the other treatment(s) in a study across all types of outcome measures. The next column lists the academic ES, which compares DI with other treatments across only the measures of academic achievement. The third column of figures is a list of the proportion of outcome measures in each study that significantly favored DI at the .05 level or less. (Not a single outcome measure in any of the 25 studies significantly favored the comparison treatment.) The means of these proportions is listed in Table 4. On the average, 53 percent of outcome measures significantly favor DI. This value far exceeds the 5 percent that would be expected by chance if there were actually no differential effects between the DI and the comparison treatments. The average advantage of .84 standard deviation units that DI treatment maintains over comparison treatments is well above the standard of .33 that has been used to determine educational significance (Horst, Tallmadge, & Wood, 1975; Stebbins, St. Pierre, Proper, Anderson, & Cerva, 1977), and approximately the same as Cohen's (1977) suggested standard of .80 as a strong intervention effect (as contrasted with moderate and small effects of .50 and .20).

A quasi-experiment that produced a nonsignificant negative effect for DI (Moodie & Hoen, 1972) compared DISTAR Arithmetic with traditional math instruction in Canadian learning assistance classes for one school year. Post-intervention interviews and questionnaires indicated that teachers liked DISTAR and were pleased with the apparent progress of their

Continued on Page 7

Table 1. Studies Qualifying for Inclusion in the Meta-Analysis

Study	Study Characteristics: Experimental Treatment	Target Skill	Degree of Handicap	Research Design
Branwhite (1983)	DI	reading	mild	Q
Campbell (1983)	DI	reading	mild	Q
Darch & Kameenui (1986)	DI	reading	mild	E
Gleason (1985)	DI	math	mild	E
Gregory et al. (1982)	DI	reading	mild	E
Haring & Krug (1975)	DI	reading	mild	Q
Hursh (1979)	DI	academics	mild	Q
Kelly et al. (in press)	DI	math	mild	E
Leiss & Proger (1974)	DI	language	mod/severe	Q
Lewis Study 1 (1982)	DI	reading	mild	E
Lewis Study 2 (1982)	DI	reading	mild	E
Lloyd et al. (1981)	DI	reading	mild	E
Maggs (no date)	DI	language	moderate	E
Maggs & Morath (1976)	DI	language	mod/severe	E
Moodie & Hoen (1972)	DI	math	mild	Q
Proger & Leiss (1976)	DI	language	mod/severe	Q
Richardson et al. (1978)	DI	reading	mild	E
Stein & Goldman (1980)	DI	reading	mild	Q
Stephens & Hudson (1985)	DI	spelling	mild	E
Summerell & Brannigan (1977)	DI	reading	mild	Q
C. Walker (1980)	DI	reading	mild	Q
H. Walker et al. (1983)*	DI	social	mild	E
H. Walker et al. (1983)**	DI	social	mild	E
Weiherman (1984)	DI	writing	mild	E
Woodward (1985)	DI	content area (health)	mild	E

* refers to Walker, McConnell, & Clark
** refers to Walker, McConnell, Walker, Clarke, Todis, Cohen, & Rankin
E= Experimental Design (random assignment to groups).
Q= Quasi-experimental design

Table 2. Potential Moderator Variables

Variable	Explanation
Length	Treatment length in number of school days
Fidelity	Extent of implementation of direct instruction
Teacher	Regular teacher or experimental teacher
Handicap	Degrtee of handicapping condition
Grade	Age range of subjects
Desigu	Research design
Test	Form of outcomes measures
Alignment	Relation between content of intervention and items in posttest

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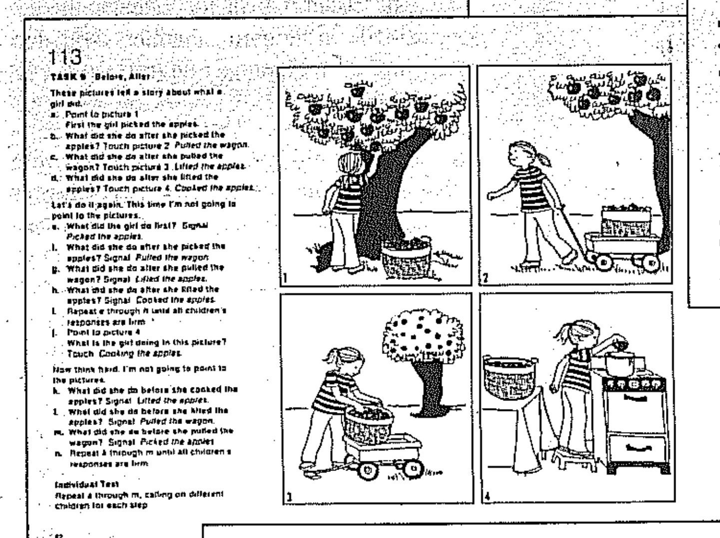

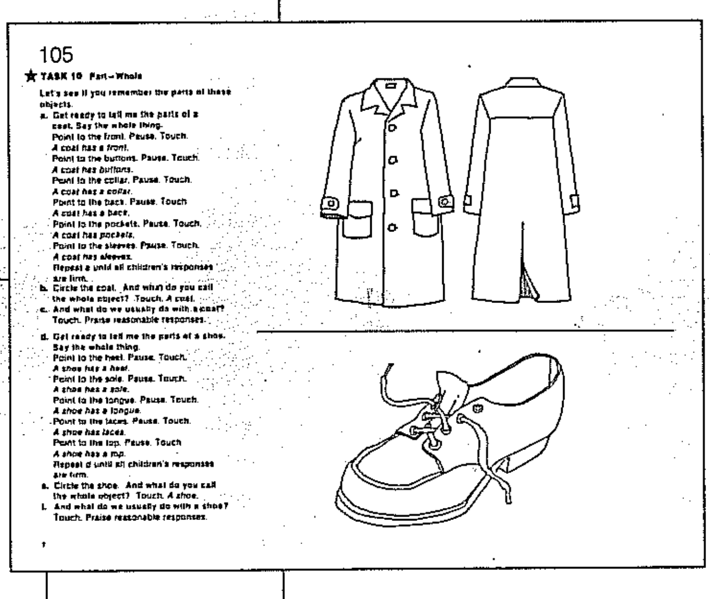

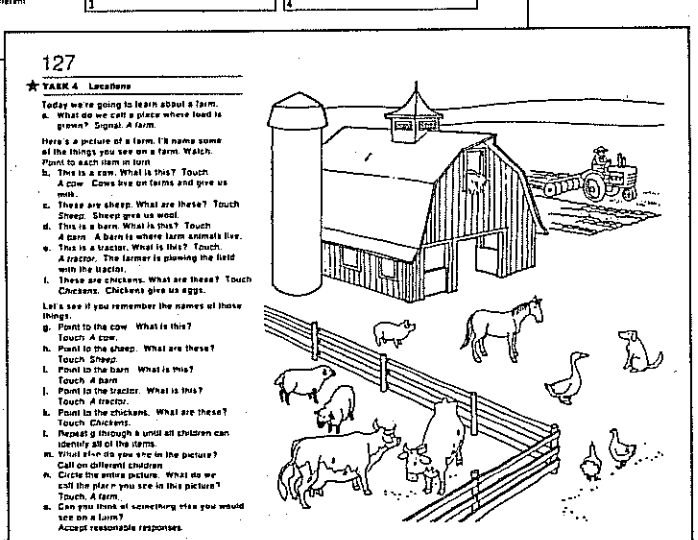

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students. The questionnaires also indicated, however, a low level of implementation of the DISTAR system. No information was provided on the comparability of experimental (N = 14) and comparison (N = 24) students at the start of the study. The authors (Moodie & Hoen, 1972) emphasized that their study had severe limitations, and offered strong subjective support for DISTAR.

One of Lewis' (1982) experiments investigated the effect of DI for 11 and 12 year olds with reading disorders. Students who were taught with traditional remedial programs and other model programs *scored higher* than DI students *on posttests* of word attack skills and reading comprehension. The respective ESs were -.47 and -.32. However, DI students averaged gains of 8.4 months in spelling, compared to 5.4 months and 3.0 months for the two comparison groups. Adequate information was not available for the calculation of the spelling effect size. None of the measures in Lewis' (1982) study produced statistically significant differences.

Reading and Mathematics

The DI studies that investigated academic outcomes have been divided according to specific skill areas. The study-weighted mean ESs for measures of reading and mathematics achievement are listed in Table 5. The mean ES in reading of .85 is consistent with the mean ESs for DI, both overall and in achievement measures. A further subdivision of reading measures (into comprehension, word attack, and total reading measures) does not support the arguments of those educators who contend that DI teaches basic academic skills of a lower-order cognitive level (such as word attack skills) at the expense of higher-level skills (such as comprehension). The study-weighted mean for DI on word attack measures across 10 studies was .64 (SD .72, median .55, range -.47 to 1.67). The corresponding mean for measures of reading comprehension across eight studies was .54 (SD .65, median .44, range -.32 to 1.59). Using a difference of .33 standard deviation units as the criterion for an educationally significant difference (Horst, Tallmadge, & Wood, 1975), there is no important difference between ESs for DI in the "low level" word attack skills and the "high level" reading comprehension skills.

The study-weighted mean ES of .50 for math was lower than the corresponding mean for reading. However, not as much confidence can be placed in a mean ES resulting from only four studies, especially considering that prior research has shown that math achievement is often more marked than reading achievement for economically disadvantaged Direct Instruction students (Gersten & Carnine, 1984).

Intelligence, Readiness

Effects of Direct Instruction on measures of intellectual ability and readiness skills are indicated in Table 6. Typically, standardized measures of intelligence are not the most responsive measures to educational intervention. However, since the earliest research on the DI model in the mid-sixties with "at risk" nonhandicapped preschoolers (Engelmann, 1968), DI has produced appreciable gains in IQ. All studies that measured IQ in this meta-analysis (Leiss & Proger, 1974; Lloyd, Cullinan, Heins, & Epstein, 1980; Maggs, n.d.; Maggs & Morath, 1976; Proger & Leiss, 1976) made use of the DISTAR Language curriculum, which was quite similar to that used in the preschool studies. Apparently, the same curriculum and approach that were beneficial for young students who are at risk for developing learning handicaps are also effective with older students with demonstrable learning handicaps. It seems that the label of a learner matters less than the level of sophistication (or naivete) that she or he brings to a task. DISTAR Language presents basic language concepts in a controlled, systematic manner, and teaches some of the language abilities (e.g., analogy, deduction) measured by most intelligence tests.

In this meta-analysis, measures of academic preskills, basic concept learning, language development, psycholinguistic abilities, and Piagetian cognitive development were pooled together and called "readiness" measures, since these skills are the ones that are stressed by most prekindergarten and kindergarten programs. Except for learning basic language concepts (e.g., under/over, singular/plural, past tense/present tense), Direct Instruction programs usually skip over so-called readiness activities in favor of academic skills. In early childhood research with children from economically deprived areas, Direct Instruction has had a definite positive impact on substantive academic skills; yet its effect is negligible on the rudimentary skills (e.g., naming letters, matching shapes) that most children seem to pick up, regardless of their academic program (Weisberg, 1984). In this meta-analysis, however, six studies (Campbell, 1983;

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Table 3. Individual Study Effect Sizes for DI

Study	Effect Sizes: Overall ES	Academic ES	Proportion of Significant Outcomes
Branwhite (1983)	+1.61	+1.61	1.00
Campbell (1983)	+1.08	+1.12	.83
Darch & Kameenui (1986)	+1.59	+1.59	1.00
Gleason (1985)	+0.57	+0.76	.33
Gregory et al. (1982)	+1.66	+1.71	1.00
Haring & Krug (1975)	+1.05	+1.05	1.00
Hursh (1979)	+0.71	+0.77	.25
Kelly et al. (in press)	+1.39	+1.39	.60
Leiss & Proger (1974)	+0.40	- -	.00
Lewis Study 1 (1982)	+0.16	+0.16	.00
Lewis Study 2 (1982)	-0.40	-0.40	.00
Lloyd et al. (1981)	+0.84	+0.85	.17
Maggs (no date)	---	---	1.00
Maggs & Morath (1976)	+1.93	---	1.00
Moodie & Hoen (1972)	-0.14	-0.14	.00
Proger & Leiss (1976)	+1.30	---	.71
Richardson et al. (1978)	+0.10	+0.10	.25
Stein & Goldman (1980)	+0.75	+0.75	1.00
Stephens & Hudson (1985)	+1.94	+1.94	1.00
Summerell & Brannigan (1977)	+0.54	+0.54	.50
C. Walker (1980)	+0.39	+0.04	.00
H. Walker et al. (1983)*	+0.29	---	.10
H. Walker et al. (1983)**	+0.99	---	.44
Weiherman (1984)	+0.33	+0.33	.50
Woodward (1985)	+1.02	+1.22	.56

* refers to Walker, McConnell, & Clark

** refers to Walker, McConnell, Walker, Clarke, Todis, Cohen, & Rankin

Table 4. Individual Study Effect Sizes for DI

	Effect Sizes: Overall ES	Academic ES	Proportion of Significant Outcomes
Mean	+0.84	+0.81	.53
Median	+0.80	+0.77	.50
SD	.64	.67	.40
(N)	(24)	(19)	(25)

Table 5. Study-Weighted DI Effect Sizes in Reading and Mathematics

	Measures: Reading	Math
Mean	+0.85	+0.50
Median	+0.80	+0.38
SD	.78	.71
(N)	(13)	(4)

Table 6. Study-Weighted DI Effect Sizes in Intelligence and Readiness

	Measures: Intellectual Ability	Overall Readiness	Concept Learning
Mean	+1.32	+1.13	+2.74
Median	+1.13	+0.89	+2.74
SD	.93	.88	.44
(N)	(4)	(5)	(2)

Hursh, 1979; Leiss & Proger, 1974; Maggs, n.d.; Maggs & Morath, 1976; Proger & Leiss, 1976) suggest that Direct Instruction students more than hold their own in readiness skills. Table 7 shows a study-weighted mean ES for the pooled readiness measures of 1.13. Positive effects were found in all five subcategories of readiness measures.

Degrees of Handicap and Type of Comparison Group

The research results show that Direct Instruction can be equally effective for mildly and moderately/severely handicapped students. The mean ES for mildly handicapped students was .80, and the mean for the more severely handicapped students was 1.01. This difference of .21 standard deviation units between the two figures does not meet the standard of .33 for educationally meaningful differences. It is difficult to compare the two groups of studies, because 18 of the 20 studies involving mildly handicapped students measured academic achievement (mean effect size of .85), whereas only one study of four involving moderately handicapped students did so.

One variable that did have a significant effect on effect size was the type of comparison group(s) used in a study. None of the studies utilized a pure control (i.e., no treatment) group, but three of them (Campbell, 1983; Walker, McConnell, & Clarke, 1983; Walker et al., 1983) utilized a comparison group that was involved in activities unrelated to the final outcome measures. These studies produced an average effect size of .79. The mean ES for these studies was probably held down to some extent by the rigorous tests of generalization in social skills used in the Walker, McConnell, and Clarke (1983) and the Walker et al. (1983) studies.

Grade Level and Other Study Characteristics

Most of the studies in the meta-analysis were conducted with subjects in the age ranges of the intermediate grades (4th to 6th) and secondary level (7th to 12th). The 13 studies in the intermediate grades were actually composed of 6 studies that fit neatly into the category, and 7 studies that included students in a wide range of grades (e.g., grades 1-6, grades 1-9) which were judged closer to the intermediate category than to any of the other categories. The mean effect size for only the 6 studies that fit the category neatly was .65, which is similar to the mean of .69 for all 13 studies categorized as intermediate. The mean effect size for 7 secondary students was 1.15. The difference is considerable, but still could be of function or chance. The data show, however, that DI is quite effective for both age groups.

Type of Posttest

Another variable that had a significant impact on the magnitude of effect sizes was the type of the posttest. Table 7 shows that criterion-referenced measures generated significantly greater effect sizes than did norm-referenced measures or "other" measures (i.e., observation, official records, and self-report). This result is consistent with the premise that criterion-referenced tests can be more sensitive to the effects of instruction than are standardized tests. Also, criterion- referenced tests that were *closely aligned* with the tasks assigned to students during intervention yielded higher effect sizes (mean of 1.76 across eight studies) than did criterion- referenced tests of *low alignment* (mean of 1.06 across six studies). These figures support Cohen and Hyman's (1982) contention that congruence between intervention task and outcome measure is a major determinant of effect size. The effect of 1.06 for measures of low alignment also indicate that Direct Instruction students transfer what they have learned to somewhat different kinds of tasks.

Teachers, Treatment Length

The teacher variable played a significant part in *academic* effect sizes, but not in *overall* effect sizes. Study-weighted mean ESs, across all outcome measures, were .81 for 18 studies that used regular (usually classroom) teachers, and a slightly higher .94 for six studies that used experimental teachers. Across measures of academic achievement, however, the difference between effect sizes exceeded the .33 standard for educational significance. For 15 studies with regular teachers, the mean was .79; for four studies with experimental teachers, the mean was 1.13. It makes sense that experimental teachers, having been specially trained in the experimental curricula, might implement the Direct Instruction intervention more faithfully, which in turn might bring about a greater effect.

Another variable, length of treatment, also had a greater differential impact on academic than on other measures, but the effect is confounded. When all measures within a study were averaged, the study-weighted mean effect for Direct Instruction in interventions lasting from six school days to one month ($N = 5$) was .98 standard deviation units. The corresponding overall mean ES for interventions ranging from over a month to a year ($N = 17$) was .77. When only academic measures within a study were averaged together, the study-weighted mean for the five comparatively shorter studies was 1.06, which is greater than the corresponding mean effect size of .77 for the 13 comparatively longer studies. The confound comes from the fact that the five shorter studies (Darch & Kameenui, 1986; Gleason, 1985; Kelly, Carnine, Gersten & Grossen, in press; Weiherman, 1984; Woodward, 1985) were all university-generated projects using experimental teachers.

Table 7. Study-Weighted DI Effect Sizes for Different Forms of Measures

	Form of Measure		
	Criterion-Referenced	Norm Referenced	Other
Mean	+1.67	+0.77	+0.70
Median	+1.13	+0.71	+0.71
SD	.94	.72	.50
(N)	(8)	(17)	(8)

Level of Implementation and Research Design

Whether or not fidelity of treatment was assessed had no systematic impact on effect sizes. Studies (N = 11) that referred to high level of Direct Instruction implementation produced a mean ES of .86; those (N = 13) that failed to mention level of implementation or that certified that implementation was poor produced a mean ES of .82. These numbers seem to conflict with other research (Gersten, Carnine, & Williams, 1982; Siegal & Rosenshine, 1973) that indicate that fidelity of treatment plays a significant role in the impact of Direct Instruction. However, some authors and observers may have judged level of implementation to be adequate, when in fact it was not. Also, in some other studies, the Direct Instruction teachers probably followed the experimental programs carefully, yet the reports make no mention of fidelity of treatment.

Type of research design (experimental versus quasi- experimental) also had no systematic effect.

Summary

It seems that there are occasional circumstances under which Direct Instruction can produce a negative effect. However, only 14 percent of the comparisons showed a negative effect for Direct Instruction. (One percent of the comparisons produced a neutral, or .00, effect. *None of the negative effects were statistically significant.*)

The 25 studies on Direct Instruction treatments of over a week in length represent a strong, consistent effect for the treatment. The strength is not limited to a particular age range, or handicapping condition, or skill area. The meta- analysis indicates that, based on 25 studies, instruction grounded in Direct Instruction theory (Engelmann & Carnine, 1982) is efficacious for both mildly and moderately/severely handicapped learners, and in all skill areas on which research has been conducted.

Author's Note: For a more thorough examination of this research, refer to the reviewer's December 1986 dissertation (The Effects of Direct Instruction in Special Education: A Meta-Analysis) at the University of Oregon.

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Correlates of Gains in Algebra for Low Performing High School Students

by Russell Gersten*, Meredith Gall, Daniel Grace, Dianne Erickson, Steve Stieber - University of Oregon and

Effects of Teacher Behavior on High- and Low-Ability Students in Algebra

Daniel Grace*, Russell Gersten, Meredith Gall - University of Oregon

Editors Note: This paper contains more complex statistical analysis than we usually include in the DI NEWS. However, the findings should be clear enough that one could skip the more complex procedures and attend to the results and conclusions.

Most research on effective mathematics instruction has involved the study of elementary schools. Few studies have investigated patterns of effective mathematics instruction at the high school level. Of these studies, only one (Oakes, 1982) sought to identify patterns of effective instruction for low-performing high school students.

The studies discussed in this paper focus on a delineation of effective instructional practices for high school students of below-average ability. The purpose of this study was to determine whether variations in teaching practices were significantly correlated with the achievement growth of low-achieving students enrolled in algebra classes.

Many states now require a minimum of three years of high school math for graduation. The more stringent graduation requirements will apply to students of all ability levels, meaning that low-ability students will be taking more--and more complex--mathematics courses, such as algebra. Yet, little research knowledge is available to guide the mathematics instruction of low-achieving high school students in courses such as basic (or elementary) algebra.

As the study progressed, we realized that within this group of "below average ability" algebra students, there was an extreme amount of variability. Thus, secondary analyses were performed using an aptitude-treatment interaction (ATI) model. The primary purpose of the ATI analysis was to determine whether different instructional practices were associated with achievement growth for those extremely low performing students in Basic Algebra.

Method

Subjects and Setting

Basic Algebra classes are typically comprised of students who achieved below grade level in junior high school math courses; eighth grade teachers say that these students lacked the skills to manage the one-year elementary algebra course successfully in the ninth grade. Basic Algebra is a two year course sequence. Much of the first year is essentially a pre-algebra course, but also includes a few of the beginning units of the standard one-year elementary algebra course. Second-year Basic Algebra, therefore, is designed to cover most of the Elementary Algebra course at a slower pace. Most students in second-year Basic Algebra classes are clearly below average in math achievement according to current high school administrative practice.

Some students had such low pretest scores that they could have been placed in General Math classes. It seems reasonable to assume that these students, although probably needing extra help, were motivated enough to learn some algebra, and/or received pressure from parents or teachers or counselors to take an algebra course. These extremely low-achieving students are the major focus of the ATI study.

Teachers. All 31 mathematics teachers who taught second-year Basic Algebra classes in 16 high schools of a large urban school district comprise the sample for the study. The schools represented a wide range: large and small schools, and both inner-city and middle income (suburban) schools.

Although some teachers taught more than one section of second-year Basic Algebra, only one section per teacher was observed. Selection of the section to be observed was based on logistics of scheduling observations.

The same algebra curriculum and textbook were used in all classrooms in the district high schools. Since the length of lessons (50 minutes) and the number of teaching days per year were consistent across all the district's high schools, all students in the study were allocated the same amount of time to learn the same content.

Measures

Classroom Observation System

A classroom observation form was developed to permit both low inference and moderate inference observation of teacher and student behavior. The observed variables were derived from studies of elementary mathematics instruction by Good and Grouws (1977), and the study of junior high mathematics instruction by Evertson (1982), as well as the work of Gall et al. (1978) on teachers' questioning.

The low-inference variables were based on the observed rate of occurrence of each variable utilizing a five-second time sampling method adapted from the Flander's system of Interaction Analysis (Amidon & Flanders, 1971). At the end of each lesson, observers used a series of Likert-type Scales to rate teacher performance on several moderate-inference variables such as the degree of clarity, enthusiasm, and variety of teaching methods.

During February and March, 1985, each of the 31 teachers was observed for three 50-minute periods on three consecutive days teaching one section of second year Basic Algebra.

Reliability. The mean interrater reliability coefficient for the seventeen low-inference variables was .81. Only two coefficients were lower than .52 (for teacher giving directions and for higher cognitive questions), while thirteen were at or higher than .83.

Temporal stability across the three observations was assessed using coefficient alpha (Frick & Semmel, 1978); these coefficients ranged from .62 to .79. Measures of temporal stability on the moderate-inference variables were also computed using coefficient alpha; the mean coefficient was .48. Four of the eleven coefficients were lower than .55 (for the variables: teacher circulates, teachers assists, number of students working together, and number of students leaving the room during the lesson). Thus, rater agreement was adequate, but temporal stability was adequate only for low-inference measures.

Achievement Measure

District high school math teachers helped the researchers select a test that measured the major course objectives. The Algebra Test I, Form A, of the Cooperative Mathematics Test (Educational Testing Service, 1962), was utilized as both the pre- and posttest. Although the 40 item test is old, the teachers considered the test valid and relevant to their curriculum. The algebra curriculum has changed little since the test was developed.

Students in all second year Basic Algebra classes took the Cooperative Mathematics algebra pretest early in Fall of 1984. In May of 1985 the posttest was given by members of the research team.

Data Analysis

Analysis of Correlates of Achievement

For this analysis, the class was used as the unit of analysis. Means of student residualized achievement (posttest achievement adjusted for difference in pretest achievement) were computed for each class. The average number of minutes spent (or average rating) on each of the instructional behaviors provide a picture of typical instructional practices of teachers in Basic Algebra classes.

The primary analysis involved correlations between each instructional practice and the mean residualized achievement growth for each class. These correlations were intended to assess instructional practices related to enhanced achievement. Finally, a contrasted groups analysis was also performed. The means of each instructional practice variable were examined for differences between the group of five teachers with the highest and the five teachers with the lowest class mean residualized growth.

The Aptitude-Treatment Interaction Analysis

In the ATI study, the student was the unit of all analyses so that variations in the use of instructional practices could be analyzed for differential effects on students entering the course with differing skill levels. A multiple regression model was used for the total sample of 534 students for each of the instructional variables following Pedhazar's (1982) procedure. First the pretest score was entered, next the score of the instructional variable, and finally an interaction term. Each was tested for significance.

Descriptive Results

Achievement

The pretest mean for the total sample of 543 Algebra students on the Elementary Level of the Cooperative Algebra Test was 15.43; and the standard deviation was 4.28. The posttest mean was 19.97 with a standard deviation of 5.39. After nine months of instruction, the overall growth for the entire sample was quite small, a mere 4.5 points on a 40 item test. The range of scores on both the pre- and posttest, however, was quite large-- 29 points on the pretest and 33 points on the post test.

Residualized growth scores were computed for each student using a simple linear regression model.

Consistency of Teacher Effects Across Sections

Sixteen of the thirty-one teachers in the sample also taught one other section of Basic Algebra. Though we did not observe the other section, students in the other section were also tested; mean residualized growth scores for each of these non-observed classes were calculated. If the teaching behaviors and student achievement growth record in the observed class are typical of a particular teacher, then similar trends in instruction and hence, student achievement growth, would be expected in that teacher's non-observed class. The resultant correlation coefficient was reasonability high, $r = .69$; $p < .01$.

Of special interest for the contrasted groups analysis presented below is the consistency of mean residualized growth scores among the five teachers whose classes made the lowest achievement growth. Three of these five teachers had both their observed and non-observed sections placed in the lowest quartile. Of the forty-seven classes for which achievement growth was measured, ten of the eleven classes with the lowest achievement growth were taught by just four of the 31 teachers.

A Typical Lesson

Total occurrences for each low-inference observation variable for each fifty-minute lesson were computed. A mean score for each of these variables (expressed in number of minutes) over the three lessons for the 31 classes was calculated for each class. These results are shown in Table 1. These data provide a sense of how Basic Algebra teachers typically structure and teach their lessons. Mean scores for each of the moderate-inference variables also were calculat-

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*Papers presented at annual meeting of American Educational Research Association, April 1987, Washington, D. C.

The Association for Direct Instruction Announces the 13th Annual

Eugene Direct Instruction Training and Information Conference

August 3-7, 1987

Eugene Hilton Hotel & Conference Center
Eugene, Oregon

The Association for Direct Instruction is pleased to announce the 13th Annual Eugene Direct Instruction Training and Information Conference. The conference will be held at the Eugene Hilton Hotel and Conference Center, in downtown Eugene. We hope that you will be able to make the Conference the highlight of your summer and join with other professionals from around the country in furthering your skills and knowledge of instructional technologies. There is a full range of sessions designed for teachers, aides, supervisors, and administrators whose goal is to promote educational excellence in all facets of education. Previous participants will find new course offerings in a number of areas of interest.

After a day of work, participants will enjoy evenings in Eugene. Next door to the Hilton is the Hult Center for the Performing Arts, a world class performance hall. Within blocks of the conference site there are scores of restaurants catering to a variety of tastes. Eugene's setting will make the conference a rewarding professional experience as well as a relaxing vacation for you and your family. To help renew old friendships or make new acquaintances, a picnic has been planned for Monday afternoon. On Tuesday and Wednesday evening there will be a social hour where trainers will be available to answer questions and provide an opportunity for making new contacts.

There are 39 sessions offered during the 5-day conference. Participants may attend up to 4. Sessions are either training or informational sessions. The focus of training sessions is on specific teaching behaviors. Task practice is involved in each of these sessions. The goal of informational sessions is to provide the kind of detailed information needed to implement successful techniques or understand the topic.

A Teaching the Beginning Reader
A Reading Mastery III-VI
A Corrective Reading, Decoding
A Advanced & Corrective Arithmetic
A Basal Reading Programs: Selecting, Transitioning to & Adapting
A Teacher Training: Teaching Others to Teach DI Programs
A Solutions to Classroom Management in Grades K-6
A Diagnosis, Corrections & Firming Procedures
A Overview of Direct Instruction Research & Theory
A Instructional Techniques for Severely Handicapped Learners
A Issues in Implementation of a Direct Instruction Curriculum

B Teaching the Beginning Reader
B Reading Mastery III & IV
B Corrective Reading, Comprehension
B DISTAR Arithmetic I & II
B Effective Spelling Instruction
B Reading Mastery II and Fast Cycle I & II
B Teaching Beginning Language Skills
B Overview of Direct Instruction Programs
B Solutions to Secondary Classroom Management
B Managing Classroom Behavior of Severely Handicapped Learners
B Training Administrators in a Supervisory Model
B Teaching Academic Survival Skills

C Reading Mastery V & VI
C Overview of Effective Spelling Instruction
C Teaching Facts and Fact Systems in the Content Areas
C Teaching Expressive Writing Skills
C Managing Chronic Behavior Disorders and Serious Emotional Disturbances
C Classroom Technology and Direct Instruction

D Videodisc Instruction in Math
D Direct Instruction Supplemental & Transitional Activities
D Computer Courseware: A Direct Instruction Perspective
D Design of Instruction for Seriously Handicapped Learners
D Overview of Direct Instruction Research

E A Direct Instruction Approach to Secondary Science Instruction
E Teach Your Child to Read in 100 Easy Lessons
E Overview of Aspects of Supervision & Monitoring of DI Programs
E DI Research on Severely Handicapped Learners
E Overview of Direct Instruction Theory

Presenters:

Zig Engelmann, Wes Becker, Randy Sprick, Bob Dixon, Ed Schaefer, Geoff Colvin, Ann Arbogast, Gary Davis, Ann Glang, Annemieke Golly, Phyllis Haddox, Tracy Hall, Melissa Hayden, Rob Horner, Gary Johnson, Bernie Kelly, Kathy Madigan, Lisa Moore, John Noell, Marty Sheehan, Jerry Silbert, Marilyn Sprick, Marcy Stein, Linda Youngmayr

AM	A	A	A	A	C/E
PM	B	B	B	C/D	Ends at 1:00 PM
Evening Events	Picnic	Meet the trainers	Meet the trainers	Annual ADI Meeting	

Early Registration
Sunday 6:00 pm to 7:30 pm
Registration
Monday 8:00 am to 9:00 am
Opening Session
Monday 9:00 am to 9:30 am
Daily Sessions begin at 8:30
Lunch Daily from 11:30 am to 1:00 pm

ed for each class over the three lessons, as shown in Table 2. These data help clarify what happens during a lesson.

Lecture-demonstration recitation. In some classes, lessons began with a few minutes spent reviewing homework problems. Teachers asked students to provide answers or students indicated problems that require reworking or explanation. It was also common, however, for classes to begin with a few minutes of non-academic discussion or announcements made by the teachers.

Approximately 25 minutes was devoted to the lecture-demonstration phase. For about 18 minutes, teachers explained concepts and demonstrated procedures for solving equations or worked through problems in the textbook. This included review of selected homework problems. By and large, the teachers in the study tended to present the material in a low key, almost routine manner, with reasonable clarity, but without communicating any special enthusiasm.

Seven of the 25 minutes of this lecture-demonstration phase involved substantive interaction between teacher and students. On the average, teachers directly called on four to six students of the 25 to answer questions. About half the teacher's questions were targeted to specific students and half were asked to the class at large.

Occasionally teachers asked their students if they understood a procedure or concept before providing further explanation or assigning seatwork problems. We observed that students seldom responded to such questions. However, students asked questions and initiated comments about the material for approximately 2% of the lesson.

Guided Practice. Rarely did Basic Algebra teachers use guided practice to check students' understanding before students practice independently. (The mean was 48 seconds.) Only seven of the 31 teachers were observed to employ guided practice for more than one minute. Sixteen teachers never utilized this strategy during observed lessons.

Seatwork. All teachers assigned seatwork (the other major phase of the lesson), averaging approximately 15 minutes. Teachers monitored seatwork for about 11 of the 15 minutes. Not infrequently, teachers sat at their desks, attending to paperwork orassisting individual students, occasionallylooking around the room. This behavior appeared to remove them from effective contact with the class.

The rate of off task behaviors tended to increase when the seatwork phase was lengthy. Usually seatwork was the final activity of the lesson, and it was common for students to conclude work early with the tacit agreement, or at least without the expressed disapproval of many teachers.

Classroom Climate. Basic Algebra teachers seldom praised students and rarely criticize them. In managing student behavior, teachers were three times more likely to use a short comment to remind students about expectations for academic or social behavior than they were to praise or criticize them. Overall, the climate paralleled what Goodlad and others had found in their observations of lower track high school classes--a somewhat business-like, unenthusiastic atmosphere prevailed. The one exception to this will be described in the qualitative case study section, below.

Homework. In response to the teacher questionnaire, teachers indicated that they assign approximately 30 minutes of homework daily. Eighty-three percent of the teachers said they collected homework assignments most of the time, but only 11 teachers (37%) indicated that they graded assignments.

Table 1. Mean Number of Minutes Spent on Selected Instructional Practices in a Fifty-Minute Lesson (N = 31 Classes)

Variable Description	M	SD
Lecture-Demonstration Phase		
Teacher academic verbal behavior	17.0	6.7
Teacher makes linking statement	0.4	0.2
Teacher gives directions	0.6	0.3
Teacher questions (product or process)	2.2	1.2
Teacher questions (checking for understanding)	0.4	0.3
Total teacher questions	2.6	---
All students have opportunity to answer	1.4	0.9
One student has opportunity to answer	1.5	1.6
Students ask questions	0.8	0.5
Students initiate comments	0.5	0.5
Guided Practice	0.8	1.7
Total Lecture Demonstration	24.5	---
Seatwork Phase		
Teacher monitors seatwork	11.0	7.5
Teacher does not monitor seatwork	3.9	2.7
Total Seatwork	14.9	---
Classroom Management		
Transitions, interruptions & non-academic verbal behavior	7.4	3.4
Teacher Feedback Contributing to Classroom Climate		
Teacher praises	0.1	0.2
Teacher criticizes	0.1	0.2
Teacher uses management statement	0.4	0.4
Percentage of students off-task*	13%	7%

*Based on a time sampling count of students off-task

Table 2. Mean Ratings on Moderate-Inference Instructional Practice Items (N = 31 Classes)

Variable Description	M	SD
Active Teaching Phase		
Number of students called on	2.2	0.9
Seatwork Phase		
Teacher circulates among students	3.3	1.2
Teacher assists students	3.3	1.2
Students work together	2.4	1.0
Teacher Style		
Teacher enthusiasm	2.6	0.9
Teacher clarity	3.3	0.8
Teacher uses a variety of teaching methods	2.3	0.6
Classroom Management		
Noise level during seatwork	2.7	1.2
Number of students entering late	3.0	1.8
Number of students leaving room during lesson	1.0	0.8

Students checked their own homework assignments in half the classes, a process usually carried out at the beginning of the lesson, and typically involved some teacher feedback to students. Teachers reported that approximately one-third of all Basic Algebra students usually did not complete homework assignments.

Results: Correlations Between Instructional Practices and Achievement

Separate correlations were conducted between each instructional practice variable (e.g., "minutes in controlled practice") and the dependent variable (residualized mean class gain scores on achievement). The class was the unit of analysis. Significant correlations--as well as those approaching significance--are presented in Table 3.

Lecture-Demonstration

Student achievement appears to be significantly enhanced when teachers asked questions at a high rate. Achievement was enhanced when teachers asked questions in a fashion so that all students had an opportunity to respond, rather than posing a question to one individual student. The total amount of teacher academic verbal behavior (i.e., lecturing, working out prob-

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lems on the blackboard) also correlated to some extent with achievement growth; $r = .25$, $p = .08$. These findings seem to parallel the findings of Good and Grouws' (1977) --the more time teachers interact with students on academic matters, the higher the achievement level. In addition, extending the amount of lecture--demonstration time (and consequently shortening the seatwork time) seems to correlate, to some extent, with achievement.

Seatwork

The amount of time teachers spend circulating is negatively associated with student achievement growth. This is not consistent with findings of previous research (Evertson et al., 1980; Good et al., 1983, Stallings, 1975). The moderately strong negative correlation between student achievement and the amount of time teachers circulate and assist students during seatwork suggests that the monitoring procedures, as implemented by teachers in this study, were not effective.

Classroom Management

A related finding concerns the level of noise during seatwork. Not surprisingly, quieter classes appear to be more effective learning environments. The significant negative correlation between student achievement growth and the percentage of students who are off-task is a logical corollary and suggests that students need to be engaged and to practice skills without distraction if they are to exhibit achievement growth.

The significant negative relationship between students' achievement growth and the number of students late for class may also be a symptom of ineffective classroom management.

Results:
Contrasted Groups Analysis

Differences in instructional practices between the five teachers, where students made the greatest achievement growth (effective teachers) and the five teachers whose students made the least achievement growth, (ineffective teachers) were tested for statistical significance. A t-test was performed for the differences between mean scores on each instructional variable. It was expected that this analysis might help clarify and enhance the correlational analysis. These results are presented in Table 4.
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Classroom Management

The most emphatic pattern of findings relates to classroom management. Effective teachers manage their classes so that fewer students arrive late for class, students work more quietly during seatwork, and throughout the lesson a much higher proportion of students remain on assigned academic tasks than in the classes of ineffective teachers. While both praise and criticism were used sparingly by effective and ineffective teachers, effective teachers praised and criticized students less and tended to use more short statements to remind students about the expectations for behavior.

Active Teaching

A second major pattern of findings centers around the amount of teacher activity. Effective teachers tended to spend more time explaining and demonstrating material, and involve more students for longer periods by asking a higher rate of product and process questions. Students were kept involved in the lesson by a combination of teacher questions that invited all students to respond and questions that required individuals to answer.

Seatwork Phase

As a consequence of their more active teaching, effective teachers generally allocate less time for seatwork. Although effective and ineffective teachers monitor seatwork for the same proportion of time, effective teachers circulate among students significantly less. Effective teachers also assist fewer students which means that a greater proportion of their students work independent of further teacher instruction once the active teaching phase is concluded.

Effective and ineffective teachers were not rated differently on measures of enthusiasm, clarity, or the variety of teaching methods used.

Table 3. Relationship between Selected Instructional Practice Variables and Student Residualized Achievement Growth (N = 31 Classes)

Variable Description	r	p
Lecture-Demonstration Phase		
Teacher academic verbal behavior	.25	.08
Teacher questions (product or process)	.41	.01
All students have opportunity to answer	.35	.03
Seatwork Phase		
Teacher circulates among students	-.34	.03
Teacher assists students	-.27	.07
Classroom Management		
Proportion of students off-task	-.47	.004
Noise level during seatwork	-.39	.01
Number of students entering late	-.49	.002

Table 4. Differences between the Means of Selected Instructional Practice for Teachers with the Highest Student Achievement Gains (N = 5) and Teachers with the Least Student Achievement Gains (N = 5)

Variable Description	Teachers with High Achievement Gains	Teachers with Low Achievement Gains	t	p
Achievement				
Residualized Gains on Cooperative Algebra Test	2.45	-2.52	14.16	.0001
Active Teaching Phase (Low-Inference Variables)				
Teacher questions (product or process) (in minutes)	3.0	1.2	2.52	.04
All students have opportunity to answer (in minutes)	1.4	0.8	1.70	.13
Seatwork Phase (Moderate-Inference Variables)				
Teacher circulates among students (Range: 1 [low] to 5 [high])	2.33	3.96	-2.45	.04
Classroom Management				
Percentage of students off-task	8.0	21.0	-2.93	.02
Noise Level during seatwork (Range: 1[low] to 5[high])	2.2	4.0	-3.09	.02
Number of students entering late	2.4	4.6	-2.08	.07

Results: Aptitude-Treatment Interactions

The interaction between components of instruction and levels of students' entering skill level was examined by performing a multiple linear regression for all students enrolled in second year Basic Algebra who took both pretests and posttests. The student was the unit of this analysis. Students' scores on the Cooperative Mathematics Algebra I posttest were the dependent variable. A separate hierarchical multiple regression was performed for each of the 33 low- and moderate-inference classroom behavior variables, following Cohen and Cohen's (1983) procedures.

The first step in the analysis was to compute the simple correlations between each instructional variable and each students' residualized growth score for the sample of 534. As might be expected, the pattern of findings from the two analyses were virtually identical, with one minor exception. Due to the increased statistical power, the correlation between Teacher Academic Verbal Behavior and Achievement Growth, which had approached significance when the class was the unit of analysis, now was clearly significant $p = .005$. Of the moderate inference variables, Teacher Clarity was found to be a significant correlate, $p = .03$.

Variables Which Had A Differential Effect on Extremely Low Achieving Students

Analyses using the class as the unit of analysis yielded surprising significant negative correlations between the teacher behaviors of circulating and assisting during seatwork and student achievement growth. The aptitude-treatment interaction analysis, however, *revealed a significant differential effect for these teacher behaviors on achievement.*

For "Teacher Assists Students during Seatwork," the interaction was significant; $F(1,530) = 4.22$; $p = .04$. For "Teacher Circulates During Seatwork," the interaction approached significance; $F(1,530) = 3.11$, $p = .07$. In each case, the effect was positive for the low ability students and negative for the high ability students.

Finally, as an adjunct to the ATI analyses using hierarchical multiple regression, we computed Pearson correlations between instructional practice variables and residual-

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ized growth scores for the two "extreme groups" of students--those beginning the course with pretest scores of 9 and below, and those entering the course with scores of 21 and above. Tests were conducted to ascertain those variables for which the correlations were significantly different. Table 5 presents the results.

The most striking finding was that the achievement growth of low-skill students appeared to be positively influenced by teachers circulating and assisting during seatwork. It appeared that students with a low entry level of achievement benefited more from teacher assistance during seatwork than they did from working independently. When this teacher-student interaction occurred it tended to have a detrimental effect on the achievement of students with relatively high levels of skill. Teachers provided them with extra instruction on the individual basis which proves beneficial. However, when teachers assisted in this way, students of higher achievement skill levels who should be able to practice independently during seatwork to reinforce their learning, were not achieving as well as their skill-attainment suggested they should.

Discussion

There were few surprises in the findings of this study. They demonstrate that most of the aspects of effective mathematics instruction delineated by Good and Grouws (1977) and Evertson et al. (1980) are equally important in teaching algebra to below-average ability students.

The pattern of teachers explaining and demonstrating material clearly, and asking many questions which provide all students with opportunities to respond consistently related to superior student achievement gains as measured by students' scores on the Cooperative Mathematics Algebra Test. It appears that the more interactive the teacher, the more he or she is effective. Effective teachers provided significantly more time for asking questions and twice as much time creating opportunities for all students to respond as did ineffective teachers.

The contrasted groups analysis revealed that effective teachers direct questions to individual students twice as often as ineffective teachers (1.8 minutes vs. 0.9 minutes). Although the effect is not significant, it seems reasonable to assume that when handled by a skillful teachers, such questions would help to keep students involved, and would be helpful in assessing student learning during a lesson.

Classroom Management

It is clear and unsurprising that well-managed classrooms are associated with enhanced student achievement growth. The most convincing pattern of correlations to emerge from the analyses, using both the class and the student as the units of analyses, was that effective teachers do not permit students to engage in behaviors which distract themselves and others from assigned academic tasks (proportion of students off-task: $r = -.47$; noise level during seatwork; $r = -.39$; number of students entering late: $r = -.49$).

These findings do not imply, however, that effective classroom management alone will enhance student achievement growth. Rather, they strongly suggest that firm and consistent classroom management is one of the prerequisites for improving student performance. Effective classroom management underscores the fact that in the classroom students are provided with an environment conducive to attending to relevant academic activities. By minimizing the amount of noise, tardiness, and non-academic activities, teachers clearly delineate an academic focus and provide all students with an increased opportunity to learn.

Finally, effective classroom management in Basic Algebra classes appears to be achieved in an essentially non-evaluative classroom climate. Little praise is offered (mean of 7 seconds) and little overt criticism is made (mean of 8 seconds in a 50 minute lesson). Evertson et al. (1980) found that more effective teachers also were more enthusiastic, nurturant and affectionate than other teachers. This characterization could be used to describe very few of the teachers observed. In fact, the absence of affective teacher behaviors, either positive or negative, provide a lasting image of Basic Algebra instruction.

The Exploratory Qualitative Study

In order to better understand the results, we spent three mornings observing the teacher with the very highest achievement gains. She taught in one of the two poorest, lowest achieving high schools in the city. The manner in which she utilized questioning illustrated that low-achieving students need not be intimidated by the use of some questions that directly probe their understanding of the lessons, or which assess whether they have completed assignments.

Teacher Questioning and Student Accountability

The teacher's strategy for checking homework was particularly interesting. Unlike many other teachers observed, Ms. Frank holds students accountable for their work and reinforces her expectations for their performance. This teacher asked each student to answer a question from the homework assignment, and obviously expected an answer:

T: "If I call on you, you need to be ready! Jamie, number six."
S: "I don't have my homework."
T: "Do it now!"
S: "I don't have a book."
T: "Borrow someone's, quickly!"

At this point the teacher waited while the student found the problem. Then, Jamie answered it correctly. On another occasion, when a student had not done the assignment, and the teacher returned to question her three times until she had satisfactorily answered the question.

In two additional observations of this teacher's lessons, the following data on directing questions to individuals were collected:

Day 1:
Number of students in class 32
Number of questions 33
Number of students called on 26 (81%)

Day 2:
Number of students in class 30
Number of questions 34
Number of students called on 23 (82%)

These direct questions, and occasional challenges to students did not appear to be upsetting. The teacher consistently used a combination of very brief praise ("Good!"), encouragement ("These are hard ones. Be careful!"), humor, and mild management statements to remind students of her behavioral expectations. When public questions were asked, students responded by raising their hands, frequently calling out, and occasionally by answering in unison.

In summary, this teacher's questioning strategies ensured that all students were actively involved, and enabled her to provide feedback--including praise--and to persist in questioning those students who were not prepared for the lesson or who had difficulty with the material. In her room, the students were consistently accountable. They worked much harder and received constant feedback on their work.

Monitoring of Seatwork

The major findings of the aptitude-treatment interaction (ATI) analyses were that the interaction effects found for the variables, "amount of time teacher circulates among students" and "amount of time teacher assists students" during seatwork. These variables were positively correlated with achievement growth for low-skill students and negatively correlated for average and high-skill students (see Table 6).

Interestingly correlations between the amount of time allocated to seatwork and student achievement growth in this study were negatively correlated as Evertson et al. (1980) found in eighth-grade math classes.

Also, this present study and others (e.g. Evertson, 1982) found the number of minutes of seatwork to be positively correlated with off-task student behaviors, so it is clear that teachers may need to not only limit the amount of time given to seatwork, but certainly need to supervise students during independent practice. Yet, for the total sample of students, a negative correlation was found for the amount of time teachers circulated and the amount of time teachers assisted students individually. This correlation was significant even when we statistically controlled for the total number of minutes allocated to seatwork (using a partial correlation). The ATI analyses suggest, however, that these teacher behaviors may actually be detrimental to the achievement growth of high-skill and average students, and helpful only to low-skill students.

What may have been occurring (which was not objectively measured in this study) was that teachers tended to have lengthy contacts during seatwork with individual students who could not manage the work independently. Evertson et al. (1980) and

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Table 5. Significant Differences between Correlations of Instructional Practice Variable with Residualized Achievement Growth for Low-Skill Students (Pretest Scores < 10) and High Skill Students (Pretest Scores > 20) in Basic Algebra

Variable Description	Low-Skill Students (N = 36) *r*	High-Skill Students (N = 62) *r*
Seatwork Phase		
Amount of time teacher circulates among students	.42*	-.11
Number of students teacher assists	.25	-.14
Active Teaching Phase		
When teacher asks a question, only one student has opportunity to answer	-.23	.1

*$p < .05$

Generalization with Precision in Community Settings

by Richard W. Albin and
Alice E. Block*
University of Oregon

Currently, a primary goal of instruction in special education is preparation for life in the "real world." One very important feature of the "real worl" is its constantly varying conditions. For example, intersections to be crossed may be controlled by traffic lights or by stop signs, or may be uncontrolled; they may include one-way or two-way streets, with one to four traffic lanes on each; and traffic may be heavy or light and move at low, moderate, or high speed. Other activities and skills: shopping for groceries and personal items, cooking, riding the local bus system, using the telephone, working in a clerical job, bussing tables in a cafeteria, working on a groundskeeping crew -- present a multitude of changing performance conditions and response requirements. Quite simply, community activities and skills must be performed in a range of conditions if they are to have an impact on the lives of people with disabilities.

This need for performance across a range of conditions creates a special problem for teachers and trainers. It is not practical to provide instruction in all of the situations in which performance is required. Therefore, generalization (i.e., responding in nontrained conditions) becomes critical to success in the community. Planning for generalization and use of instructional procedures that consistently produce generalization must become standard practices.

Developing an instructional technology for generalization has become a major objective for both researchers and practitioners. However, the analysis of performance needs underlying these efforts too often fails to fully recognize the degree of sophistication in responding demanded by many community settings. Functional generalization in applied settings requires two features: (a) responding occurs *across the full range* of appropriate, nontrained conditions that the learner will encounter, and (b) responding does not occur in conditions in which responding is inappropriate (Horner, Bellamy, & Colvin, 1984). Generalization must occur with a precision that meets the demands of the community. Responding only in a very limited subset of appropriate conditions, or indiscriminate responding across both appropriate and inappropriate conditions, is not acceptable.

A couple examples illustrate this. A student's IEP calls for learning to purchase snack items at convenience stores or "mom and pop" type stores. Training occurs at the convenience store next to her high school. Posttraining assessment in another store from the same national chain shows that generalization does indeed occur, and the teacher proudly notes the objective as met. Enthusiasm is tempered, however, when the student's parents report that she remains unable to purchase items from any of the small markets around her home without substantial assistance. A good community activity has been learned, but that activity's life-style impact is minimized because it cannot be performed across the full range of appropriate conditions. A second student receives training on properly greeting and shaking hands with the people to whom he is introduced. Training occurs in several locations and includes introductions to several different people. After training the student correctly greets anyone to whom he is introduced. Unfortunately, he also greets and offers his hand to everyone he encounters, regardless of whether an introduction is occurring. The learned skill has become a problem behavior because responding occurs in inappropriate situations.

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A Technology for Generalization With Precision

Direct instruction procedures designed to teach general case responding provide the basis for an effective technology of generalization in applied settings (Albin, McDonnell, & Wilcox, 1987; Engelmann & Carnine, 1982; Horner, McDonnell, & Bellamy, 1986; Horner, Sprague, & Wilcox, 1982). The general case approach provides specific recommendations regarding the development of the precise "generalized" responding demanded by community settings. General case programming guidelines focus both on establishing responding across the full range of appropriate conditions, and on insuring that responding does not occur in inappropriate conditions.

To date, most generalization research and analysis has centered on the role of positive teaching examples. Researchers and practitioners too often overlook the importance of negative teaching examples (Albin & Horner, in press). For many community activities and skills, over-generalization (i.e., responding in inappropriate conditions) may constitute as much of a problem for the learner as lack of generalization (i.e., not responding in appropriate conditions). Consider the following examples.

In teaching students who cannot read to select grocery items using picture cards as a list, we do numerous teaching trials with each picture to show which item to select (i.e., positive examples), but we fail to do trials that involve items that should not be selected (i.e., negative examples). As a result, even after extensive training the students continue to select incorrect items.

If learners are to succeed in natural community conditions, they must learn the discriminations required by the community.

Using Negative Examples in Teaching Community Activities

Research and analysis related to using negative examples in teaching community activities and skills to learners with severe disabilities are relatively limited. However, at least four recommendations can be offered related to using negative examples to produce generalization with precision (Albin & Horner, in press). These recommendations are based on the results of recent research efforts addressing the role of negative examples in general case instruction of community activities and skills (Albin, 1986; Horner, Albin, & Ralph, 1986; Horner, Eberhard, & Sheehan, 1986). This research builds from the guidelines and supporting research described by Engelmann and Carnine (1982), and continues the development of general case programming principles for teaching community activities and skills (Albin et al., 1987; Horner et al., 1982; Horner, McDonnell, & Bellamy, 1986).

1. z. Perhaps the most frequent error made related to negative teaching examples is the failure to use them when they are needed. Horner, Eberhard, and Sheehan (1986) provided a good example of general case instruction involving both positive and negative examples that taught a needed discrimination. Four students labeled moderately or severely mentally retarded were trained to bus tables in a cafeteria-style restaurant. The task involved removing dishes, silverware, and trash from the table top, chairs, and floor; wiping the table top; straightening the chairs; placing dirty dishes and silverware in a receptacle; and placing trash in a trash can. However, prior to performing this sequence of responses, students had to discriminate whether the table should or should not be bussed. Obviously, correct discriminations are essential for job success as a table busser. Few customers and fewer bosses are likely to be forgiving when a tray of uneaten food is cleared while the customer returns to the line for a napkin.

Fifteen different nontrained table conditions, ten that were to be bussed and five where bussing was not appropriate, served as the primary measure of activity performance. Students were shown a table and asked if they would bus it. If appropriate, students were to correctly bus the table; if bussing was not appropriate, students were to say no. Prior to training none of the students could correctly bus tables. Training occurred on six table set-ups, four positive examples sampling the range of appropriate bussing conditions and two negative examples presenting conditions in which bussing was not appropriate, located in a different cafeteria from the 15 probe test tables. After training, students correctly bussed and correctly rejected 80-100% of the nontrained probe test table conditions.

2. *Use maximum difference negative examples to quickly teach differential responding.* Negative teaching examples can vary greatly in terms of their similarity to positive examples. Maximum difference negatives share no or very few features with positive examples, while minimum difference negatives share many features with positive examples. Because positive and maximum difference negative examples are very different, discriminations between them are relatively easy to learn. For learners with severe disabilities the relative ease of such discriminations is important. Often in teaching community activities and skills, we must first teach learners with severe disabilities that different responses are needed under different conditions. By using some easily discriminated maximum difference negative examples, such differential responding is more quickly learned.

3. *Use minimum difference negative examples to teach precise discriminations.* When teaching learners with severe disabilities, there may be a tendency to try to maximize learner success by using only maximum difference negative examples so that discriminations are easy. Although maximum difference negative examples are useful in teaching that an activity or skill requires different responses in different conditions, they do not teach the precise discriminations that may be essential to successful performance. We do the learner no favor by teaching only easy discriminations when the community demands much more precise responding. Engelmann and Carnine (1982) emphasize the critical role played by minimum difference negative examples in producing precise responding. The importance of teaching with minimum difference negatives has been documented in research involving both cognitive concepts (Carnine, 1980) and community activities (Horner, Albin, & Ralph, 1986).

Horner, Albin, and Ralph (1986) used grocery item selection as the task in a study comparing training with maximum difference examples and training with minimum difference examples. Five learners with severe disabilities were trained to select 10 items using item pictures as cues. Two sets of teaching examples were used. Both sets included the same positive examples (i.e., items to be selected), but differed in the negative examples (i.e., items to be rejected) included to teach discriminations between the pictured item and other items. One set used maximum difference negatives, and the other used minimum difference negatives.

Participants were tested in a store in which no training had occurred. They were given the opportunity to select the 10 positive items, which were to be placed in their grocery cart, and 20 nontrained minimum difference negative items (two for each positive), which were to be rejected. Each minimum difference training and test probe item shared several features (e.g., package type, size, shape, and color; product color; label logo; label picture) with one of the positive items. None of the participants could correctly select and reject items prior to training.

Following instruction, all participants were able to correctly select positive items, regardless of the negative training examples used. However, participants correctly rejected a substantial number of negative test items only after training with minimum difference negative examples. Participants who could correctly reject maximum difference negative examples in training could not correctly reject the minimum difference negative test items. Precise responding in the grocery store required training that included minimum difference negative examples.

4. *Select minimum difference negative examples to avoid problems from restricted control over responding.* To perform correctly in community settings, it is often necessary to attend to multiple features or dimensions of compound stimuli. The worker in a commercial laundry sorts clothing by color and fabric type; the stock person in a grocery store shelves items based on brand, product, and size; a bus rider attends to both digits of bus numbers to board the correct bus (e.g., board #42, but not #46 or #22). When responding in such situations is actually controlled by a single component or subset of the relevant compound features, generalization errors will occur as a result of this restricted control (Horner et al., 1984). For example, in stocking grocery items, if responding is controlled only by brand logo, all the Del Monte products may end up mixed together because all the different products share the same logo. Compound stimulus situations present specific needs relating to the selection of negative teaching examples.

Restricted control errors reflect a lack of precision in discriminating between appro-

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Generalization

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priate and inappropriate conditions for responding. Responding is appropriate only when all relevant features of the controlling compound are present. Training must include specific minimum difference negative examples to teach that the full set of compound features, and not some restricted subset of features or single feature, should control responding. Albin (1986) reported two studies indicating the importance of training with minimum difference negatives that contain some, but not all, of the relevant features of a compound stimulus. Tasks were different in the two studies (circuit board insertion in one and grocery item reshelving in the other), but each required learners' responding to be controlled by stimulus compounds with two relevant features. In both studies generalization was assessed with a set of nontrained examples that included two types of negative examples, some containing neither of the two relevant features, and some containing one or the other of the features, but not both of them.

When participants received training that involved discriminating only between positive examples and negative examples containing neither of the relevant features, a pattern of errors occurred during generalization tests that reflected restricted control problems. Participants' patterns of responding suggested that only one of the compound features controlled responding. Nontrained test examples that contained one, but not both, of the features were treated as if they were positive examples (i.e., examples containing both features). After training that involved using negative examples with one or the other of the relevant features, errors reflecting restricted control problems were substantially reduced. Where compound stimuli are involved, the selection of minimum difference negative teaching examples requires careful attention to the discriminations required of the learner.

Summary

The main purpose of this article has been to highlight the importance of negative teaching examples in producing generalized responding that meets the precision demands of the natural community. The recommendations offered and the research described show once again the applicability of direct instruction principles to teaching community skills to learners with severe disabilities. Practitioners must be able to recognize when negative teaching examples are needed, and then select examples that will teach the discriminations required for successful community performance.

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Teacher Behavior and H.S. Algebra Gains- Continued

Stallings (1975) found that lengthy contacts negatively correlated with achievement. While engaged in these tutoring contacts, teachers were essentially no longer monitoring other students, so that only a few students benefited and other students, who may have also required occasional assistance and reminders about staying on-task, received little or no attention from the teacher.

Perhaps the ways that circulating and assisting were used by many Basic Algebra teachers generally render these practices ineffective. Effective use of circulating and assisting during seatwork was demonstrated, however, by the teacher in the qualitative case study. In these two additional observations of this teachers, the following data on her circulating and assisting behaviors during seatwork were collected:

Day 1:	
Number of students in class	32
Number of teacher-student contacts	25
Number of teaching assistant-student contacts	12
Total of contacts	37
Number of students contacted by teacher	16 (50%)
Total number of students contacted by teacher or teaching assistant	21 (66%)
Day 2:	
Number of students in class	30
Number of teacher-student contacts	31
Number of teaching assistant-student contacts	15
Total of contacts	46
Number of students contacted by teacher	18 (60%)
Total number of students contacted by teacher or teaching assistant	21 (70%)

This teacher clearly saw the need for providing close supervision to many students while they practiced new skills. Unlike many Basic Algebra teachers, she typically monitored to the end of the lesson period. (Many others circulated for 5 to 10 minutes, then sat at their desks and only assisted students who came up to the desks).

Some students with very low entering skills experience severe problems managing the level of work despite instruction which is effective for other students. For example, if they have no knowledge of decimals, they may become lost in a lesson involving equations with decimals, requiring extra assistance during seatwork. If provided extensively by the teacher , this extra assistance could result in reduced overall classroom monitoring for other students. This problem suggests that either tutoring assistance from someone other than the teacher (e.g., a peer tutor, an aide) may be necessary, or that these student(s) may be inappropriately placed in Basic Algebra.

Other Findings from the ATI Study: Teacher-Student Verbal Interactions

Findings for two teacher-student interaction variables--teacher questions that invite all students to respond ($r = .04$; NS) and teacher questions that direct individual students to respond ($r = -.23$; $p < .09$)-- suggest that these teacher-directed questions were not helpful to low-skill students. In contrast to this pattern, were the substantial positive correlations between low-skill student achievement growth and these low achieving students asking questions ($r = .20$; $p < .08$).

It may be that in classes where teachers are more receptive to student contributions, low-skill students feel comfortable requesting and receiving help at their level. The classroom climate may tend to be more relaxed and consequently less threatening to low-skill students.

Alternatively, it may be helpful for low-skill students to listen to other students ask questions relevant to difficulties the low-skill students experience in understanding the material, even if the low-skill students themselves do not ask questions or contribute comments. If student questions and comments are helpful to low-skill students for the latter reason, then why are teacher questions not helpful? This question may be answered in at least two ways. It appears that low-skill students perform better in classes where teachers spend time tutoring them individually during seatwork. It may also be that students have become dependent on the combination of initial teacher presentation and individual assistance, and that they simply do not attend carefully during other, public interactions. A similar psychology may also operate from the teacher's perspective: Lower-performing students take longer to understand material and usually cannot correctly answer questions during the active teaching phase. Therefore, teachers tend not to involve them in the public questioning but instead provide lengthy assistance during seatwork.

While other explanations also may be valid, what seems to be clear is that an instructional strategy which is effective in elementary and eighth grade math classes, and in Basic Algebra classes generally, is not effective with the very low ability Basic Algebra students.

The findings suggest that teachers be taught to better monitor seatwork activities so that extra assistance can be provided to those students who need it, without this assistance necessarily detracting from the performance of other students.

Teachers need skills in providing brief, effective assistance to many individuals, a practice Rosenshine and Stevens (1986) and Stallings (1975) have found to be effective. The use of peer tutors also may be an appropriate and effective way to provide this assistance. More important, perhaps, is the development of skills in effectively teaching content material so that students become active learners and can quickly become firm in their understanding and applications of concepts and skills.

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Teaching Complex Content to Secondary LD Students - Using Mastery

by Douglas Carnine • University of Oregon*

A major obstacle to mainstreaming is the performance difference between learning disabled students and their peers. Various interventions have been offered to help overcome these differences: Curriculum-based assessment (Fuchs, 1986), Direct Instruction curriculum design (Engelmann & Carnine, 1982), technology (Leiber & Semmel, 1985), mastery learning (Bloom, 1984), tutoring (Scruggs & Aidder, 1986), learning strategies (Deshler, Schumaker, & Lenz, 1984), and so forth. Since presenting these interventions singly has been found to improve student learning, combining several of these interventions would probably produce even stronger effects. Such comprehensive interventions might well be essential for cognitively complex topics such as fractions, chemistry, reasoning skills, etc. This review covers research on interventions that have combined Direct Instruction curriculum design, technology, and mastery learning to provide instruction in complex topics.

The interventions focused on secondary students who were experiencing increasing demands to learn complex material, exemplified by new high school graduation requirements, particularly in science. Secondary science textbooks are not designed to meet the needs of learning disabled students. These textbooks look more like reference books than instructional programs. Many biology texts have increased in size by over 300 pages during the past several years. According to Mary Budd Rowe of the University of Florida, an average high school science text requires students to master 3000 terms and symbols or an average of 2 per minute of class.

A required course, such as earth science, deals with the solid earth, the oceans, and the atmosphere, and generally includes geology and geophysics, meteorology, oceanography, and solar-terrestrial astronomy. This extremely large collection of material provides a great challenge even to the earth science teacher, let alone the resource room teacher. Typically, each of these earth science topics is covered independently, with its collection of rules and nomenclature, as if there was no connection among the topics. Explanations of the ways in which the earth, the atmosphere, and oceans work are usually presented in a disjointed way that leaves students with a jumbled collection of unrelated words and facts.

We have attempted to remedy these and other problems for secondary learning disabled students by integrating instructional design, technology and mastery learning procedures into a comprehensive intervention.

Instructional Design

One of the primary principles of instructional design set forth by Engelmann & Carnine (1982) is to show how seemingly unrelated phenomena can be unified through a common set of rules. Learning a small set of related rules that then makes sense out of dozens of facts is easier than learning those same facts as unrelated bits of information. This approach is illustrated in Figure 1, taken from the Earth Science course of the Core Concepts in Math and Science series (Systems Impact, Inc., in press). After a brief introduction to the properties of solids, liquids, and gases, several component concepts and relationships are taught. These constitute Level I in Figure 1: buoyancy, density, temperature, and pressure. At Level II, component concepts are combined to form operations. These are the processes of convection, the relationships between pressure, temperature, and density, and the phase changes of matter. These simple operations provide the unifying basis for the study of earth science and are the foundation upon which the rest of the course is based. Convection in particular is central for formulating models for the structure and dynamics of the earth, the atmosphere, and the oceans.

The remainder of the course is devoted to generalizing the operations to a wide range of applications (Level III in Figure 1). An examination of Figure 1 shows the importance of convection for applications to earth science. For example, the medium of mantle convection is rock. While this appears implausible, it is known that, over long periods of time and under the influence of tremendous temperatures and pressures, rock in the mantle flows like a liquid. The heat source for mantle convection is the residual heat from the earth's formation, trapped near the center of the earth. The convection process moves heated material from the core toward the surface.

Figure 2 illustrates the relationship of mantle convection to most of the important large scale geologic features on the earth's surface. The convection currents are very slow moving but they are massive, dragging the crust of the earth and moving continents and ocean beds around. For example, at point A in Figure 2, the convection currents are rising and moving outward, pulling the ocean crust apart. Molten rock upwells in this area, forming the vast mid-ocean ridge system, with undersea vulcanoes and earthquakes due to the movement and cracking of the crust and the upward push of molten rock.

At locations where the convection currents are coming together (B in Figure 2), the ocean (floor) crust collides with the continental crust. The ocean crust is more dense than the continental crust, so the heavier ocean crust sinks below the continental crust, in a region called a subduction zone. The continental crust is pushed upward and giant granite mountain chains are formed, while the downward moving ocean crust forms deep trenches in the ocean along the edge of the continents. Earthquakes and volcanoes form along subduction zones, as the ocean crust slides against the continental crust, moves down, and melts. If zones where earthquakes, volcanoes, and mountain chains occur are mapped on the earth's surface, we get an idea of where the major convection currents in the mantle are moving up or down.

Thus, convection, specifically the process of mantle convection, helps explain many, seemingly diverse phenomena such as the occurrence of mountains, volcanoes, earthquakes, mid-ocean ridges, ocean trenches, and fault systems. Once the process of convection is understood, these major topics of earth science are easily and logically presented. Convection can also account for many of the phenomena found in the ocean and atmosphere--the global heat pattern and the wind patterns of the earth, as well as the dynamics of fronts and clouds, and ocean currents and the temperature structure of the world's oceans.

Technology

The technology component of the *Earth Science* Course is the laser videodisc. One side of a videodisc contains up to 54,000 individual high-resolution video frames. The frames can be shown in rapid succession to create motion sequences or displayed singly for any period of time. Moreover, by pressing a few keys on a remote control pad (very similar to the remote control for a TV), the teacher can move anywhere on the disc in just a second or two. Automatic stops built into the disc allow still frame exercises to appear and stay on the screen following an

Figure 1

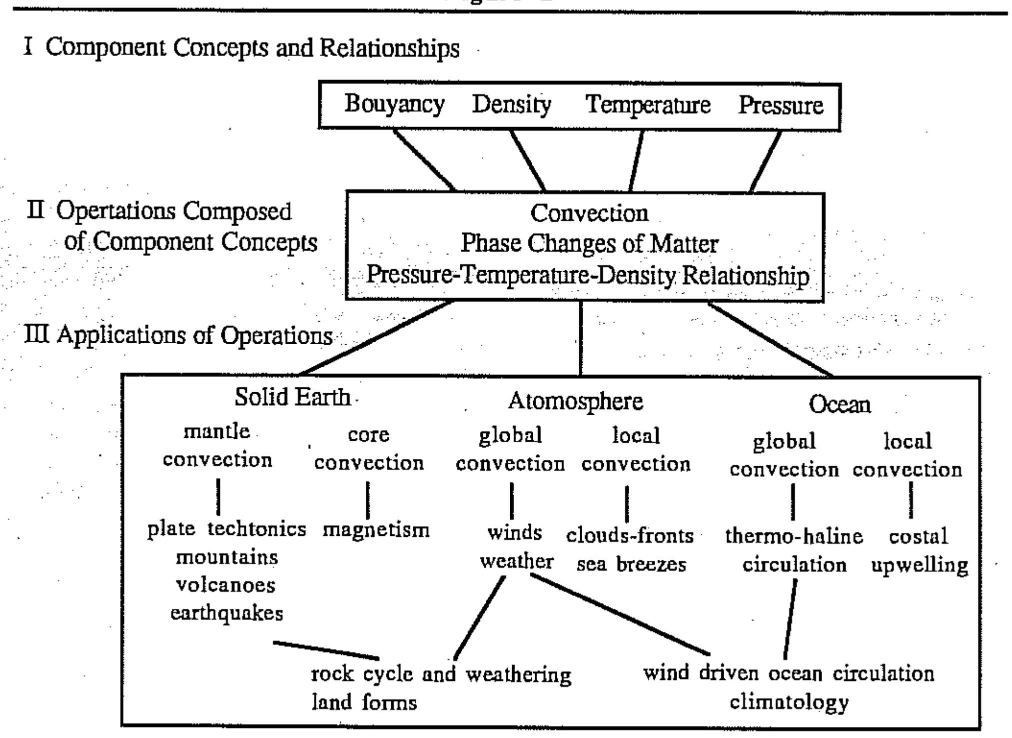

Table 1. Summary of Studies and Instructional Design Principles

Study	Technology	Instructional Design	Mastery Learning Principles
Chemistry	Videodisc	Teach unifying rules	a. Oral responese b. Work Check with remedy
Fractions	Videodisc	Present a full range of examples for a concept. Provide a mix of problem types.	c. Homework d. Daily quiz with remedies e. Weekly test with remedies f. Continued review
Health Promotion	Computer Simualtion	Teach knowledge skills, then explicit problem solving strategies.	Easier simulations must be mastered before more difficult ones are introduced.
Reasoning Skills	Computer Assisted Instruction	Teach step by step procedures for rule governed content. Relate student errors to earlier-taught rules.	Missed questions are automatically reviewed at a later time, until answered correctly.
Vocabulary	Computer Assisted Instruction	Teach only what students don't know in small sets of items. Review what has recently been taught.	After the words have been learned, they are again tested and, if necessary, retaught
Comprehension	Inexpensive Computer Networking	Give students continuous immediate feedback.	Use technology to score and summarize responses and provide them with usable information, which frees time for more teaching.

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explanation or demonstration.

The way these features are orchestrated can be illustrated with an example: The teacher is presenting a videodisc lesson from *Earth Science* on a large monitor to an entire class of students. She diagnoses students as having difficulty with the concept of bouyancy, so she enters the address for the segment of the disc that explains bouyancy. Within seconds, the students are reviewing bouyancy with a dynamic video presentation. At the end of the demonstration the disc stops automatically, displaying an application exercise. With the remote control device, the teacher is able to move around the room to see when students have had enough time to complete the exercise. The teacher then uses the remote control to advance the player to the next frame, which shows the answer to the exercise.

Thus, videodisc technology allows an *interactive format* usually not possible with conventional audio visual materials. The videodisc technology also dynamically presents experiments and demonstrations that are difficult or expensive to conduct in classroom situations. Vivid visual demonstrations are associated with nearly every concept that is presented, rendering them easily understood. Computer graphics, sound effects, brisk pacing, highlights and other techniques also help maintain students' attention.

Mastery Learning

Earth Science has a specific system for helping teachers diagnose and remedy student difficulties. This system is embedded in six steps that are utilized with all concepts introduced in the program:

1. During the initial explanation of a concept, the narrator on the videodisc asks questions which students answer orally.
2. Immediately following the initial explanation students write answers to a series of problems. The last problem serves as an informal test. If more than 20% of the students miss it, the teacher plays an explanation from the disc. This pattern of demonstration followed by practice is repeated for each concept presented in a lesson.
3. Students do homework without supervision.
4. The next lesson begins with a quiz covering the one or two major concepts introduced in the previous lesson. The screen gives the disc address for a remediation if one is needed.
5. Every fifth lesson is a test. Again, teachers diagnose student errors and select remedies from the disc based on student performance.
6. After being tested, a concept is reviewed every few lessons.

The instructional design, videodisc technology, and six-step mastery learning procedure make it easier for the teacher to present essential content in a visually-compelling manner. Courses like Earth Science are particularly helpful to less confident teachers, since the academic content is presented in a clear fashion from which students will learn. Moreover, the course provides an in-class, daily model of effective teaching practices.

The remainder of this paper describes a series of research studies that incorporate a variety of instructional design principles, technologies, and mastery learning procedures. (See Table 1 for a summary.) Most of these studies asked specific research questions, using random assignment to treatment groups of learning disabled students and, in some studies, remedial students as well.

Research Studies

Chemistry

The components of the *Introduction to Chemistry* course from the Core Concepts series (Systems Impact, Inc., in press) were very similar to those of the *Earth Science* course--unifying principles were taught to an entire class via a tape version of the videodisc course with the same six-step mastery learning procedure. In the study (Carnine, Kelly, Noell, & Hayden, 1986), the subjects were students who had not yet passed a science class, which was a high school graduation requirement. Of the 16 students who participated, five were learning disabled and 11 were remedial. Ten students were in the 10th grade, five were in the 11th grade, and one student was in 12th grade. Students were taught with the chemistry program for four weeks, approximately 40 minutes per day. At the end of the four weeks, the students were given a post test. The test was also given to advanced placement, second year chemistry students at the same high school. (The mean percentile score on the math section of the Stanford Achievement Test was 17 for the experimental students and 95 for the advanced placement students.)

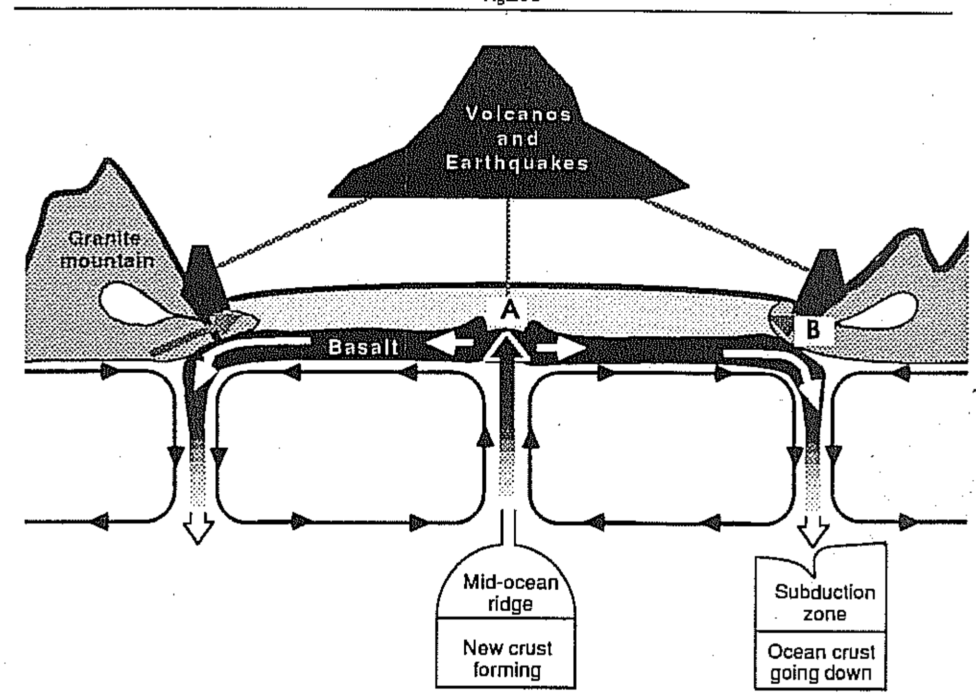
To insure that the test was not biased toward the content of the Core Concepts course, two high school chemistry teachers from another high school in a different district examined the test. After carefully considering each item, four questions were rejected. Each teacher felt the remaining questions were a fair measure of beginning chemistry, the kind of items that they would expect beginning chemistry students to know.

The experimental students had an average pretest score of 17.3 percent and an average posttest score of 76.9 percent. Advanced placement students averaged 82.1 percent on the posttest. The advanced placement students did not score significantly better than the experimental students who had received instruction with the Core Concepts Chemistry course.

Fractions

Mastering Fractions (Systems Impact, 1985) is another videodisc course from the *Core Concepts in Math and Science* videodisc series, with the same six-step mastery learning procedure. Earlier research (Kelly, Carnine, Gersten & Grossen, in press) compared *Mastering Fractions* with a widely-used math basal. Instructional design principles in *Mastering Fractions* reduced the number of errors learning disabled and remedial students made in several areas, including reversals of the terms numerator and denominator, misconceptions in analyzing fractions, and confusions in multiplying and adding fractions. For example, in *Mastering Fractions*, demonstrations and guided practice on a mix of multiplication and addition problems reduced confusions between these operations. The basal program always separated multiplication problems from addition problems, precluding the opportunity for students to practice discriminating the two operations.

Figure 2



A later study (Carnine, Kelly, Noell & Hayden, 1986) compared the performance of eight learning disabled middle school students placed in a self-contained classroom (mean percentile on total math for the CTBS was 16) with 21 seventh graders in a high-track math class (mean percentile on total math for the CTBS was 90). The learning disabled students were proficient in math facts, but scored only 5% on a fractions screening test. The learning disabled students took between three and four months (at 25-30 minutes per day) to complete 31 of the 35 lessons in *Mastering Fractions*. On a fractions test the mean score was 77% for the high-track seventh graders and 72% for the learning disabled students. Although the learning disabled students took a long time to complete most of the program, they could then perform fraction skills at a level comparable to their non-handicapped peers.

Health Promotion

In this study (Woodward, Carnine & Gersten, in press) 30 learning disabled high school students learned health-related facts concerning heredity, disease, nutrition, exercise, stress management, drinking, smoking, life styles, etc. through text material and lectures. They then learned problem-solving strategies for health promotion via a computer simulation. The mastery learning procedure required students to successfully apply the strategy to simpler character profiles before more complex ones were introduced. The problem-solving strategy required students to prioritize and change undesirable health habits, check stress level, and maintain health habit changes over time. The careful preteaching of relevant content, combined with instruction on explicit problem-solving strategies, resulted in over two-thirds of the 15 learning disabled students becoming proficient in health promotion analysis. Only two out of 15 nonhandicapped seniors in a health class exhibited this same level of problem-solving sophistication.

Reasoning Skills

Collins, Carnine and Gersten (in press) conducted research on a computer assisted instruction program that taught individual remedial and learning disabled students to draw syllogistic conclusions and critique arguments. The mastery learning procedure entailed each missed item being presented again later in the lesson, until the student answered it correctly. Students learned step-by-step procedures for constructing arguments and for critiquing arguments. The specific instructional design principle targeted for investigation was the use of process feedback, which related student errors to previously taught rules. Process feedback lead to higher scores on the posttest and a transfer test, without resulting in students taking significantly more time to complete the program.

In a later study (Collins & Carnine, 1986), the performance of four groups of students was compared: Learning disabled high school students, general education high school students, college students in an introductory logic class, and college pre-service education students. The results appear in Table 2. On the constructing-arguments subtest (Part I), the learning disabled students were quite proficient, comparable to their general education peers and to the logic students. The college preservice education students scored significantly lower than the other three groups. On the critiquing-arguments subtest (Part II), the logic students scored significantly higher than the other three groups. Overall, the learning disabled students scored comparably to two of the three other groups, indicating a lack of any performance deficits.

Vocabulary

Johnson, Gersten and Carnine (in press) compared two computer assisted instruction (CAI) programs that taught the meaning of 50 words that were identified as high utility words by three high school special education teachers. Twenty-four learning disabled high school students were randomly assigned to learn the 50 words from one of the two programs.

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Teaching Complex Content- Continued from Page 17

The experimental CAI program incorporated these instructional design principles: (1) test students to identify the words requiring instruction so that instruction can be focused; (2) teach the words each student did not know and review previously introduced words; (3) maintain a teaching set of seven unknown words--a large enough set to require students to retain the word meanings but not so large as to overwhelm the students; (4) when a student responds correctly twice to a word on two consecutive lessons, move the word to a review pool and add another unfamiliar word to the teaching set.

The mastery learning procedure used in the program was to cumulatively review learned words. After a student learned ten unfamiliar words, these words were presented again as test words. If a student missed any of these words, they were moved back into that student's teaching set.

Eighty-three percent of the students in the experimental group mastered the 50 words versus 67% in the comparison group, who learned from a CAI program nationally recognized for teaching vocabulary. Students in the comparison treatment took significantly longer to master the 50 words--an average of 9.1 sessions compared with 7.6 sessions for the experimental group.

The performance of the learning disabled students was compared to that of 30 general education tenth graders in an English class; the mean score on a test of the 50 words was 86% for the learning disabled students and 81% for their general education peers.

Efficiency

The previous studies illustrate a variety of technologies, instructional design principles, and mastery learning procedures that contribute to the effectiveness of instructional programs. Efficiency is another important program attribute. Consider vocabulary instruction. Beck, Perfetti, and McKeown (1982) taught 104 words in 75 thirty-minute lessons. At the end of the study, students knew an average of 85 words that they did not know prior to the program, but this took 2,250 minutes of instruction or approximately 26 minutes per word. This amount of time is considerably more than that typically devoted to vocabulary instruction in secondary schools.

If technology can free the teacher from delivering drill and practice instruction, a significant efficiency could be realized. The computer-assisted program in the Johnson et al. study (in press) taught about 30 words, but a teacher was not required to instruct. Similarly, the reasoning skills program did not require a teacher. Although the computer simulation and videodisc courses required a teacher, the technology still made the instruction much more efficient. For example, iu one study a teacher presented the content of the *Mastering Fractions* program on overheads rather than on the videodisc (Hasselbring, Sherwood & Bransford, 1986). The students learned as much from the overhead presentation as did other students (randomly assigned) who learned from the videodisc course. However, the teacher who used the overheads required a half-time assistant to create and manage the overheads!

Other research we have conducted has focused more exclusively on technology as a means of increasing efficiency. The technology was a low-cost networking system, Teacher Net, that instantly gives both teachers and students feedback on performance by networking eight or more keyboards to a single IBM computer (Carnine, 1984).

Table 2. Means for Parts I and II and Total Score (with Standard Deviations) for Learning Disabled Students, General Education Peers, College Logic Students, and College Preservice Education Students.

Group	Number	Construct Argument Mean	Critique Argument Mean	Total Test Mean	Total Test Standard Deviation
Learning Disabled	23	11.09	7.96	19.00	4.11
General Education	53	10.94	6.42	17.36	3.74
College Logic	30	11.33	8.73	20.07	3.10
Teacher Preservice	41	8.15	7.29	15.44	5.11

In a study by Golden (1986), each learning disabled secondary student responded on his own keypad to questions interspersed throughout a series of instructional sessions on reading comprehension. Responses were immediately scored and summarized by Teacher Net for the teacher. With Teacher Net, the assignments of 16 learning disabled students were scored almost instantaneously. Consequently, the teacher was able to immediately adjust her class presentation to address the difficulties experienced by individual students. The teacher scored the comparison students' answers after class and gave feedback at the beginning of the next day's class. The teacher took 35 minutes each day to score and analyze the responses of these students. Other studies using Teacher Net have found time savings of a comparable size in test administration and scoring of independent work.

Simple networking offers more than just efficiency. The Teacher Net students had significantly higher posttest scores on new comprehension material than comparison students taught the same comprehension curriculum without Teacher Net The Teacher Net students also had significantly higher engagement rates (89% versus 52%) and more positive attitudes toward instruction (78% versus 25%).

Conclusion

While the findings about the capability of learning disabled students to learn complex material are encouraging, the studies have several serious limitations--lack of follow-up data, use of experimenter-designed instruments, quasi- experimental design, etc. These are legitimate concerns. For example, learning disabled students' performance would probably deteriorate on follow-up measures if they were not given opportunities to periodically review what they had learned. Beside the limitations of the studies are the constraints imposed by the interventions themselves. Videodisc and low-cost networking require active teaching with frequent student teacher interactions, which is at odds with individualized, worksheet- oriented programs found in many special educations classrooms. In addition these educational technologies are very new and not widely found in schools; acceptance of new technology can come very slowly. On the other hand, computer assisted instruction is becoming common place. Yet CAI programs require extensive time on the computer, which is too expensive to provide in many schools. Some of our recent research (Noell & Carnine, 1987) suggests that low-cost networking might be an answer to the expense problem. In the short run, however, the availability of computers limits the practical significance of the present findings on effective CAI.

Looking further ahead, combining the capability of technology, Direct Instruction curriculum design and mastery learning may have to be tapped if learning disabled students are to make substantial gains in complex cognitive areas. Ultimately the expense of human teachers and the limits of what they can do within the school day necessitate new forms of instructional support. Without some such support, swings from mainstreamed to self-contained classes and back will continue.

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Corrections-
Separation of Similar Responses and Similar Stimuli

by Douglas Carnine
University of Oregon

In previous work, Carnine (1976) showed that separating two highly similar sounds (*e* and *i*) in a teaching sequence resulted in more correct responding by first graders and more rapid sound acquisition by preschoolers than was obtained from a teaching sequence where the similar sounds were contiguous. The present study extends the application of this principle to correction sequences. It should be noted that stimuli can be similar both in their visual form and in the acoustical properties of responses to them. Study 1 defines similarity in terms of the acoustical properties of sounds. Study 2 looks at the same issue based on visual similarity.

Study 1

First, the sound e was introduced with a drawing of an ice cream cone. Then four progressively-expanding training sets were presented:

- *e, ice cream cone,* and *m*.
- *e, m,* and *u*.
- *e, m, u,* and *s*.
- *e, m, u, s,* and *i*.

The stimuli were presented on sheets of paper with 15 on a page. All stimuli within a set appeared an equal number of times in random order, except that letters most similar to *e* (*u* and *i*) never immediately preceded or followed e.

Twenty preschoolers aged 2 1/2 to 7 who could answer simple questions, but who did not know the sounds, were included in the study. They were all given pretraining to ensure that they could visually discriminate the letters. The preschoolers were matched in pairs according to age and one member of each pair was randomly assigned to each experimental group. They were also grouped into older (over four) and younger (under four) groups so that the experimental effects could be examined for age effects.

The experimental conditions varied the correction procedure when an error was made on the sound *e*. The *similar-sounds group* often received a correction sequence consisting of *e* and either *u* or *i*. In general, the correction sequence consisted of *e* and the letter the child mistook it for. If the child said "iiiii" for *e*, the correction sequence was *e* and *i*. Table 1 lists the correction sequences used for each type of error. Trials in the correction sequences were counted in the measure of trials to criterion.

In the *dissimilar-sound group*, the teacher corrected by modeling the correct response for *e* (/e/), tested the student for e, and then presented the next letter in the training set. Since the letter e was never contiguous with u and i in the four training sets, children in this group did not encounter juxtaposed examples of the highly similar vowel sounds (*e, u, i*).

All training sessions lasted 10 minutes per child. Difficulty in saying sounds was minimized by giving practice in saying new sounds before they appeared in a training set. The child had to say a new sound correctly 3 times before training proceeded. In each training set, the children continued until they reached a criterion of eight consecutive correct responses to the new letter plus five consecutive correct responses to each of the familiar letters in the set. Each child received as many 10-minute training sessions as needed to reach criterion on each of the four sets. A posttest was given one week after criterion was reached.

Results

Table 2 gives the numbers of trials to criterion for each group. The interaction term was significant ($p < .01$), indicating the younger children receiving the similar-sound correction required more trials than younger children in the dissimilar-sound correction.

Table 3 presents the data by training set. The means for the training sets with *u* and i were 77.6, 54.0, 68.6, and 10.8. The means for the training sets with *m* and *s* were 26.5, 32.7, 36.3, and 37.2. Thus, with one exception (10.8), training sets with phonemes most similar to *e* (i.e, *i* and *u*) are associated with more trials to criterion.

The follow-up posttest a week later did not show significant differences. Apparently, requiring all children to reach the same criterion washed out the group difference found on trials to criterion.

Conclusion

The similar-sound correction was less effective than the dissimilar-sound correction, especially for younger children. This finding is consistent with Carnine's (1976) finding that showed that separating the introduction of highly similar sounds as far as possible leads to faster learning of the set of sounds.

Table 1. Correction sequences following errors on *e* for each stimulus set and for each possible error.

Stimulus Set	Response to *e*	Grapheme Pair Presented Following the Error on *e*
e, , m	m	e, m
	other responses	e, m
e, m, u	m	e, m
	u	e, u
	other responses	e, u
e, m, u, s	m	e, m
	u	e, u
	s	e, s
	other responses	e, u
e, m, u, s, i	m	e, m
	u	e, u
	s	e, s
	i	e, i
	other responses	e, i

Table 2. Average number of trials to criterion on *e* for younger and older subjects and for Similar and Dissimilar correction sequences.

Correction Sequence	Age: Younger	Older
Similar	74.4	52.3
Dissimilar	28.2	33.7
Mean	51.3	34.7

Table 3. Average number of trials to criterion on *e* in the four training sets for the Similar and Dissimilar correction sequence.

Correction Sequence	Training Set 1	2	3	4	Mean
Similar	26.5	77.6	36.3	68.6	52.3
Dissimilar	32.7	54.0	37.2	10.8	33.7
Mean	29.62	45.81	36.77	39.71	

Study 2

In this study, 16 preschoolers who passed an object-identification screening test were assigned to similar and dissimilar correction groups, as in Study 1. They were also divided into younger and older groups. The training procedures and sequences were the same as in Study 1, except that geometric designs were used as the training stimuli rather than letters. The three designs were very similar, differing only in the position of a dot. These corresponded to the similar phonemes *e, u,* and *i*. One of the three similar forms was designated the target stimulus and thus paralleled *e*'s function in Study 1.

Results

Table 4 shows the results by age and similarity of correction. The *similar-figures group* required significantly more trials to criterion on the target stimulus than did the *dissimilar-figures group* ($p < .05$). Also the younger children required more trials than older children. ($p < .05$). The results also showed that trials to criterion were significantly higher for training sets in which highly similar figures were introduced (2 and 4) than training sets where highly dissimilar figures were introduced (1 and 3).

Conclusion

The basic finding supports the importance of using corrections with dissimilar members included in the set. The analysis

Corrections

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of the data over training sets suggests that students can learn a discrimination within a set containing dissimilar members and appear to "forget it" when a highly similar member is introduced to the set. For example, a student may consistently give the correct sound to *b* until *d* is introduced to the set. The student may then begin to make errors on *b*. This effect can be minimized by separating the introduction of *b* and *d* as far as is reasonable within the set by interspersing less similar letters.

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Table 4. Average number of trials to criterion for the target stimulus for younger and older subjects and for Similar and Dissimilar correction sequence.

	Age		
Correction Sequence	Younger	Older	Mean
Similar	316.5	103.5	210.0
Dissimilar	79.8	60.3	70.0
Mean	198.2	82.9	

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