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Wes Becker Retires

Dear Readers,

After 11 years of editing the ADI News this is the last issue that I have primary responsibility for. It has been an exciting time in the development of Direct Instruction and I hope that you have benefited from what we have been able to put together.

Bonnie Grossen and a new editorial board will be taking over with the next issue.

Sincerely,

Wes Becker

John Woodward Leaves ADI Board

John Woodward recently accepted a position at the University of Puget Sound, in Tacoma, Washington. John served 4 years as President of ADI. We thank him for his contribution to ADI and wish him well in his new position.

Sincerely,

Geoff Colvin,
President

Preservice Teacher Performance in a Direct Instruction Practicum Using Student Teachers and University Personnel as Supervisors

by Nancy E. Marchand-Martella
Special Education, Gonzaga University
and Benjamin Lignugaris/Kraft
Special Education, Utah State University

Field-based experiences are an important component of many university teacher training programs. However, this component presents educators with some of the most serious problems in teacher education (The Holmes group, 1986). These problems include few opportunities for preservice teachers to improve their teaching skills (Lindsey, 1978) and unclear field experience objectives (Mills, 1980). These problems are compounded by a lack of consistent and effective field-based supervision.

Field-based supervision typically involves observation of trainee performance, evaluation about the adequacy of the trainee's teaching (Showers, 1985), and feedback to improve targeted teaching behaviors (Englert & Sugai, 1983). Preservice teacher supervision is necessary, yet time consuming for university personnel who have other teaching, research, and university service responsibilities. Factors that restrict supervision time for university personnel often include the large number of trainees in varied locations in the community who need supervision and budgetary restrictions which may affect the frequency of visits or time spent with trainees (Englert & Sugai, 1983). These problems are compounded by the low status practicum supervision receives in tenure and promotion decisions (Warger & Aldinger, 1984).

One method of supervising practicum students that overcomes the time restrictions involved in supervision is the use of preservice teachers. In two studies (Englert & Sugai, 1984; Rolider, McNeil Pierce, Van Houten, Molcho, & Ylevitch, 1985) preservice teachers observed their peers in the same field-based practicum in a nonevaluative manner (i.e., no grades were provided by the peers). The peers observed each other teach and gave each other feedback on their teaching performance. They provided more feedback than the university supervisor might have provided alone. However, typical university practicum supervision requires evaluation and judgment of a trainee's adequacy in the classroom (Showers, 1985). This might be accomplished by using advanced students, such as student teachers, as peer supervisors. Using student teachers to observe, to evaluate, and to provide feedback to preservice trainees may be an effective means of providing increased and effective supervision. Learning to provide effective supervision to others is a much needed skill for student teachers who may eventually be responsible for supervision of various paraprofessionals (e.g., instructional aides, peer tutors) in their own classrooms.

Unfortunately, student teachers often lack classroom management and teaching experience, and have trouble pinpointing critical teaching skills (Gassman, Lignugaris/Kraft, & Marchand-Martella, 1991). These problems may be overcome by carefully defining objectives for the field-based experience and training student teachers to observe critical behaviors and to structure feedback based on their observations of the preservice teacher's performance in the classroom.

The purpose of this paper is to describe the performance of preservice teacher trainees in a highly structured Direct Instruction practicum. A cadre of trainees were supervised by student teachers, and a cadre of trainees were supervised by university personnel.

Method

Participants and Settings

Four student teachers enrolled in a special education certification program served as supervisors. They had completed a seminar and practicum in Direct Instruction. Supervision responsibilities were included as part of their student teaching requirement. Each supervisor was assigned two undergraduate students (trainees) in special education who were enrolled in a 10-week Direct Instruction seminar and practicum. Two student teachers supervised trainees placed in the same elementary school resource rooms where they were student teaching. One student teacher supervised trainees placed in a high school resource room where she was student teaching and one student teacher supervised trainees placed in a nearby elementary and middle school resource room.

In addition to the four student teachers, two university personnel served as supervisors. One university supervisor was an assistant professor of special education, and the other served as a school district coordinator and as a clinical supervisor for the university. Both university supervisors had extensive experience in practicum supervision. One university supervisor (i.e., assistant professor) was assigned two trainees placed in elementary school resource rooms; the other supervised five trainees placed in elementary and middle school resource rooms.

The Direct Instruction programs used in this investigation included *Reading Mastery I* (Engelmann & Bruner, 1988a), *Reading Mastery II* (Engelmann & Bruner, 1988b), *Reading Mastery III* (Engelmann & Hanner, 1988), *Reading Mastery IV* (Engelmann & Hanner, 1983), *Reading Mastery V* (Engelmann, Osborn, Osborn, & Zoref, 1984), *Corrective Reading Decoding B* (Engelmann et al., 1978), *Corrective Reading C* (Engelmann, Meyers, Johnson, & Carnine, 1978), and *Corrective Mathematics/Subtraction* (Engelmann & Carnine, 1981).

Targeted Teaching Behaviors

In this practicum, trainees were taught a number of small group instructional procedures. The targeted teaching behaviors, definitions for each behavior, and criteria are listed in Table 1. (A complete list of the operational definitions can be obtained by writing to the authors.)

The criteria for the targeted teaching behaviors were the same as those used by Brynildson and Vreeland (1991) in a Direct Instruction investigation involving inservice teachers. Since a criterion was not provided for accuracy of praise statements in that study, 90% of praise statements delivered appropriately was determined to be an acceptable performance level.

Data Collection and Feedback Forms

Student teacher and university supervisors used three forms to record trainee performance and to provide written feedback to their trainees. The first form was used to record the frequency of correct and incorrect teaching behaviors by trainees. The second form (grade form) was used to change the frequency counts into an observation grade. Each targeted behavior was assigned a rating from 0 to 4 that corresponded to percentages of correct occurrence of the targeted teaching behavior. For pacing a rating was assigned based on the response rate per minute. A rating was also assigned based on the percentage of group responses out of the total number of group and individual responses. The ratings were tallied across the various categories and divided by the total number of behaviors for an overall rating and observation grade (i.e., 3.85 to 4.0 = A; 3.67 to 3.84 = A-, 3.33 to 3.66 = B+, 3.00 to 3.32 = B, 2.67 to 2.99 = B-, 2.33 to 2.66 = C+, 2.00 to 2.32 = C, 1.67 to 1.99 = C-, 1.33 to 1.66 = D+, 1.00 to 1.32 = D). The third form was used to provide written feedback to trainees about their teaching performance. The categories of teaching behaviors were listed on the written feedback form (e.g., presentation, error corrections). A space was provided below each category to indicate what the trainee did well and to describe techniques the trainee needed to improve. The grade form and written feedback form were copied on carbonized paper so that the supervisor could give one copy to the student and one copy to the cooperating teacher.

Table 1. Targeted Teaching Behaviors and Criteria

Teaching	Abbreviated Definition	Criterion
Presentation	Trainee provides focus word, phrase, or question, followed by a 1 second pause and a hand, touch, or auditory response to signal a simultaneous group response	90% correct
Accuracy	Group responses are correct and simultaneous; individual responses are correct	85% correct
Signal Error Correction	Group does not respond simultaneously or one or more pupils do not respond. Trainee indicates what must be done (e.g., "I need to hear everyone") followed by a request for group to respond again	85% correct
Response Error Correction	Group or individual provides an incorrect answer. Trainee models correct response followed by a request for group/individual to respond again	85% correct
Praise Statements	Specific (e.g., "good reading *mother*") or general praise statements given after an appropriate behavior	90% correct
Pacing	Number of group and individual responses divided by the total number of minutes of observation	9 per minute

Data Collection and Recording Procedures

Observations. Supervisors conducted graded (formal) observations for each trainee four times during the 10-week quarter. The formal observations included at least 6 minutes of data collection, completion of a grade form, and completion of a written feedback form. Additionally, participants conducted nongraded (informal) observations during the weeks when formal observations were not conducted. Informal observations included watching the trainees and collecting data (if desired), as well as completing a written feedback form.

At the beginning of the quarter, student teacher and university supervisors were given a calendar with informal and formal observation time periods blocked out. Student teachers made arrangements with their cooperating teachers to include at least one observation and feedback session with each trainee each week as part of their regular student teaching schedule. University personnel also made arrangements with the cooperating teachers to include at least one observation and feedback session with each trainee each week.

Trainee evaluations. At the end of the quarter, trainees were asked to evaluate the Direct Instruction practicum. First, trainees were asked to indicate whether they were supervised by a student teacher or a university supervisor. Second, they rate their supervisor on three statements using a five-point scale (5 = strongly agree, 3 = agree, 1 = strongly disagree). These statements included: "My supervisor's verbal feedback was useful"; "My supervisor's written feedback was useful"; and "Good communication exists between me and my supervisor." Third, they rated the quantity of feedback provided to them during the quarter using a five-point scale (5 = too many observation and feedback sessions, 3 = about the right number of observation and feedback sessions, 1 = too few observation and feedback sessions). Fourth, the trainees rated the quantity of feedback provided to them after each observation session using a five-point scale (5= overwhelming; too much information given during feedback sessions, 3 = about the right amount of feedback given, 1 = not enough information given during feedback sessions). Fifth, they rated the quality of feedback during informal and formal observations using a five-point scale (5 = always clear, precise, and easy to follow, 3 = sometimes clear, precise, and easy to follow, 1 = never clear, precise and easy to follow). Finally, trainees rated their practicum experience in general on three statements using a five-point scale (5 = strongly agree, 3 = agree, 1 = strongly disagree). These statements included: I learned a great deal about teaching during this practicum; I have the skills to use Direct Instruction programs effectively in the future; and I could apply Direct Instruction programs effectively in the future; and I could apply Direct Instruction teaching methods to other teaching situations.

Supervisor Training

Training of supervisors was conducted by a university practicum coordinator. The university coordinator assisted in the development of the data collection and feedback forms.

Student teacher supervisors. The student teacher supervisors were trained in four steps. First, the student teachers were asked to read a packet that included the Direct Instruction definitions and scoring procedures, the data collection instrument, grade form, and written feedback form. Second, the student teachers were shown two videotapes. The first tape included presentation techniques of Direct Instruction (i.e., Science Research Associates, 1984a); the second tape included correction techniques of Direct Instruction (i.e., Science Research Associates, 1984b). Each student teacher scored the teaching interactions presented on the tapes using the data collection instrument. After this practice, a training session was conducted in which the trainer reviewed each definition, how to tally the data, and how to transfer the data to the grade form. The student teachers were then shown the two videotapes; however, this time the trainer stopped the tape after each teaching interaction and discussed the scoring procedures.

Third, the student teachers were administered a test on how to tally the data. This test included two data collection instruments which were already scored. The student teachers were instructed to tally the data, transfer these data to the grade form, and provide written feedback based on the data. The criterion for passing the test was correctly and accurately completing all calculations on the data collection instrument, transferring this data to the grade form, and calculating grades accurately. One student teacher required two tests; three student teachers required three tests. Additionally, the student teachers were provided feedback on completion of the written feedback form. This feedback included positive and corrective comments, with emphasis on providing specific feedback such as "Your signals were consistent and audible to the group. That's great" or "Remember to model the word if pupils say it incorrectly" rather than saying "You did well" or "You need to work on corrections." Finally, the student teachers watched a videotape that included various teaching interactions and scored the tape with the trainer. They had to achieve at least 80% agreement on high frequency count behaviors (five or greater) and at least 50% agreement on low frequency behaviors (four or less). After reliability was achieved, each student teacher supervised two students for one quarter prior to student teaching; one interobserver agreement check was made by the trainer and feedback provided if agreement was lower than 80% on any targeted behavior. After this quarter of supervision, the student teachers were asked to attend a brief review session. During this session, all procedures were reviewed before beginning student teaching.

University supervisors. The university supervisors helped develop and field test the observation forms. One supervisor (i.e., district coordinator) was provided training. She watched two videotapes (Science Research Associates, 1984a, 1984b) and scored the teaching interactions presented on the tapes using the data collection instrument. After scoring the videotapes, the videotapes were reviewed and the scoring of each teaching interaction was discussed. After this, the supervisor watched a novel videotape including various teaching interactions and scored the tape with the trainer. Training was completed when she achieved at least 50% agreement on low frequency behaviors (four or less).

Interobserver Agreement

Interobserver agreement was calculated using a frequency ratio. This ratio was calculated by dividing the smaller number of behaviors by the larger number of behaviors and multiplying by 100 (Kazdin, 1982). Interobserver agreement was calculated on 25% of the formal observations. These data are reported as means across student teacher and university supervisors and are presented in Table 2. The university coordinator served as the primary rater for both student teacher and university supervisors.

Table 2. Mean Interobserver Agreement Percentages Across Student Teachers and University Supervisors

Teaching Behavior	Student Teachers		University Supervisors	
	Mean	Range	Mean	Range
Presentation	91.5%	(88.2-100)	92.2%	(90.9-93.5)
Accuracy	94.1%	(85-98.2)	96.2%	(92.8-100)
Signal Error Corrections	84.3%	(74.1-100)	81.3%	(33.3-92.3)
Response Error Corrections	74.2%	(57.1-83.3)	85.0%	(83.3-87.5)
Praise Statements	85.7%	(76.7-92.9)	82.1%	(67.7-97)
Pacing	96.4%	(94.7-98.5)	92.7%	(84.1-97.1)
Overall Rating Agreement	91.1%	(80.7-97.8)	90.5%	(85.7-95.6)

Overall, interobserver agreement between the university coordinator and the student teacher supervisors was high; mean agreement about 80% was noted for presentation, accuracy, signal error corrections, praise statements, pacing, and overall rating agreement. Mean agreement below 80% was noted for one teaching behavior (i.e., response error corrections). For the university supervisors, mean interobserver agreement was above 80% for all teaching behaviors.

Descriptive Analyses

Trainee Performance on Targeted Teaching Behaviors

Table 3 presents the mean and range of correct teaching behaviors and the proportion of trainees who met the target criteria for each formal observation by student teachers and university personnel.

Trainees demonstrated improved performance for the targeted teaching behaviors across the four formal observations. The mean percentage of correct presentations improved by 11.6% from the first to the fourth formal observation for trainees supervised by student teachers and 1.1% for trainees supervised by university personnel. Accuracy of pupil responses for trainees supervised by student teachers fluctuated across observations from a low of 72.2% (first formal) to a high of 77.6% (third formal). For trainees supervised by university personnel accuracy improved 3.4% from the first to the fourth observation. Correct signal error corrections improved 6.4% from the first to fourth formal observation for trainees supervised by student teachers; the mean percentage of correct response error corrections for these trainees increased by 10% from the first to the fourth formal observation. For trainees supervised by university personnel the percentage of correct signal error and response error corrections improved by 27% and 11.3%, respectively. For all trainees, the mean percentage of correct praise statements remained stable at 100% across formal observations. Finally, trainees' pacing remained stable across the observations. Trainees supervised by student teachers showed a negligible decrease of .07 responses per minute from the first to fourth formal; however, the difference from the first to third formal and from the second to the third formal was 1.00 and 2.40 additional responses per minute, respectfully. Trainees supervised by university personnel decreased .22 responses per minute from the first to the fourth observation.

Table 3. Trainee Performance When Supervised by Student Teachers of University Personnel

University Personnel—Percent Correct Teaching Behaviors

Formal Observation #		Presentation	Accuracy	Signal Error Correction	Response Error Correction	Praise	Pacing
				Student Teacher Supervisors			
1	PC[a]	88.4%	72.2%	87.5%	87.7%	100%	10.6
	Range	(0-100)	(53-87)	(67-100)	(40-100)		(7-17)
	MC[b]	7/8	1/8	5/8	4/8	8/8	6/7
2	PC	99.5%	70.8%	90.3%	83.9%	100%	9.2
	Range	(95-100)	(50-85)	(67-100)	(40-100)		(7-11)
	MC	8/8	2/8	6/8	6/8	8/8	3/5
3	PC	100%	77.6%	88.3%	91.2%	100%	11.6
	Range		(60-94)	(50-100)	(43-100)		(8-15)
	MC	7/7	2/8	5/7	7/8	8/8	4/7
4	PC	100%	75.2%	93.9%	97.7%	100%	10.5
	Range		(65-80)	(67-100)	(67-100)		(8-12)
	MC	7/7	0/7	6/7	6/7	7/7	4/5
Formal Observation #				University Personnel Supervisors			
1	PC	96.9%	77.0%	57.9%	84.2%	100%	11.98
	Range	(81-100)	(28-84)	(0-100)	(0-100)		(7-18)
	MC	6/7	1/6	2/7	4/7	7/7	5/6
2	PC	93.5%	77.7%	74.6%	84.6%	100%	12.59
	Range	(84-100)	(54-90)	(33-92)	(50-100)		(9-22)
	MC	5/7	2/7	2/6	4/7	7/7	5/6
3	PC	100%	76.2%	82.0%	83.0%	100%	11.75
	Range		(60-86)	(50-100)	(29-100)		(9-16)
	MC	7/7	2/7	4/6	4/7	7/7	6/6
4	PC	98.0%	82.4%	84.0%	95.5%	100%	11.77
	Range	(90-100)	(71-93)	(60-100)	(83-100)		(10-20)
	MC	6/6	2/7	5/6	6/7	7/7	7/7

Note: Denominators for criteria are not always equivalent since data may not have been collected on a particular behavior for a trainee because it was not exhibited during the observation.
[a]Percent correct teaching behavior
[b]Number of participants who met criterion

The percentage of trainees who met the criterion for each targeted teaching behavior was also examined. Trainees supervised by student teachers and university personnel surpassed the criterion for praise during each formal observation. On presentations, an average of 97% and 89% of the trainees supervised by student teachers and university personnel, respectively, met the criterion across formal observations. Trainees had more difficulty meeting criteria for correcting signal and response errors. For signal error corrections, 73% of the trainees supervised by student teachers met the criterion across observations, while only 52% of the trainees supervised by university personnel met the target criterion. For response error corrections, an average of 74% of the trainees supervised by student teachers met the criterion, while 64% of the trainees supervised by university personnel met criterion. In contrast, only 71% of the trainees supervised by student teachers met the pacing criterion across formal observations, while 92% of the trainees supervised by university personnel met the criterion. In general, trainees had the most difficulty meeting the accuracy criterion. Only 16% of the trainees supervised by student teachers and 26% of the trainees supervised by university personnel met the targeted accuracy criterion across formal observations.

Trainee Evaluations

On the three statements in which trainees evaluated their supervisors, all trainees indicated agreement to strong agreement that their supervisors' verbal feedback was useful, written feedback was useful, and that good communication existed between them and their supervisors. All trainees also indicated that they received about the right number of feedback sessions during the quarter. All trainees supervised by student teachers also indicated that they received about the right amount of feedback after each observation session. In contrast, 71% of the trainees supervised by university personnel indicated that it was about the right amount of feedback after each observation session. For the informal and formal observations, 75% of the trainees indicated that their student teacher supervisors always provided clear feedback, while 57% (during informal observations) and 71% (during formal observations) of the trainees indicated that their university supervisors always provided clear feedback. On the three statements that pertained to a general evaluation of the practicum experience, 96% of the trainees supervised by student teachers and 86% of the trainees supervised by university personnel reported agreement to strong agreement that they learned a great deal and could apply their skills to other teaching situations.

Discussion

Field-based experiences are critical components in preservice teacher preparation programs (Welch & Kukic, 1988). During these experiences preservice teacher trainees practice and refine desired instructional skills. Frequent supervision and detailed feedback are important components of these experiences. The structured observation system described in this investigation provided a useful format for student teachers and university personnel to provide detailed feedback and to evaluate preservice teacher skill development. Moreover, most of the preservice trainees indicated that the practicum was a valuable experience and that their supervisors provided clear feedback.

Englert and Sugai (1983) found that peer coaches who used a well-defined observation system and provided structured feedback based on that system were more effective than peer coaches who did not use well-defined supervision instruments. This investigation extends the work of Englert and Sugai (1983), as well as Rolider et al. (1985) by including student teachers as supervisors for their less experienced peers. Using student teachers as supervisors has been largely ignored in the literature. This investigation suggests that students in the latter part of their training program might supervise preservice trainees as effectively as university personnel given a structured observation system and proper training.

The trainees supervised by student teachers and university personnel in this program consistently demonstrated the targeted presentation and praise techniques. The only teaching behavior in which students supervised by student teachers and by university personnel sharply contrasted was instructional pacing. Instructional pacing is influenced by several factors including the teacher's familiarity with an instructional format, their familiarity with the materials, and the frequency and topography of praise statements (see Lignugaris/Kraft & Rousseau, 1982 for a review of the variables that impact instructional pacing). Student teacher supervisors may require additional training to detect which factors are having a detrimental effect on instructional pace. Additional research is needed to identify other instructional problems that may prove troublesome for student teachers to remediate. It is interesting to note that all trainees had more difficulty consistently demonstrating error correction techniques and meeting the criterion for student accuracy. Gersten et al. (1982) reported similar findings in an inservice training program with certified teachers and paraprofessionals. In a recent study, Brynildson and Vreeland (1991) reported that inservice teachers improved their performance in these skill areas using an audiotape self-monitoring feedback system. However, the teachers did not consistently achieve criterion performance levels for error or student accuracy. It seems that these behaviors require more intensive programming and practice than are available in a short-term training practicum.

Additional research is also needed to determine how the student teacher supervision experience impacts the supervisor's teaching skills. It is likely that student teachers who participate in a peer supervision program gain communication skills that might be useful in training and managing aides or providing feedback to colleagues on their teaching. It is not clear if the observation training and structured supervision system also result in better understanding of instruction and refinement of the supervisor's teaching skills. Each of the student teacher supervisors in this study reported that they learned a great deal about teaching and that conducting observations of peers promoted an appraisal of their own Direct Instruction skills. A careful delineation of the competencies acquired by peers is needed if student teacher supervision is to be used broadly within an undergraduate training program. Finally, the student teacher supervisors who participated in this program required fairly extensive training to use the observation system and in providing feedback to trainees. For supervision to become a standard component of student teaching, we must develop efficient, low-cost supervision training systems.

In summary, the use of student teacher supervisors in preservice teacher education programs may permit more frequent teaching observations while maintaining the quality of training. The practical utility of student teacher supervision programs will be determined by careful integration of student teacher supervision into the undergraduate training program, development of efficient supervision training packages, the identification of the skills that are difficult for student teacher supervisors to remediate, and the educational value of the supervision process for the student teacher supervisor. ◆

Author Notes: We wish to thank Tammy Pettigrew for serving as a university supervisor and for her help in developing the Direct Instruction materials used in this program. Also, we would like to thank Ronald C. Martella for his help in developing the data collection instrument and in providing editorial comments on the manuscript. Additionally, we would like to thank Kareena Jensen, Marty Blair, Sandra Bihr, and Laura Wirthlin for serving as student teacher supervisors. This descriptive analysis was supported in part by the U.S. Office of Education Grant #H029B90235-91. Reprints can be obtained by writing to:

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Teaching Reading to Low Performing First Graders in Rural Schools: *A Comparison of Two Instructional Approaches*[1]

by Bobbie Umbach, Craig Darch and Gerald Halpin
Auburn University

Abstract. The objective of this study was to determine if there was a difference between the reading performance of students taught by two distinctly different reading approaches–a traditional basal approach and a more structured direct instruction approach. The students in the basal group were provided reading instruction from the *Houghton-Mifflin Reading Series* (1983), while the direct instruction students were taught with the *Reading Mastery Program*. These programs differed from each other significantly, in areas of curricular design, correction procedures, and implementation methods. The 31 subjects who comprised the two instructional groups were first graders living in a low income rural area in the Southeast. All but one of the subjects were black. Students were posttested on both decoding and passage comprehension measures (*Woodcock Reading Mastery Test*). After one year of instruction, analysis of covariance and *t* tests revealed a significant difference in the two groups on the posttest measures with the direct instruction group scoring higher on both decoding and passage comprehension. Possible explanations for the differences are discussed in the context of developing improved reading instruction for rural children who reside in low-income areas.

In the last two decades, interest in rural education programs which predominantly serve black students has been on the rise. This interest has often focused upon isolated rural communities where program development has lagged behind larger, more affluent districts. This focus has not only generated causal interest, but often intense feelings from writers in this research area. Recently, an article in *Education Week* (1988) eloquently and forcefully highlighted the problems facing education in poor rural areas in the Southeast: "Academically, the Black Belt has long been a land of low expectations, educators and political observers say. Graduation and literacy rates, test scores, and other academic indicators have traditionally been among the lowest in the nation."

Answers to how best to make significant changes in the academic programs for students in low SES rural areas have been slow in coming (Helge, 1988). Undoubtedly, one reason for this continuing problems is that no single answer has, or will emerge as a remedy to the ills of all schools. There is currently an awareness that there are important differences between school improvement in rural and urban schools. For instance, students from isolated rural areas often have associated language problems which contribute significantly to the low reading achievement levels of many of these students. It is therefore essential that the professionals who are responsible for selecting instructional programs for students in low performing rural schools acknowledge these ubiquitous academic problems and choose reading programs that have the greatest likelihood of providing students a successful learning experience. One approach that can be used to achieve this goal is for research designed to look at alternative methods and materials for teaching the low achieving rural student to be done so that a clearer picture will emerge as to what approaches to instruction are best suited for these students.

The major purpose of this article is to present the results of a year-long study designed to look at the effects of two highly dissimilar approaches to teaching reading to low-performing students attending a low income rural elementary school. It was our hope that by looking at both the strengths and weaknesses of various approaches to reading instruction, we could better understand how to best spearhead future curricular reform efforts designed to bolster rural schools. In addition, because the students who participated in this study were in first grade and already experiencing academic failure, it allowed for an analysis of the effects of the two reading programs on difficult-to-teach students.

The overwhelming majority of first grade classrooms use one of the major basal reading series. For a child from a home with parents having little formal education, these basals series often assume too much in the way background knowledge (Beck, McCaslin, & McKeown, 1981). This problem is of particular interest in isolated rural communities where many students have serious deficits in several academic areas. The failure of educators to match accurately appropriate instructional materials to the specific academic needs of students in rural schools is of great concern to both practitioners and parents. Reading and related language deficits are among the problem areas often identified as critical areas of school reform projects. (Nachtigal, 1982).

Because of the continuing failure of some of the more traditional curricula and instructional approaches to teach students basic academic skills in the primary

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grades, we decided to investigate the impact of using a reading program (*Reading Mastery Program*, 1986) that is unconventional in structure. This program, whose early version (DISTAR) was the core curriculum used in the Direct Instruction Follow Through Model, differs considerably from traditional basal reading programs typically used in rural school districts (Becker, Engelmann, Carnine, & Rhine, 1981). In general, the *Reading Mastery Program* is designed to provide an innovative curriculum, increase the academic engaged time of the students, and increase the amount of time given to small group instruction. At a more specific level, the *Reading Mastery Program* includes several curriculum features which differentiate this reading program from many of the basal reading programs. We felt that this type of approach would be especially successful with low income black children residing in rural areas because of the heavy emphasis of teaching basic skills.

The present study which compares the progress of two groups of first grade students–one taught with a basal approach and the other taught with a Direct Instruction curriculum–was designed to extend the research that has been reported on the efficacy of the Direct Instruction approach with low income students (Becker, et al., 1981) and to replicate some of its findings relating to rural districts which predominantly serve black students.

Method

Sample

The subjects for this study were 31 first grade students (19 male and 12 female, 30 black, and 1 white) in a rural community in the Southeast (see Table 1). The school was situated in a low income area. In a county where the Stanford Achievement Test scores usually were at or slightly below the state average, students in this school typically scored much lower than the county average, especially in the reading and language areas.

Table 1. Descriptive Charatcteristics for Both Experimental *(Reading Mastery Program)* and the Contract Groups *(Houghton-Mifflin Program)*.

	Reading Mastery (Direct Instruction)	Houghton-Mifflin (Basal Program)
Male	10	9
Female	5	7
Total	15	16
Black	15	15
White	0	1
Total	15	16

The subjects were from the two first-grade classrooms composed of students nominated by the regular classroom teachers as students who were having difficulty with reading and needing extra help. These students were randomly assigned to either the experimental group or the comparison group. Each group received reading instruction that was designed to accelerate the reading achievement of the students.

In an effort to confirm group comparability, the groups were compared using the school abilities index from the *Otis Lennon School Abilities Test* and the Total Reading Score of the *Woodcock Reading Mastery Test*. A t-test between the means of the experimental (M = 99.067) and comparison groups (M = 94.250) on the Otis Lennon showed that there was no significant difference in the IQ means of the two groups, t (25) = .690, p > .05. It should be noted that for each group, subjects' IQ levels fell within the normal IQ range. A t-test on the means of the experimental (M = 28.059) and comparison groups (M = 34.546) on the Woodcock also showed no significant difference t (26) = -1.710, p > .05.

Teachers

The comparison groups were taught by the two regular first-grade teachers. Each teacher had one university supervised practicum student. Both regular classroom teachers were experienced having each taught 10 or more years. These teachers were expected to teach the group as they normally would. This meant that the teachers follow the teacher's guide of the basal program and adhere to the instructional time allocated to their groups.

The experimental groups were taught by four masters' degree students who were participating in a practicum at a nearby university. These teachers were trained to implement the experimental program as part of their graduate program requirements. Both the basal and the experimental groups received daily instruction for the entire school year.

Instructional Materials and Methods

Although there were important differences in the instructional programs presented to the two groups in this study, several variables were equated across the contrast and experimental groups. Both the basal and the experimental group were taught for approximately 50 minutes each day of the week. Although there were occasional session interruptions for both groups (e.g., assemblies, special programs), these breaks in the schedule favored neither group. Teaching occurred from 8:30 a.m. to 9:20 a.m., for all groups. In addition, the focus of instruction for both groups was to teach the students entry level decoding and comprehension skills. This was deemed especially appropriate for these students as all students were academically behind their appropriate grade norms on beginning of the year reading measures.

Experimental group. The students in this group were taught from the *Reading Mastery Series* (1986). This program is radically different from the basal series used for the comparison group in this study in several respects. The materials are specifically designed with structured, scripted teacher presentation manuals. Nothing in the way of entry skills for the student is assumed. Students are taught every required academic skill–from left-right orientation to strategies for sounding out words and to comprehension and problem solving skills. Utilized is a synthetic phonics approach in which all skills are broken into small steps and opportunities for repeated practice are provided. The sequence of introducing new letter-sound correspondence is carefully controlled according to research-based principles of curriculum design (Carnine & Silbert, 1979). For example, the teaching of sounds or symbols which students are likely to confuse, such as "b" and "d," or "i" and "e," is separated by several weeks. The rate at which new sounds are introduced is much slower than the readiness level of most basal series. Students are allowed as much time as necessary to learn each new sound before the next is introduced.

Students are also taught to blend sounds together before they are required to sound out simple words. This practice in blending is emphasized to develop automaticity and to prevent one of the major reading problems students experience in the primary grades. Within several weeks, students begin reading simple stories and answering questions based on these stories.

The strategies and techniques used in teaching the experimental group were based on current research on maximizing achievement growth. They included: (a) teaching to mastery; (b) explicit step-by-step modeling of strategies; (c) systematic correction procedures, to enable the teacher to correct all errors effectively and efficiently and to transform student errors into positive learning experience; (d) frequent use of unison group responses; and (e) positive reinforcement and clear statement of rules and procedures.

Comparison group. The comparison groups were taught in two first-grade classrooms using the *Houghton-Mifflin Reading Series* (1983) which was the one adopted for use in the school system. Instruction was carried out daily in groups of approximately eight students. Each classroom was managed by the primary teacher and a university practica student.

The teachers closely followed the teacher's guide when implementing the lessons in the basal reading program. Consequently, as the program's teacher guide recommended, students were presented a variety of activities in ever-changing organizational structures. The basal program provided for a large number of small group activities designed to augment the more formal instruction these students received. This was in contrast to the reading program presented to the experimental group (described earlier). In the basal program, correction procedures were administered in a much less explicit manner than those used in the experimental group. For example, the following is taken from the Houghton Mifflin (1983) teacher's guide on how a teacher should correct a student's error in discriminating between various word groupings: "Have a child come and point to the word <u>lunch</u>. If a child points to the wrong word, show the child that word and the word <u>lunch</u>, one above the other, and help the child discover the differences between them" (p. 37). As can be noted the teacher is allowed great range in how to interpret this correction procedure. For example, how will teachers interpret the directive to allow the child to "discover" the difference between the words. In this correction procedure, students are not explicitly shown how to sound out the word, thereby using sound symbol relation knowledge, left to right sequencing, and blending.

Supervision and Staff Development

Prior to implementation of this study, the experimental teachers received training in Direct Instruction teaching and remediation strategies as part of their university masters program. These sessions consisted of role playing and discussion of how to implement the *Reading Mastery Program.* Practice teaching sessions were videotaped to be used to critique teaching skills as well as to document the intervention that was taking place. Once the implementation of the study began, all teachers, both those teaching the *Reading Mastery Program* and those teaching the basal program, were observed at least once a week. Following classroom observations, if the teachers were not following the specified format of the specific program, teachers were given feedback. This allowed for all teachers to implement properly their assigned reading program and ensured fidelity of each treatment.

Measurement

All students, both comparison and experimental, were pretested upon entry into the program with the *Woodcock Reading Mastery Test* which included subtests in the areas of letter identification, word identification, word attack, word comprehension, and passage comprehension. Students were again tested at the end of the school year with the alternate form of the Woodcock.

Results

Table 2 presents the posttest means and standard deviations for each group on both the Word Identification and Total Reading from the *Woodcock Reading Mastery Test.* Significant difference between the adjusted posttest means on Word Identification was obtained as indicated in Table 2. The experimental group ($M = 30.430$) scored significantly higher than the comparison group ($M = 17.070$), $F (1, 25) = 8.255$, $p < .01$.

Because all students had 0 scores on the pretest of the Word Attack subtest, analysis of covariance could not be used since this condition produces a singular matrix for main effect and covariates. Results of a *t*-test revealed significant differences on the Word Attack posttest means for the experimental ($M = 15.470$) and the comparison ($M = 1.000$) groups, $t (29) = 8.86$, $p < .001$.

In addition to the decoding measures, the students were also tested on Passage Comprehension. These results are also reported in Table 2. T-tests for independent samples were performed on the raw scores. As can be noted from looking at Table 2, the students in the *Reading Mastery Program* were significantly outperforming the comparison students who received reading instruction in the basal program.

To give the reader a better sense of how students performed at the end of the academic year, raw scores were converted to the grade equivalent scores on Woodcock Total Reading for both the reading mastery group and the comparison students. Students in the experimental group were performing at grade level 2.0, while the comparison group was approximately one-half year behind the expected level, reading at a 1.3 reading level at the end of the year. When the Passage Comprehension raw scores were converted to grade equivalent scores, the results were almost identical to the decoding outcomes. The *Reading Mastery Program* students were performing at a 1.9 comprehension level, while the students in the basal group scored at the 1.5 passage comprehension level.

Discussion

The results of this study demonstrate significantly higher achievement scores for the experimental group which was taught with the Direct Instruction curriculum as compared to the comparison students who were taught using the basal reading curriculum. This difference occurred in all areas measured–word identification, word attack, and total reading.

It is believed that several factors contributed to the significantly higher scores of the experimental group. One factor that we expect contributed to the overall positive effect of the direct instruction intervention was the curriculum used. The *Reading Mastery Program* was radically different from the basal program that the comparison group received. Some of the differences between the two reading programs that contributed were the degree of structure, the amount of practice provided, and the strong phonics emphasis.

Nothing was left to chance in the *Reading Mastery Program.* The sessions were structured so that all students were given an opportunity to respond and participate in the academic program. This was particularly true with the low performers. Because the Direct Instruction approach utilized group responding as an integral part of the program structure, lower achieving students were given many opportunities to participate and contribute to the activities in the classroom. This helped to reinforce the early learning of the basic blending and letter sound correspondences and allowed for these students to develop a mastery of the content. The result of this extensive practice was that these students were able to retain the critical reading skills of sound symbol relationships and blending.

Whereas the children taught in the Reading Mastery Group would frequently request to take their individual story books home, the children in the basal group seldom asked for extra opportunities to read. In general, this hesitancy resulted in this group of students to be much less enthusiastic about reading. Consequently, the students who were taught in the basal

Table 2. Means and Standard Deviations for Each Group's Performance on the Word Identification Subtest, the Passage Comprehension Subtest, and the Total Reading Measure on the Woodcock Reading Mastery Test.

	Group			
	Reading Mastery (Direct Instruction)		Houghton-Mifflin (Basal Program)	
Measure	M	SD	M	SD
Word Identification	30.43	9.75	17.0	10.36
Passage Comprehension	9.46	5.30	3.83	4.82
Total Reading	97.50	10.11	47.57	14.65

program had less out of class reading experiences resulting in significantly less opportunities for these children to practice their newly learned reading skills.

Evidence for this assertion is provided on the word attack subtest or the *Woodcock Reading Mastery Test.* The difference in performances on the word attack measure between the two groups was probably a result of the students taught in the Reading Mastery Group having mastered the initial letter-sound correspondences. The active responding required in the *Reading Mastery Program* probably accounted in part for the word attack differences between the two groups. It was evident that the Reading Mastery Group learned these early decoding skills and were able to apply this knowledge to sounding out new words. In contrast, the students who received instruction in the basal program had not developed a strong foundation in letter-sound correspondence. Consequently, these students experienced difficulty in effectively decoding new words. These students taught with the basal reading program were typically much more hesitant in their approach to decoding new words. Because of this, these students required teacher assistance when reading independently, even towards the end of the year.

Practice on basic reading skills in the experimental program was carefully sequenced throughout the year. This repeated exposure to key concepts, rules, and isolated facts led to mastery of often difficult-to-learn concepts. This systematic practice was not as evident in the basal program. Although students practiced key skills in the basal program, the practice was not as carefully sequenced nor as frequently provided as it was in the experimental curricula. This problem, which occurs in some basal reading programs, has been discussed by others (Beck, McCaslin, & McKeown, 1981). The failure to provide borderline students with repeated exposure to key reading skills is one variable that has been posited as a contributing factor to the reading difficulties of some students, particularly students in poor, rural school districts.

Possibly the most important feature of the *Reading Mastery Program* was the highly phonetic emphasis of this reading program. The students were provided a very strong foundation of letter-sound correspondences, blending skills, and repeated practice of the application of phonetic skills to decode words. Students were allowed to overlearn many of these core skills. This resulted in students developing an automaticity in their responding. Others have indicated the importance of developing automaticity in beginning readers, particularly learners who are experiencing some difficulty (Beck, et al., 1981).

The differences in Passage Comprehension scores which favored the students being taught in the *Reading Mastery Program* are important and warrant comment. Although the *Reading Mastery Program* has decoding as its primary early emphasis, this program provides students with systematic instruction in language development training (e.g., vocabulary development) in addition to story comprehension activities. For example, throughout the oral reading of stories, students were frequently asked comprehension questions to ensure that all children in the group comprehended the passage. If it happened that one or more students failed to answer a comprehension question accurately, the teacher would quickly provide the group with the correct answer and require that the students reread the sentence in the passage that contained the answer to the question. Then, after a few minutes had passed, the teacher would ask the question once again thus ensuring that the students were retaining the information. This approach of correcting comprehension errors is in contrast to the approach recommended in some basal programs. For example, students' errors are often handled much less directly. Teachers are often directed (by the teachers' guide) to allow the student to find the correct answer on their own with very little teacher input. It was clear to us, as we watched students in both the Reading Mastery Group and the Houghton-Mifflin Reading Group, that the less structured approach utilized in the basal program was not as helpful to the type of student often found in low income, rural areas. These students often lack the necessary language skills to work independently when attempting to correct their reading errors.

Undoubtedly, many variables impact on a successful school improvement effort in low income rural areas. The educational, sociological, and political realms interact to create a complex, but not impossible, situation to alter. Our purpose in this article was to look at one part of a school improvement effort–the identification of appropriate reading programs. We feel that if school personnel carefully consider the type of reading programs that are provided to low achieving rural students and select programs that are carefully designed for the student who frequently enters the first grade with less than adequate prerequisite language development, then the cycle of academic failure for many low achieving rural students can be broken. Clearly, the choice of one reading program over another will not be the only component that needs to be considered in school improvement efforts in low income, rural areas, but we feel it may be the foundation that other efforts can be tied. ◆

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Brief Report—*Connecting Math Concepts in Special Education*

by Lynn Helmke
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Level C of Connecting Math Concepts has been available for about a year. This report of the progress of two special education students suggests the utility of the program for at least some special education students. Both of the students received their total math program in the special education room. Student A had been receiving math instruction since second grade; Student B had been receiving math instruction since third grade. The same special education teacher had been the instructor through these years, but in the fall of 1991 *Connecting Math Concepts* C was begun. The gains for the two students in Connecting Math Concepts C are summarized below:

Stanford Diagnostic Math Test, Form G, Level: Green

Student A: Four previous years of math instruction were provided by the same teacher.

	Date: 11/91			Date: 3/92		
	GE	%	SS	GE	%	SS
Numeration	2.9	<1	<65	5.5	33	93
Computation	2.9	2	69	4.3	11	82
Applications	1.8	<1	<65	6.0	44	98
Total:	2.3	<1	<65	5.0	23	89

Student A's greatest gain was in applications, from a 1.8 grade equivalent to a 6.0 grade equivalent.

Student B: Two previous years of math instruction were provided by the same teacher.

	Date: 10/91			Date: 3/92		
	GE	%	SS	GE	%	SS
Numeration	2.9	18	86	6.0	50	100
Computation	3.5	14	84	5.2	33	93
Applications	1.6	<1	<65	2.7	5	75
Total:	2.5	8	79	4.6	21	88

Student B's greatest gain was in numeration, from a 2.9 grade equivalent to a 6.0 grade equivalent. Neither student's greatest gain was in computation.

Next school year, it will be exciting to see the growth for many more students, because *Connecting Math Concepts* will be used in all of the special education classrooms in Dubuque. ◆

Content Knowledge and Methodology in Teacher Preparation*

Michael R. Vitale
and Nancy R. Romance

Representation of the structure of content knowledge in a discipline has come to be recognized as a determining factor for both direct learning outcomes and learning applications (Muthukrishna, Carnine, Grossen, & Miller, 1990). This view holds that if instruction is to avoid producing fragmented learning outcomes having minimal transfer, it must be driven by curriculum designs that directly teach students the core concepts in a discipline–core concepts that subsequently serve as the basis for learning mastery (Carnine, 1992). By mastering the hierarchical organization of core concept relationships, students become able to use knowledge they have learned in reasoning deductively in higher order thinking or problem-solving applications (Woodward & Noell, 1992). Although such integrated learning outcomes might result from naturally occurring experiences or teacher-guided patterns of activities, given enough time, the most efficient way to insure the realization of these outcomes is through the application of instructional development processes that Gagne (1987) has referred to as "designed." When applied in a technically sound fashion, the purpose of designed instruction is to foster the same rapid rate of mastery for all students while providing the most appropriate forms of learner support for students in special populations (e.g., students at risk).

Application of the preceding perspective on curriculum (and instruction) to the preparation of teachers necessarily involves a number of complexities. Certainly, when teachers are considered as learners of the knowledge they are to teach, their instruction in a content discipline must meet the same requirements as those of their students if problem solving and transfer are to occur (e.g., see Niedelman, 1992). However, of equal importance, teachers also must gain mastery of curriculum analysis skills and instructional methods that are themselves knowledge-dependent refinements (Shulman, 1990) of more general instructional design principles (e.g., Engelmann & Carnine, 1982). Considered together, the implications of this perspective for teacher preparation are as follows:

1. Mastery of subject matter content must be an integral part of the teacher education process.
2. Improvement of teaching methods within a content area cannot be addressed independently of the knowledge structure of the discipline.
3. Discipline-specific teaching methods must be consistent with the general principles of instructional design theory.

From the standpoint of ecological validity, existing practices in teacher preparation and school instruction provide the context for research problems exploring the implications listed above. More specifically, in emphasizing content-free teaching processes, current approaches to teacher education methods simply assume that preservice (and inservice) teachers possess the comprehensive background knowledge necessary for effective teaching. Yet, to the contrary, college instruction in content areas is widely recognized as inadequate in terms of both number of courses required and quality of instruction, given the needs of teacher (e.g., Benson & Yeany, 1986). And, unfortunately, the school textbooks that stress superficial content coverage in the form "mentioning" or "browsing" are of little assistance to teachers or their students in terms of the development of the meaningful forms of understanding required for transfer and application.

With this in mind, the present chapter outlines the rationale, results, and implications of an ongoing multiyear program of research addressing the improvement of science teaching in elementary schools. The primary focus is on the development of core concept understanding in students and teachers and the effects of science knowledge upon classroom teaching in science. Although the program emphasized science education, in the long term, this research is expected to promote development of research strategies that will be useful for improving the general teacher education process across all disciplines.

Toward a Research Agenda for Improving Elementary Science Teaching

The underlying strategy of the research program integrates a general constructivist perspective of science education (Lawson, Abraham, & Renner, 1989; Shymansky, 1989; Tobin, Kahle, & Fraser, 1990) with the perspectives of two rapidly developing and highly complementary disciplines: (a) cognitive science (Posner, 1989); Resnick, 1989) and (b) instructional technology (Gagne, 1987; Larkin, Scheftic, & Chaby,

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Rationale for the Research Agenda

The dual definition of science as a body of knowledge to be understood and as a process for acquiring new knowledge presents a particularly difficult problem for science educators in terms of elementary science methods courses and inservice teacher training (Linn, 1987). From both perspectives, the mastery of core science concepts is an important prerequisite for effective teacher preparation and practice. More importantly, a general lack of science concept understanding is recognized in the literature as a major cause of the avoidance of science teaching or the reduction of science instruction to rote, textbook-based teaching methods by elementary teachers (Dykstra, 1987; Tilgner, 1990). Consistent with this condition is a corresponding body of research (Stefanich & Kelsey, 1989) documenting the negative attitudes of preservice and practicing elementary teachers toward science and science teaching.

Just as the understanding of core science concepts is required for mastery of effective science teaching skills (e.g., process skills activities, inquiry questioning, concept development) so must the science knowledge of elementary teachers be considered in the designing of research that purports to advance the theory and practice of science teaching. This position is supported by a number of different perspectives. First, recent work in cognitive science (e.g., Anderson, 1982, 1987; Gagne, 1985) has emphasized the centrality of knowledge as a basis for "strong" problem-solving expertise (vs. weaker, knowledge-free strategies), a perspective consistent with newly developing conceptions of teaching and learning (Glaser, 1990), Second, recent advancements in instructional design (e.g., Engelmann & Carnine, 1982) that offer significant potential for immediately improving science teaching in the form of teaching algorithms are highly dependent on content-based analyses of the knowledge domain to be taught (e.g., Hofmeister, Engelmann & Carnine, 1989).

Considered together, both cognitive science and instructional design perspectives imply that research pursuing significant advancements in science pedagogy and teacher education cannot be conducted meaningfully without experimentally controlling the science knowledge of teachers–a constraint that is recognized in other content domains of teacher education as well (Shulman, 1990). At the same time, because science curriculum content in elementary schools is relatively well defined in comparison to that in other curriculum areas (e.g., reading, thinking, writing, social studies), it provides a sound vehicle through which knowledge-based research on teacher education can be pursued.

In terms of gaining experimental control over science knowledge in the present research program, a unique videodisk-based technology developed by Systems Impact (Hofmeister et al., 1989) has provided a crucial methodological technique. On the one hand, the videodisk program is used to deliver direct instruction to preservice and inservice teachers in order to engender their mastery of core science concepts. In producing such concept mastery and understanding, the videodisk program serves as a treatment condition whose effects upon preservice and inservice teachers (and even students) can be investigated in a variety of applied contexts (e.g., cognitive skills development, attitude formation, problem-solving capability). In complementary fashion, the videodisk program also provides an essential methodological capability in working analytically toward the improvement of teacher preparation in science education pedagogy at the elementary school level. In this use, the videodisk program serves as an experimental tool through which levels of understanding of basic science concepts in earth science of participants can be "manipulated" in teacher education research projects. Gaining methodological control over teacher science knowledge provides the means for addressing an important range of cognitive-science-based research issues in science pedagogy, including the interaction of teacher science knowledge with effective science teaching skills.

Scope of Research Agenda: Models, Methods, and Results

This section overviews project research results in the context of data and models from a series of research studies (Romance & Vitale, 1989a, 1989b, 1989c, 1989d, 1990, 1991a, 1991b, in press; Vitale & Romance, 1988, 1989, 1990, 1991a, 1991b, in press; Vitale, Romance, & Meshbane, 1989) conducted over the past 3 years. In general, interdisciplinary concepts from science education, cognitive science, and instructional technology provide the foundations of the research program. Included among these is the fundamental assumption that the acquisition of science concepts and understanding is an actively constructive process that involves the incorporation of declarative knowledge with the development of complex cognitive skills applied as procedural knowledge. The discipline of science provides the knowledge-based objectives for science learning, while those of cognitive science and instructional design provide the foundations of approaches to science pedagogy designed to engender such learning. Thus, a key long-term objective of the research program is to provide the methodological basis to tie these three areas together.

A second key assumption of the research program is that the same science teaching model serves as a basis for both preservice and inservice education. Within this context, the underlying science teaching model for the research program views the preparation of elementary science teachers as analogous to preparation of science learners. Thus, teacher preparation focuses on the interaction of declarative science knowledge with procedural knowledge of science pedagogy implemented as forms of cognitive skills. Since such skills are considered science knowledge dependent, a key research goal is to tie forms of science knowledge in with more in-depth approaches to science pedagogy. In this regard, the use of videodisk-based instruction in core science concepts is an invaluable methodological technique. Complementing this perspective has been the initial development (e.g., Vitale & Romance, 1989) and subsequent field-testing of a classroom-based model for science teaching for normally achieving and at-risk students.

Models Underlying the Research Program

Figures 2, 3, and 4 show three conceptual models that provide the major themes for the project research components outlined in Figure 1. Detailed discussions of each conceptual model can be found in the research cited above. The purpose of including the models here is to provide an informal guide to the organization of the findings of the research studies presented in the following section in relationship to the research program shown in Figure 1.

Figure 2 represents a hypothesized interdependence between the proficiency levels developed in preservice science methods courses and core science knowledge that directly affects teachers' subsequent classroom preferences. In the absence of adequate core knowledge, science methods courses engender negative attitudes toward and poor self-confidence in science teaching that, in turn, result in the avoidance of science instruction. Specifically, the model suggests that both strong methods skills in and positive attitudes toward science teaching are highly knowledge dependent and stable. A number of experimental studies reported here focus directly on major elements of this concern.

As shown in Figure 3, the lesson preparation task of the science teacher requires whatever additions or enhancements to existing instructional resources (primarily textbooks) are necessary to engender successful learning for the student population. In turn, the

Figure 2. Knowledge and Attitude in Science Teaching: The Role of Science Knowledge and Understanding in Teachers' Attitude Toward and Confidence in Teaching Science.

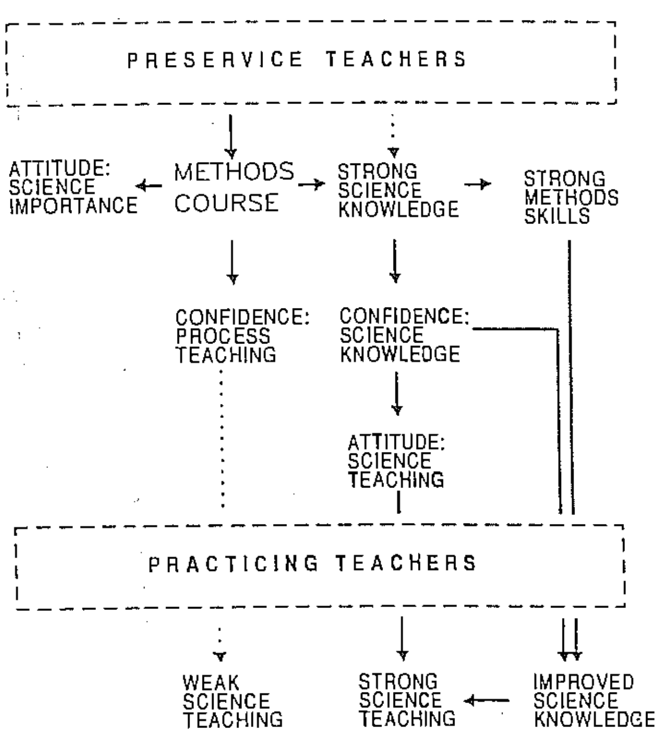
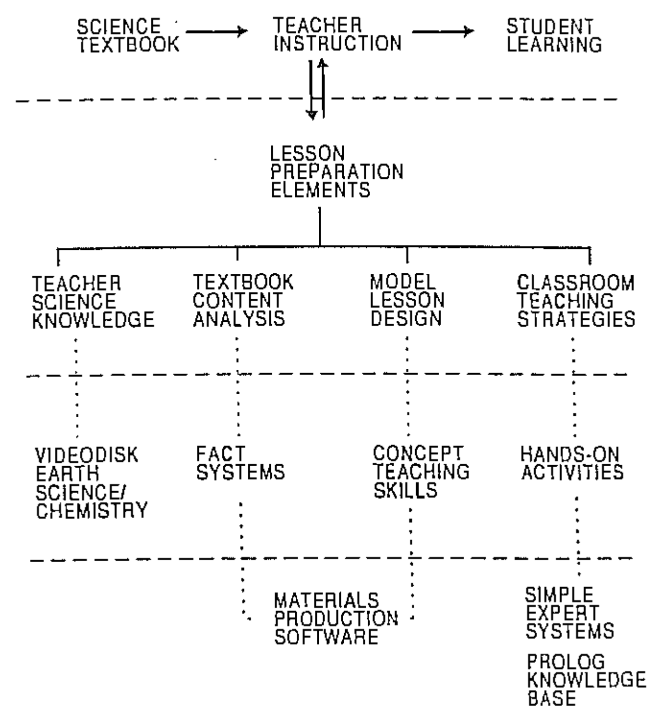


Figure 3. Science Teaching Model: The Role of the Science Teacher From an Instructional Design/ Systems Perspective.



lesson preparation task is composed of four key elements that can be considered as reflecting combinations of science knowledge with various teacher skills and/or performance categories.

In the research studies to date, lesson preparation elements have been addressed primarily in the form of "proof of concept" within inservice or preservice efforts rather than as treatments within experimental research studies. For example, in teacher training contexts, videodisk-based instruction in core science concepts was used to build teacher understanding of science that served as a basis for (a) building fact systems (or graphics organizers) as a technique for textbook content analysis; (b) using an abbreviated concept teaching model (discussed in Figure 4) to guide model lesson development; and (c) planning student activities designed for classroom use, including student science experiments, research projects, and student construction of simple expert systems and/or PROLOG-based knowledge bases. In the latter two categories of classroom activities, students used computer software environments in conjunction with their science knowledge to construct either simple consultative (e.g., a weather predictor) or information (e.g., classification data base for plants or animals) systems. Finally, teachers used graphics-oriented document production software to develop model teaching materials (e.g., graphics organizers, fact systems, concept teaching examples) based upon their lesson objectives.

Figure 4. Model Science Lesson Structure: Major Organizational Elements of Elementary Classroom Science Lessons: Curriculum Implementation, Teaching Activities, and Curriculum Planning.

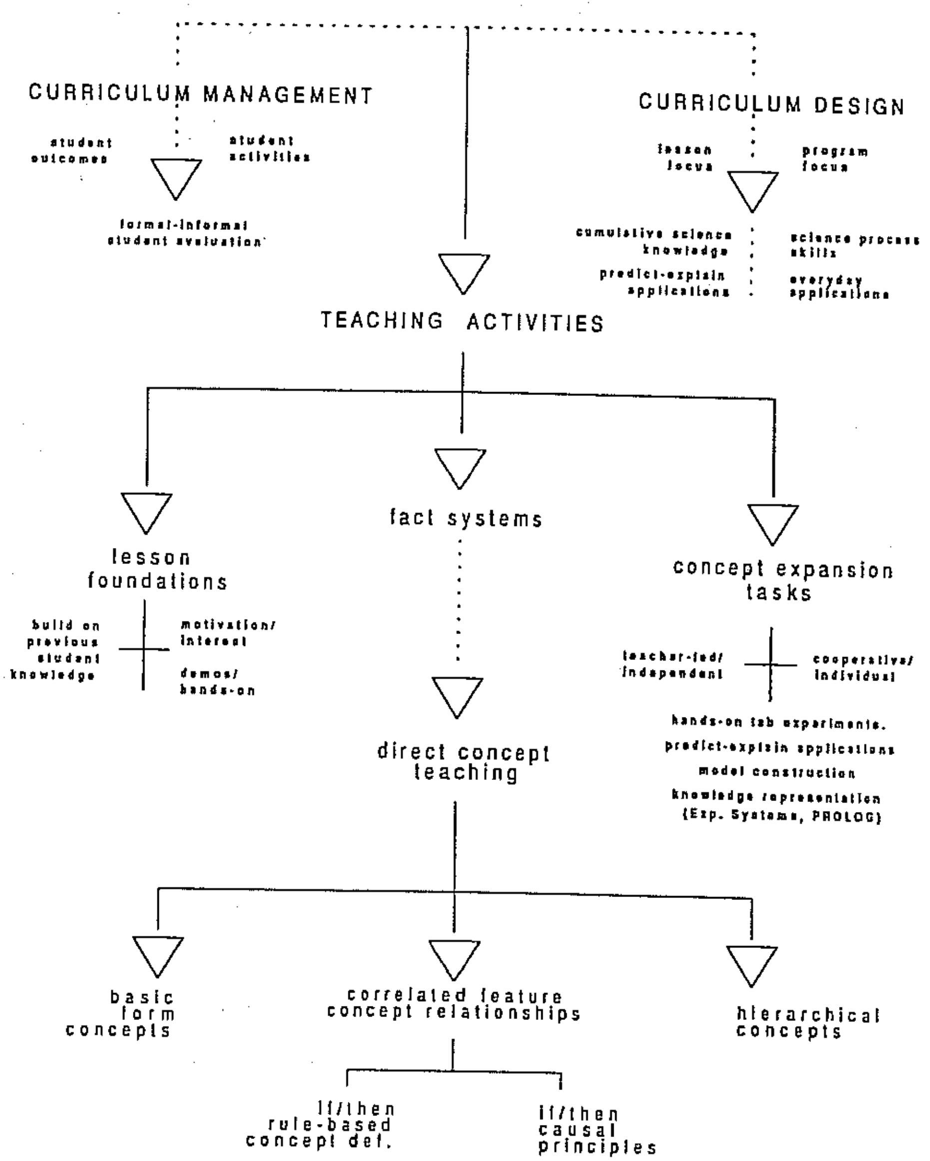


Figure 4 outlines a scheme for representing key elements of strategies for teacher-developed model science lessons in a form suitable for training or research. Although the model recognizes that teaching activities are embedded within a broader context of curriculum management and curriculum design issues, efforts to date have been limited to "proof of concept" efforts with lesson-focused teaching activities. In the model, such science teaching activities are viewed as consisting of three components: introductory lesson foundations, fact system-based (or graphics-organizer-based) direct concept teaching, and follow-up concept application tasks. In the concept teaching (middle) component of the model (shown in Figure 4), which incorporates selected elements of Engelmann and Carnine's (1982) instructional design model, teachers first develop graphic representations of science concepts and concept relationships (fact systems) to be taught that they identify in student textbooks or other resource material. Then, with master (i.e., retention) of these visual relationships as a teaching goal, understanding of the component concepts and concept relationships are pretaught (as necessary), using appropriate direct instruction initial teaching logorithms from Engelmann and Carnine's (1982) instructional design model.

Results of Selected Studies

Research Focusing on Preservice and Inservice Teacher Education. Several studies within the program have explored knowledge deficiencies of preservice and inservice teachers regarding their understanding of the physical and earth science concepts that commonly appear in the elementary school curriculum. This research repeatedly has found both preservice and inservice teachers to be deficient in intuitive understanding of the core concepts in these teaching areas. Even more alarming, given the forms of instructional materials used in elementary schools, it is virtually impossible for teachers having such conceptual knowledge deficiencies to use typical science classroom materials effectively with their students.

Given these knowledge deficiencies, a number of studies in the series have investigated whether technically well-designed videodisk-based instructional materials are effective in building mastery of core concepts in science by preservice and inservice teachers. This research has shown repeatedly that Systems Impact videodisk-based instruction can be used in a variety of preservice and inservice settings to effectively remediate deficiencies in core concept understanding in earth and physical science. More importantly, such mastery of core concepts provides many teachers with their first experience in understanding *any* science concepts. When such information is combined with training in the use of hands-on activities, teachers become empowered to teach science in such a way that they engender concept mastery and higher order thinking in their students.

The tendency of elementary teachers to avoid teaching science, a fact well accepted in the literature, provided the problem context for a number of our studies. In these studies, we explored both short- and long-term effects of instructing preservice and inservice teachers in science core concepts upon their attitude, self-confidence, and locus of control in science teaching. This research has shown repeatedly that as a result of mastering core science concepts and gaining an appreciation of science concept understanding, preservice and inservice teachers display more positive attitudes toward science teaching (including more positive teaching aspirations and less anxiety), more positive attitudes toward their own future pursuit of science knowledge, and more positive attitudes toward the importance of science in the curriculum. However, despite consistent attitude effects, teacher locus of control has not been influenced by gains in science content knowledge.

Based on the immediate attitudinal effects of increased science knowledge, another series of studies explored the follow-up (i.e., transfer) effects of mastery of core concepts in science by teachers in classroom settings. The results of this recent follow-up research with preservice teachers completing their internship have shown consistent transfer of the attitudinal effects for as long as 1 year after the completion of preservice training. In addition, during teacher interns' science teaching, they devoted more time to science instruction and used more open-ended knowledge-dependent activities (e.g., higher order questioning) than the comparable preservice controls, who reported emphasizing traditional textbook assignments. Other follow-up research with preservice and inservice teachers who have completed the videodisk program is currently in progress.

Given the importance of science knowledge and the potential of the Systems Impact videodisk-based instruction to engender it in teachers, another series of studies explored the effects of mastery of core concepts in science by inservice teachers upon their curriculum skills for analyzing textbook content and their mastery of instructional design-based concept teaching techniques. This research has demonstrated that when general education teachers gain knowledge of core science concepts, they readily can learn to analyze science textbook content for curriculum strengths and weaknesses. In addition, when these teachers identify such weaknesses, they are able to learn to remediate them using concept teaching techniques in combination with graphic organizers, in accordance with the models shown in Figures 3 and 4. Additional follow-up research with such inservice teachers focusing upon their classroom practices is presently in the planning stages.

Research Focusing on Curricular Organization for Science in Elementary Schools. One reason identified in the literature for poor science teaching in elementary classrooms has been the lack of time in the elementary curriculum that is allotted to science instruction. In an effort to provide the increased time for science required for an "in-depth" approach using curriculum integration strategies, a series of studies explored the effects of replacing basic skills (e.g., reading and language arts) instruction with expanded in-depth science instruction upon the achievement of average-performing fourth-grade students in reading and science. In these studies, in-depth science denoted a high emphasis on hands-on experiments, inquiry teaching, and extensive reading/discussion of science materials, with a continuing emphasis upon the cumulative development of concepts and concept applications.

The results of these studies have shown repeatedly that fourth-grade students for whom all reading and language arts instruction was embedded within an in-depth science program displayed improved standardized test achievement not only in science, but also in reading. Although improved science achievement was expected, the concomitant effect on reading achievement supports the view that materials with structured content knowledge–in this case, science materials–are more beneficial for upper elementary students than the traditional topic-fragmented basal reading materials typically used. In addition, the achievement effects obtained in Grade 4 have been found to carry over through the end of Grade 5. Additional research with both average fourth-grade students and fourth- to sixth-grade at-risk students is under way.

In addition to assessing the effect upon achievement, the same series of studies also investigated the effects of the curriculum integration strategy upon the attitudes and self-confidence of elementary students toward reading and science. The results of these studies have shown repeatedly that fourth-grade students for whom reading and language arts instruction was embedded within an in-depth science program displayed not only improved attitudes toward and greater self-confidence in science classroom activities, but also more positive attitudes toward reading in school and toward out-of-school science activities. Additional research in this area with different student populations (e.g., at-risk) is presently ongoing.

Encouraged by the results of the curriculum integration strategy for combining in-depth science instruction and reading/language arts, a series of studies has begun to explore the use of the strategy with at-risk students in Grades 4 through 6. The initial data available from these studies have focused upon the implications of the strategy upon the quality of curriculum content experienced by at-risk students in comparison to a general at-risk instruction based upon traditional curriculum approaches. These data have shown that the general curriculum for at-risk students emphasized the perseveration upon fragmented basic skills in reading and language using strategies common in traditional instruction, with the at-risk students, spending little or no time on science (or any content-based) instruction. Thus, despite the knowledge deficiencies typical of at-risk students, no curricular emphasis was placed on their learning important knowledge that serves as a foundation for higher order thinking. By way of contrast, the curriculum experienced by at-risk students in the in-depth science program was found to parallel that for gifted students. Basic skills instruction was addressed only within the context of science instruction that, in turn, emphasized the understanding of science concepts and applications. In addition, the expanded time available allowed extensive student discussion about concept relationships, teacher-guided higher order questioning, highly motivating hands-on science activities, and extensive reading of supporting science content trade books.

Because of the dramatic differences between the curriculum for at-risk students receiving in-depth science integrated with reading/language arts and the more traditional curriculum-based approaches, a series of studies explored the effects upon teacher perceptions of instructional content and strategies appropriate for the same target population of at-risk students. The results of these studies found that the perceptions of general teachers of at-risk students conformed to a basic stereotype of remedial instruction for low achievers. These teachers were frustrated due to a failure to achieve targeted "rates of coverage" of isolated curriculum objectives in basic skills and content areas with their at-risk students. In general, instruction was highly "rushed," with no time available for in-depth pursuit of concept understanding in any content area, an occurrence consistent with these teachers' low expectations for at-risk populations. Based on their experiences, these teachers believed that science concepts were too difficult for at-risk populations. By way of contrast, teachers of at-risk students in the in-depth science program were highly motivated due to the perceived success of their at-risk students' understanding of science concepts. The teachers reported high expectations of their at-risk students' potential learning ability. These teachers felt that addressing basic skills objectives within the context of science instruction was highly effective and that an emphasis on well-taught science concepts and concept applications could provide the most sound curriculum approach for both normally achieving and at-risk students.

As part of the curriculum integration project with at-risk students, a series of studies has begun to explore the effect on classroom practices of inservice training for at-risk teachers combining videodisk-based core concept instruction in earth science with science teaching methods. The preliminary results of this research indicate that the participating at-risk experimental teachers readily gained mastery of the core

The pattern of results from the present research program in science teaching suggests a number of important priorities in general teacher education that apply to both preservice and inservice setting. These priorities fall into two categories: curriculum analysis and teaching methods, each of which is highly dependent on teachers' understanding of core concepts in the discipline they are to teach (Carnine, 1992). Faced with less than adequate textbook and related instructional materials, teachers individually or in groups must use content knowledge and pedagogical skills to first identify key concepts to be learned and then reduce them to teachable components arranged within learning sequences appropriate for students. In this regard, particularly given the implied demands for expanded content expertise in multiple disciplines, videodisk technology meeting the instructional design standards of the earth science program developed by Systems Impact provides a unique means for mastery of different content domains by teachers as well as a strong model for curriculum analyses conducted by teachers in different content areas.

With regard to teaching methods, the present research program focusing on science supports the view that any approach to teacher education that focuses only on improving teacher knowledge or only on pedagogical skills (ignoring content knowledge) is highly limited in its potential to improve teaching. Just as research addressing both concerns within the context of changes in school curricular organization promises to improve the understanding of effective science teaching in elementary schools, answers to the above questions should allow the development of more powerful, theoretically based general teaching skills, curriculum design, and teacher preparation models for use in teacher education. The research data and perspective presented and discussed in this chapter promise to contribute toward this end. ◈

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The Missing Link in Improving Schools—*Reforming Educational Leaders*

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The general public probably believes that educational reform occurs in a manner similar to reforms in other disciplines: new knowledge is acquired through scientific means, that knowledge is widely publicized, and reform takes place. In medicine, for example, we all frequently share in the dissemination of new, scientifically acquired knowledge when *New England Journal of Medicine* articles are publicized on the nightly news. Like medicine, education has its professional journals, full of ostensibly scientific articles. Unlike medicine, however, educational practice is rarely subject to even marginal scientific procedures for verifying effectiveness, much less rigorous scientific method. When educational knowledge is to any degree scientifically based, dissemination of such knowledge is poor, and frequently has little influence on practice.

The absence of a scientific perspective in education perpetuates wide-spread failure that endangers public education. The analysis to be presented in this essay is not intended as a new excuse for the failure of educational reform, but as a call for an added tactic—to transform the culture of education, to move it from a dogmatic to a more scientific outlook. Objective evaluations and scientific inquiry are essential in building professional knowledge and tools that teachers can employ to better educate their students—to improve the quality and quantity of interactions in school. This transformation is complex and enormous, largely because educational leaders themselves must be the target of the reform instead of being considered at the vanguard of reform.

Educational Leaders Should be the Target of Reform

The columnist James Kilpatrick (1991) offers a conventional critique of education—deteriorating performance accompanied by lame excuses:

> The SAT Scores for 1991 came out a few days ago, and what do you know: The verbal scores of high school seniors hit an all-time low. Scores on the mathematics part of the exam declined for the first time since 1980. The response from the educational establishment was predictable: same song, umpteenth verse.

Kilpatrick also blames the typical culprits:

> Looking at these miserable results, some educators were honest enough to lay the blame squarely where it belongs—upon the teachers, principals and administrators of the public school system, and also upon the permissive parents of a generation gone morally and intellectually soft.

Making Teachers the Scapegoat is Unfair and Futile

Pushing teachers and principals to the forefront of reform and later making them the scapegoats has been a strategic blunder for those seriously interested in reform. Teachers and principals often have little to say about the educational approaches a school is required to implement. When these approaches turn out to be inept or only marginally effective, teachers are blamed—for doing what they were required to do. Unfortunately, the educational leaders who have the power to set these requirements are guided primarily by dogma—current fads.

Dogma in Education is Common Around the World

It's important to realize that the challenge of reforming teaching and learning is world wide. The following quote is from an article by Daniel Mkhonto, a Black South African educator:

> I could not believe when I was going through some adopted U.S. basals how they also did not teach what they purported to teach. The discovery method is used in many of these books. But the teacher does not know what is to be discovered, who must discover it, or how this discovery is done. . . . The teachers ask endless questions, for which the children have no answers. The result of these methods is failure, frustration, drop-outs, and a need for real instruction.
>
> I was surprised to find that these poor discovery methods are also widely recommended in American schools. I had thought that these poor methods were pushed on Blacks as a result of apartheid, and that the good methods were used in White schools. When I found these methods are also used in American white schools, I was shocked. I remember what I said to an American colleague—that apartheid in my country has done us harm, because all the good methods of teaching

> were done by South African Whites. I still remember what she said: "No, we use these same poor methods in the U.S., although we are White and educated by Whites. Here, it is not apartheid but a matter of learning and research—the irresponsibility of a system that allows the use of methods that don't work." I was startled and without further comments.

"A matter of learning and research"—this is at the heart of all professions and is what will eventually make education a true profession. Just as every professional baseball player was once a rookie, every true profession was once merely an occupation.

Pre-professionalism is characterized by dogma. A scientific knowledge base to give the practitioner expertise and confidence is lacking. Consider medicine. Initially, the income of a doctor was determined by salesmanship—his bedside manner. It was patient-centered medicine; a client-centered occupation. According to the dogma of the time, the doctor asked the patient what he or she thought would be a good remedy! When a practitioner doesn't have an agreed-upon body of knowledge for solving problems, the practitioner defers to the client.

Medicine was Once Dogmatic like Education

One of the revolutionaries who ushered in modern medicine did so by moving from dogma to science. Several hundred years ago, the standard treatment for battle wounds was boiling oil. During one battle, this physician ran out of boiling oil. To the rest of his patients, he administered salve. This was not remarkable. What set him apart from his colleagues and their dogma was what he did next. He actually went to visit his patients to see if there were differential effects for boiling oil and salve. The evaluation of different approaches helped medicine on the road to science.

The Need for Professionalism in Education

Let's review the development of educational thinking, beginning with excerpts from a math textbook and a language arts textbook:

> Changes in the methods of instruction in our schools and in the modes of transacting business have made it necessary to revise (this text) . . .

> What children are interested in, and what they may easily be led to be interested in, determined the nature of most of the lessons here presented. Many of these lessons are suggestive, and in the hands of a good teacher may be enlarged or otherwise modified to suit the environment and development of the pupils. . . .

The math text was published in 1877; the language arts text in 1898. The thinking and methods today are substantively the same as in the 1800s. The lack of a scientific perspective has prevented the development of a body of valid and agreed-upon knowledge that allows educators to be effective service providers. Instead, educators rely on the prevailing dogma—deferring to the students to select, construct, and in general solve their own educational problems—client-centered learning.

Curriculum Reforms Resemble Abandoned Fads

Dogma leads educators in circles. For example, in mathematics education, from 1900–1935, the focus was on skills for solving problems of everyday life. This emphasis was faulted for being too narrow. Thus from 1935 to 1958, meaningful arithmetic and problem solving characterized by experimentation and discovery (now called constructivism) came to the forefront. Next came the "new math," with a new content focus but a continued emphasis on discovery (constructivism). "The primary emphasis [of new math]," said Irving Cowle (1974), "is on insight and comprehension, *not* meaningless manipulation and reciting by rote. We want thinking, reasoning, and understanding, rather than mechanical responses to standard situations" (p. 71). However, critics such as journalist Richard Martin (1973) pointed out that, "There is one slight hitch: many of these kids can't add, subtract, multiply or divide."

The reaction was a "back-to-basics" movement. Now "back to basics" is passe, replaced by a return to discovery (constructivism) in the new standards of the National Council of Teachers of Mathematics. Such cycles characterize many social movements (e.g., temperance movements in the U.S. have occurred in the mid-1800s, the late 1800s through the early 1900s, and most recently beginning in 1979). When such cycles dominate an occupation such as education, however, dogma prevails and professionalization is impossible to achieve.

Several examples of dogma comes from the National Council of Teachers of Mathematics Standards (1989).

National Council of Teachers of Mathematics Likens Itself to Food and Drug Administration

Near the beginning of the NCTM standards, the authors stated they were protecting the American public from shoddy practices, just as the Food and Drug Administration does. The standards included provisions that dictated the best method for instruction. Were these mandates based on scientific research in which the method is tried out with students? This statement from the same document answers that question: It "suggested the establishment of some pilot school mathematics program based on these standards to demonstrate that all students—including women and under-served minorities—can reach a satisfactory level of mathematics achievement" (p. 253). Yet these recommendations are now being implemented in many school districts across the country. Can you imagine the Food and Drug Administration approving a drug and mentioning that it would be a good idea to try it out at some later time to show how wonderful it is?

National Council of Teachers of Mathematics Admit That Their Recommendations are Largely Untested

As the authors of the NCTM standards admitted, their recommendations had, in fact, never been systematically tested in any school. As an afterthought, they suggested the idea of trying out the recommendations. The suggestion eventually took hold. The following quote is from the May 1991 *News Bulletin* published by NCTM:

> Forty-eight participants at an NCTM Research Catalyst Conference held 8–10 March have begun studies in six focus areas related to the *Curriculum and Evaluation Standards for School Mathematics*. (emphasis added).

How can the NCTM have a set of standards published in 1989 that are based on ten years of research and yet not begin research on those standards until 1991?

Another example of a dogmatic approach involves the NCTM's insistence on manipulatives. A videodisc fractions program that the U.S. Department of Education's Program Effectiveness Panel had certified as being exemplary in its effects on students' learning did not feature manipulatives, because it was video-based. A mathematics curriculum specialist working from the NCTM Standards responded in this way to a teacher's request to pilot the program: ". . . No mention is made of hands-on manipulatives which are so important to the mathematics program, in particular to the areas of algebra and ratios. . . . For the above reasons, it is my opinion that a pilot of this program through the Curriculum Department would not be in keeping with the instructional direction we are undertaking at this time." The fact that it was an effective teaching tool was irrelevant.

Educationally Correct Thinking Outweighs Research

Similarly, an August 1991 National Council of Teachers of Mathematics review of a research study on the order of presentation of algorithms noted that the results of the research study were contrary to the position of the National Council of Teachers of Mathematics. Accordingly, an anonymous reviewer rejected the study:

> Ten years ago there was considerable discussion and interest about order and how the order of presentation of algorithms affected learning. In 1991, the mathematics education community has agreed . . .

The research findings were irrelevant because the mathematics community's dogma had already decided on the "correct" order for presenting algorithms.

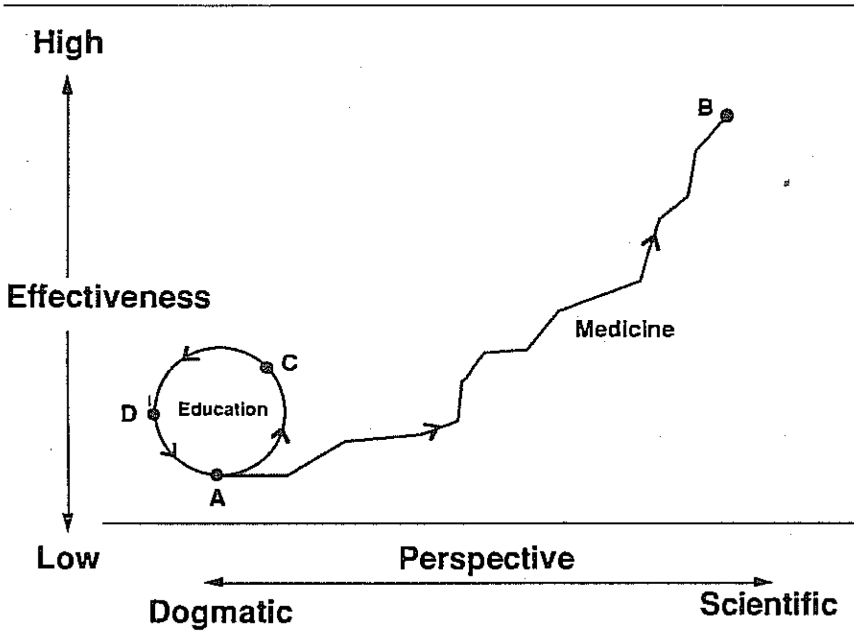
The practice of relying on dogma is not confined to mathematics instruction. A second example comes from the California State Board of Education's mandated "best method" for language arts in first grade—the teaching of reading, in particular. In 1988, the State Board of California issued a document spelling out the characteristics mandated for beginning reading programs. As is often the case in education, "research" for this method was based primarily on opinion rather than data. A review of scientific research related to this mandated method for teaching beginning reading in first grade found no research support for the mandate (Stahl & Miller, 1989), which is affecting the instruction that tens of thousands of students receive.

Unfortunately, some educational leaders are not content to ignore research; they actively discourage research. A California law requires that before instructional materials are adopted, they must be tried out with students and then be revised, based on problems the students had. The California State Board of Education explicitly refused to comply with this law, stating that the 1976 law "... is not to be considered as part of the criteria for recommending materials to the State Board of Education" (p. 15). For explicitly ignoring the 1976 law and other reasons, a judge recently ruled that the State Board's procedure allowing untested curricular methods to be adopted was illegal (Long, James L., Judge of the Superior Court, 1989). The California State Board's response to the judge's rule was this: It threatened to sue the California Attorney General if he attempted to enforce the judge's ruling!

Educational Leaders Rate Blank Book as Above Average

An incident reported by noted physicist, Richard Feynman (1985), when he served on a commission of the California State Board of Education to evaluate textbooks, illustrates the pervasiveness of dogma in education. A math textbook with blank pages was sent to the commission members. Six of the ten members actually gave the book a rating of "above average," even though all the pages were blank.

Figure 1.



The differences in the evolution of education and medicine is illustrated in Figure 1. Both fields started out at point A, a state characterized by decision-making based on dogma and a resulting low level of effectiveness. The acquisition of a scientific perspective has enabled medicine to rise to a new stage characterized by higher effectiveness and decisions based on what has proven effective (Point B in Figure 1). An overreliance on dogma has contributed to a circular movement (Points C and D in Figure 1) of recycled fads that has stunted growth in the effectiveness of education.

Dogma Asserts "One Best Method" for All Students

Dogma is particularly counter-productive in the context of the changing demographics of American public schools: more children than ever before are poor, are of different races, come from fractured families, receive special education services, and speak different languages. In contrast to this acceleration in student diversity, educational leaders continue promoting the faddish "best methods" that have gained popularity and are recommended for all students and, in many school districts, mandated without any prior knowledge of relative effectiveness. Reyes (1991) refers to this as a "one size fits all" mentality. For example, the National Council of Teachers of Mathematics, in its new teaching standards (1991), insists that its "progressive" teaching methods applies to all students. These are the students who should be taught according to this "best method":

- Students who have been denied access in any way to educational opportunities as well as those who have not.
- Students who are African American, Hispanic, American Indian, and other minorities as well as those who are considered to be a part of the majority.
- Students who are female as well as those who are male.

- Students who have not been successful in school and in mathematics as well as those who have been successful (p. 4).

The disillusionment felt by minorities about such imposed "progressive" methods is captured by Delpit, in her *Harvard Education Review* article (1988):

> Several Black teachers have said to me recently that as much as they'd like to believe otherwise, they cannot help but conclude that many of the "progressive" educational strategies imposed by liberals upon Black and poor children could only be based on a desire to ensure that the liberals' children get sole access to the dwindling pool of American jobs. Some have added that the liberal educators believe themselves to be operating with good intentions, but that these good intentions are only conscious delusions about their unconscious true motives. One of Black anthropologist John Gwaltney's (1980) informants reflects this perspective with her tongue-in-cheek observation that the biggest difference between Black folks and White folks is that Black folks *know* when they're lying! (p. 285)

Consequences of Dogma are Particularly Severe for At-risk Students

The sense of alienation is further articulated by Reyes (1991), who studied a carefully implemented progressive method for teaching reading. He found that Hispanic students didn't seem to benefit. Instead of feeling like

> . . . "members of the literacy club" as Frank Smith (1986) refers to readers, the students wrote comments in their journals and literature logs like: "I hate reading," "The book is too boring and too long," or "Please tell me a bit about the book so I'll know what it is about." These revealed that the students were outside the club. The students provided many hints that they needed help in mastering the literacy tasks, but their pleas went unheeded by the teachers who felt that it was only a matter of time before the kids would get the hang of it. The process needed time. The teachers hesitated "imposing" their expertise in the selection of books. They advised students to keep trying, that they would eventually find a book of their liking (p. 4).

The contradiction between one correct educational method and incredibly diverse students' educational backgrounds is not limited to race or even income. Special educators have long lamented that typical educational practices are not meeting the needs of persons with diverse abilities (Lloyd, Singh, & Repp, 1991). Thus, Delpit's allegation that the "progressive" method might be fine for Liberals' children, but not for poor Black students, might be extended to poor Hispanic students and special education students.

These examples of dogma are not the only evidence of educators' lack of a scientific perspective—a perspective which leads to knowledge and tools that define a profession. Educators are not subject to a legal standard of competence, as are other professionals; e.g., in malpractice suits, courts have ruled that education lacks a body of agreed-upon knowledge that is required for legal accountability. Professionalism entails not only rights but also obligations, one of which is to acknowledge, define, and own up to malpractice.

Education Lacks Legal and Professional Accountability

In addition, educators are not subject to routine internal review, as are other professionals. Medicine has autopsies; law has appeals courts; engineers have boards of inquiry. Nothing comparable exists in education. In fact, just the opposite perspective often prevails. Alessi (1988) reviewed over 5,000 teacher-generated analyses of students' learning problems. In every case, the learning problem was related to the student or family deficiencies. Not one student problem out of 5000 was said to have resulted from professional error.

These structural omissions—legally recognized competence and institutionalized reviews of competence—result in large part from the dogmatic perspective of educational leaders. The more immediate consequence of dogma is the limited professional knowledge that makes educational tools (teaching practices, textbooks, computer programs, and so forth) relatively ineffectual. This notion of tools is broader than just books or software. In this broad sense, for example, diagnostic procedures in medicine are tools, including not only particular instruments, but also the ways in which they are used.

Without potent professional tools, in this broad sense, what can be expected of teachers as a group? Try to imagine a surgeon repairing a hernia, given only a set of tableware and a bottle of aspirin. This analogy draws into question the reasonableness of accountability in the absence of professional tools. It is neither fair nor productive to hold teachers accountable when the developers and transmitters of the professional knowledge used by teachers and principals are guided by dogma. Teachers and principals are responsible for applying the knowledge of the profession, not deriving it.

Toward an Agenda for Professionalizing Education

Many organizations and individuals are working with various plans to make teachers and principals accountable for adequate student learning. Clearly, fair and effective accountability procedures for teachers and principals are necessary.

Educational Establishment Should be Held Accountable

However, if teachers are to be held accountable, then the educational establishment must be held accountable for providing relevant knowledge and the viable professional tools that would derive from that knowledge. Overlooking the failure of educational leaders to provide these tools continues to undermine reform efforts on a large scale.

A major thrust of educational reform should target those responsible for providing knowledge to teachers. Some specific target organizations and groups are:

School district curriculum specialists
State textbook adoption committees
National curriculum organizations
Superintendents
Educational publishers
Teacher and administrator certification programs
Educational researchers
Teachers' unions

These stakeholders are virtually ignored as targets in school reform efforts. They continue to operate with impunity and in no way are accountable for their pronouncements and mandates; i.e., there is no accountability and no quality control. How can those responsible for developing and disseminating a professional knowledge base be made accountable? Clearly, this is the central question. The following suggestions regarding these target groups are only preliminary, a departure point for a concrete, plausible, and effective agenda for professionalizing educational leaders.

Abolishing Curriculum Positions is Better Than Maintaining Dogma

1. School district curriculum specialists are responsible for evaluating curricular material. In many cases, these individuals do not make decisions based on the effectiveness of curricular material, but rather on its popularity. To prevent current abuses that result from curriculum specialists making dogmatic decisions, schools, districts, and state departments might consider simply eliminating the post and transferring the funds to the research department. Any large-scale implementation, such as adoption of a new basal series or a new method, should be preceded by procedures to assure the validity of the approach. Such validation is best done by persons without prejudices. For the present, curriculum specialists should not be allowed to mandate any program that has not been learner verified, or forbid the use of any program that has been validated.

2. In some states, textbook adoption agencies have the responsibility of ensuring that teachers in an entire state receive tools that reflect standards of decency, accuracy, and effectiveness. Although these agencies were created to protect the public, their actual utility is questionable. As indicated earlier, they traditionally have not judged programs from objective standards of how well programs have worked with students, but instead have relied on expert "opinion" and dogma. One suggestion is simply to eliminate state adoption agencies and let local districts make their own decisions, which is currently the case in about 30 of the 50 states.

School Children Deserve Protection as Much as the Spotted Owl

3. National curriculum organizations aggressively promote content, instructional assessment, certification, and staff development standards for each discipline. For example, the National Council of Teachers of Mathematics hired a public relations firm and spent hundreds of thousands of dollars to promote the new

standards. As illustrated earlier, these organizations often make decisions based on the prevailing dogma. One possible course of action is to develop a coalition of concerned advocacy groups, such as The Business Roundtable, Children's Defense Fund, American Psychological Association, Mexican American Legal Defense Fund, NAACP, etc., to monitor standards for teaching to determine the extent to which they are research based and based on student outcomes. This scrutiny might make school districts more hesitant to adopt unproven methods.

4. Superintendents are responsible for helping set and implement the priorities for a district. The processes they use to make decisions about teaching and learning set a model for other educational leaders in the school district. Unfortunately, in large districts, superintendents tend to have little time or energy for instructional issues; keeping a large school district in business is a daunting challenge. A recent headline in *Newsweek* captured the current dilemma—*"Miracle workers wanted—More and more big cities can't find anyone to run their schools."* Many superintendents shuttle from one district to the next. One urban superintendent who was fired for fiscal mismanagement is now a finalist for becoming the superintendent of a much larger district. Another urban superintendent was fired after two years when he could not obtain an accurate count of the number of students enrolled in his district.

One response to the problem of obtaining competent managers for large urban districts is to hire a manager from outside education who understands and can implement quality control and accountability systems. These managers need not have an educational background; an assistant superintendent for instruction could help link the management practices to teaching and learning measures. Of course, hiring non-education managers is not an end in itself, merely a possible means to institutionalizing quality control measures. Superintendents, regardless of their background, need both the authority and responsibility to improve student learning and should be held accountable for that learning. A possible course of action to make all superintendents more accountable for teaching and learning is to have school boards require superintendents to take a vow to endorse or mandate a new program only after it has been tried out on a small scale in the district or it has been systematically evaluated elsewhere.

Superintendents Should Take the Lead in Promoting a Scientific Outlook

To help educational leaders hold to this vow, parents, school board members, and community leaders should respond to all instructional reform suggestions with this question:

"How do you know it will work?"

If the answer is, "We have research," respond in this way:

"Tell me about the research, but no jargon, please." Some sample questions to ask:

- Was the research valid, e.g., were the variables effectively controlled?
- Does the instructional reform have consistently positive effects?
- Will its results lead to a substantial improvement over our current practices?
- Was the research conducted with students similar to the students who will receive it here?
- Were the measures appropriate?

The next questions have to do with training and monitoring. An approach may work in the hands of a great teacher, but may not be something that an average teacher is able to implement. Here are possible questions:

- What are the procedures to ensure that teachers receive adequate training to implement the approach?
- How will teachers and students be monitored to ensure that students are succeeding?

5. Educational publishers produce and sell most of the tools used by educators. Textbooks are designed to be complete in their coverage of the discipline and to be attractive to teachers. One marketing survey found the single most important characteristic in the purchase of math textbooks was the attractiveness of the art. Basal textbooks used in the elementary schools are not field-tested and revised based on their effectiveness with students. In almost every case, the actual textbooks are not even written by people who were trained as educators or who have worked as teachers.

However, publishers are extremely responsive to the marketplace. When a substantial number of educators begins purchasing instructional material based on effectiveness, many publishers will adapt and textbooks will incorporate more effective practices. It is possible that no particular action is needed for publishers, given the assumption that they will incorporate reforms endorsed by the educational establishment. Those endorsements will have to be perceived as serious and long lasting; publishers have to respond to many special interest groups and, because of the 20 to 40 million dollars required to develop and market a basal textbook series, they are quite reluctant to make major changes.

If Colleges Cannot Prepare Competent Teachers, Maybe School Districts Can

6. Teacher certification programs control who will be allowed to teach. Colleges of education have not been particularly successful in preparing teachers to work effectively with a wide spectrum of students, especially at-risk students. One possible reason is that the faculty in the colleges of education are often oblivious to the consequences of the methods they advocate. The monopoly held by college certification programs on preparing teachers makes reform extremely difficult. One possible course of action is to establish a national advisory board with representatives from mature professions, such as medicine, engineering, and law. The charge of the board would be to review the certification process for teachers and make recommendations for improvements. Pilot programs could also be explored, e.g., closing some colleges of education and transferring the resources to exemplary school districts, which would assume responsibility for certifying teachers following the "teaching hospital" concept, with prospective teachers working with many groups of students over a period of several years, as do residents in a hospital.

7. Educational researchers are responsible for producing most of the scientific knowledge that can serve as a basis for the development of professional tools for educators. The areas of inquiry that interest researchers are often irrelevant to making informed decisions about effective practices. For example, huge educational movements, such as whole language, affect literally millions of students; yet the movement is largely ignored by researchers. The greatest concentration of research funding goes to the educational labs and centers. One possible course of action is to coordinate research funding with relevant trends in education, collaborating with school districts to evaluate new ideas on a small scale before the idea is mandated for millions of students. Legislation is being considered by the Food and Drug administration "to protect consumers from health-endangering diet plans promoted by misleading and deceptive ads that are a scam on the American public." Even the spotted owl benefitted from mandated environmental impact studies. Yet, no one is even discussing true protection for American students from mind-endangering fads. Researchers can contribute greatly to creating a scientific perspective in education and thereby help protect students from harmful fads. (Problems relating to educational leaders' lack of interest in research can be ameliorated by instituting accountability procedures, such as those discussed here.)

Researchers Should Help Answer Pressing Questions

8. Teachers' unions are responsible for representing the interests of teachers. Teachers' unions can be at the forefront of the struggle for professionalism by not allowing teachers to be scapegoats for the failures of educational leaders. Teachers' unions can (a) educate their members in how to seek methods that have been scientifically validated, (b) pressure school districts to implement small-scale tryouts of programs before installing larger-scale implementations, and (c) press for accountability at the administrative levels.

Focusing the Agenda—Learner Verification

All of the suggestions given in the prior section focus around one central theme—the concept of learner verification—that educational tools, in a broad sense (i.e., teaching practices, textbooks, etc., that comprise a particular approach or method), must be tried out and then revised, based on the results obtained with students. Improvement in student performance has to be documented, along with the range of effectiveness of the tool indicated by the types of students involved (e.g., to what extent were at-risk students included? How well did they perform?); and the feasibility of the tool, in terms of training requirements, ease of use, and cost.

Learner Verification is a Way to Identify Effective Approaches

Actions of reformers, in education and out of education, could make learner verification their focus. For example, the business and professional community could work with universities and educational publishers. A national commission composed of representatives from acknowledged professions could be convened to review teacher preparation. One important focus would be the role of learner verification in methods and materials courses taught in certification programs.

Business leaders can work with educational publishers to seek ways in which learner verification can be carried out in a cost-efficient manner, especially for at-risk populations.

Agencies that represent at-risk children could play a prominent role in being the advocate for at-risk students, ensuring that learner verification is fundamentally integrated into all reform plans.

Groups of all types could lobby state legislators to require learner verification for curricula material that is to be adopted. The primary targets might be California and Texas, for these reasons:

(a) They have the most influential state-wide adoption policies, because of market size.

(b) They have agreed to jointly develop curriculum standards, which would increase their influence.

(c) California already has learner verification legislation, although it is being intentionally ignored. Efforts to make learner verification reliable and manageable might help change California's attitudes.

This paper has presented suggestions for opening up a new front in the movement to reform education. Hopefully, the common goal of moving from dogma to a scientific perspective, exemplified by learning verification, can result in the alliance of many groups with different interests, both inside and outside of education. The formation of a national organization devoted to infusing science into education could be a valuable resource in working to transform the culture of education.

The Educational Establishment Needs a Watchdog

Such an organization would require a board of directors and a staff. The board would set priorities, suggest courses of action related to each priority, and oversee staff implementation of the suggestions.

The staff would gather the information needed for each set of suggested actions, then make phone contacts, give presentations, prepare press releases and make a newsletter, and so forth.

This paper has suggested a new front in the effort to reform education. Reactions and recommendations from you will help determine what happens next.

Conclusion

I am an educator, without any experience in building organizations to further school reform. I do, however, recognize the need to try to move the educational establishment away from dogma to a more scientific perspective that could lead to professional tools which would empower teachers and, in the process, benefit students.

Any attempt to reform American education that ignores or bypasses the educational establishment and works with individual schools (e.g, the America 2000 Plan and many others) is shortsighted. Ultimately, central administrators, university professors, professional organizations, and educational publishers shape the thinking of teachers and principals. The development of model schools, while an essential component of any comprehensive reform effort, will not by itself lead to a more scientific perspective in education.

Educational Reform is Still a Slogan

William Raspberry, the syndicated columnist, explained why reforming individual schools is, in the long run, short-sighted. In *Are Educators Even Looking for Answers?* he wrote, ". . . But pitifully few school districts are sending their administrators to observe and learn from these successes. Few principals even send teams to visit the more successful schools in their own hometowns. Indeed, few teachers even bother to wander across the hall to learn from a more successful colleague. It may well be that getting the best out of our children will require the reorganization and reform of our schools. But before we embark on that tricky path, wouldn't it make sense to try to reproduce the success that some schools are already achieving?"

The bureaucracy of educational leaders has repeatedly promulgated fads as reforms and continues to do so. For example, the 1988 California Framework recommended heterogeneous grouping of students for instruction. The public, as represented by Paul Greenberg, a syndicated columnist, viewed this action with derision. "The newest approach is to throw kids together regardless of ability or knowledge; it is assumed that the superior knowledge and skills of the sharpest will rub off on the rest. Uh huh. This is the kind of assumption that would make Pollyanna look like a hard-bitten cynic. If it weren't so dangerous and destructive, the notion would be charming for its sheer naivete. As George Orwell once said of another fashionable idea: One has to belong to the intelligentsia to believe things like that; no ordinary man could be such a fool.... But seriously, folks, does anyone really think that eliminating a level of learning is going to automatically raise standards? If that were so, all the schools need do is erase all levels but the highest and, bingo, they'll have instant excellence" (p. 3c).

At this time, there are no incentives for the educational leadership to move from dogma to science. Educational leaders pontificate while the teachers get the blame. The Soviet Union finally realized that its problem was not with the specifics of its newest five-year plan but with the system that generated the plans. Americans may come to a similar realization, that educators have been coming up with "new" solutions for at least 50 years, and that the current promises give little more hope than a new five-year plan. Change is possible, however, beginning with sustained, intense, concrete actions to encourage a scientific outlook on the part of educational leaders.

Good Intentions are not Enough

Non-educators must play an important role in transforming the culture of education by pressuring educational leaders to adopt a scientific outlook. Educational leaders have to respond. Because they do not have an agreed-upon knowledge base, they are not empowered to protect themselves from outside meddling—every group in the country feels comfortable telling educators how they should do their job. Thus, non-educators can wield enormous power in changing the culture of education by championing specific policies. These policies should not target teachers, but rather the educational leaders who are responsible for developing and disseminating professional knowledge and the tools that derive from that knowledge.

The development of professional tools is not the complete answer to successful reform. It is, however, one indispensable ingredient. At present, we do not even know how potent education as a true profession could be in overcoming other societal adversities, such as poverty, abuse, and so forth. With professional tools, it will become clearer what educators can and cannot do. From those experiences, society can better decide what additional resources are needed and how they can best be utilized.

Medicine was once guided by the dogma that patients knew best, primarily because practitioners didn't know very much. Today, many educators believe that the students know best. Education will change, just as medicine has. An 1889 physiology textbook had a full page of advertisements for miracle-cure drugs. Such advertisements cannot even be published in the U.S. today. Someday, miracle-cure educational ads, such as those for "Hooked on Phonics," will be looked back upon as an oddity, just as the advertisements for miracle-cure drugs of the 1800s are now.

Moving From Dogma to Science is Painful

However, this scientific revolution will be no easier for education than it was for biology and medicine. Claude Bernard, considered to be one of the fathers of modern medicine, was accused of reducing biology and the mystery of life to the banality of a machine. He gained immortality in *The Brothers Karamazov* when a character shouted "Bernard" as a term of derision for the mechanistic spirit of science. But as Campbell (1986) pointed out:

> Bernard's unique contribution to science and thought was to show that life is not governed by a collection of laws that fit together according to human logic, but by laws that need to be looked at in the light of nature's logic, which is quite a different thing. What seems absurd to us may not seem absurd to nature (p. 46).

America's educational leaders, particularly in light of the growing diversity in our schools, have an obligation to pursue nature's logic. This responsibility is owed not only to teachers and their students, but to the country as a whole. Such a pursuit is more difficult in education than in medicine, in part because the goals of education seem endless and at times contradictory. While these difficulties can thwart the pursuit, they should not be seen as excuses to abandon it. The circles of dogma form an inexorable whirlpool. ◈

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