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ABSTRACT

This study sought to determine whether or not student teachers who were trained and required to use a data-based problem-solving approach in their practicum classrooms would obtain higher levels of pupil achievement in reading and mathematics than student teachers who did not receive the training. Student teachers (N=23) were randomly assigned to practicum placements in elementary special education programs for pupils with mild learning handicaps. Thirteen of these student teachers received training and supervision in data-based instruction which involved teaching the student teachers to identify important learning problems, design and implement effective instructional interventions, and make valid assessments of short-term academic gains. Pretests measuring reading and mathematics abilities and off-task behavior of pupils were administered during the first week and after the eighth week of student teaching. The focus of the study was on the achievement of the mildly disabled students. The majority of the pupil achievement data indicated that the student teachers who were trained and supervised in the implementation of the data-based approach provided generally more effective instruction. (CB)

The Effectiveness of Data-based Instruction by Student Teachers in Classrooms for Students with Mild Learning Handicaps

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The Effectiveness of Data-based Instruction by Student Teachers in Classrooms for Students with Mild Learning Handicaps

Student teaching is generally regarded by both preservice teachers and teacher educators as a crucial component of teacher training programs. For teacher trainees, practice teaching helps to allay their concerns as to whether or not they could actually conduct instruction. Student teaching, thereby, helps to affirm the trainee's choice of an occupation (Lortie, 1975). Teacher educators often express higher expectations for the student teaching practica. Teacher educators frequently consider that the purpose of the student teaching experience is to provide teacher trainees with the opportunity to apply principles and procedures of effective instruction that presumably were presented during the academic portion of their preservice training program. Given the general importance and goals that teacher educators attach to student teaching practica, it is reasonable to consider that pupils who receive instruction from student teachers should benefit from their experience, and that pupil achievement should be regarded as an important indicator of effective performance by the student teacher.

Teacher trainers and researchers interested in preservice teacher education have rarely addressed the effectiveness of instruction provided by student teachers as indicated by measures

of pupil achievement. The student teaching experience itself typically appears to be, as Lortie (1975) suggests, a short activity which is more apt to contribute to the socialization of the prospective teacher than to substantially increased teaching skill. Both student teachers and teacher educators tend to be generally focused upon process variables. Considerably less attention is given to the influence that student teachers have on their pupils' achievement. Researchers have been similarly occupied with process variables. When researchers have investigated the effectiveness of instruction delivered by student teachers, they have substituted more proximate indicators of successful teaching such as supervisor evaluations for more direct measures of student achievement. Despite the lack of evidence supporting the ultimate value of student teaching experiences, teacher educators, policy makers and the public frequently argue for an increased reliance upon field based experiences in order to improve the preparation of prospective teachers. Contrary to popular wisdom, it appears that student teachers may gain as much teaching sophistication in eight weeks as they do in 16 weeks (Davis, 1976). There is also reason to question the value of student teaching and other field-based experiences (Berliner, 1985; Feiman-Hemser, 1983; Griffin, Barnes, Hughes, O'Neil, Defino, Edwards, & Hukill, 1984; Lortie, 1975). Given the concern for the quality of novice teachers and

the current impulses to lengthen and otherwise modify field experiences it is not premature to study the effects of instruction provided by student teachers upon pupil achievement.

Although researchers of preservice teacher education have not addressed pupil achievement, a very encouraging body of research on the relationships of teacher behavior and student achievement has been accumulating (see Brophy, 1979). Gage (1984, p. 22) considers, "It would be nice if the evidence on improving the performance of teachers through the use of research-based teaching practices could be drawn from the work in regular preservice teacher education programs."

In his review of issues related to research on the effects of teacher behavior Brophy (1979) observed that by the late 1970's it became apparent to classroom researchers that:

> Although there may be a few truly universal instructional principles (match level of instruction to student ability), there do not appear to be any universal teaching competencies (i.e., specific behaviors such as praising or asking higher level questions) that are appropriate in all teaching circumstances.... Teachers must not only master particular skills they must know when to use them. (p. 735)

One approach for dealing with changes in the contexts of instruction is based upon Dewey's (1904, 1933) philosophy. Dewey considered that student teachers should not seek (or be provided with) ready solutions to instructional problems. Instead they should develop analytic problem-solving skills for planning and evaluating their teaching. Dewey (1933) considered that an effective problem-solving approach requires that a teacher who encounters an instructional problem engage in: observation, data collection, hypothesis generation, and hypothesis testing in order to resolve the instructional difficulty.

Although the process described by Dewey (1933) has been suggested by teacher educators as a basis for helping teachers become more rational and self conscious about their instructional decisions, his suggestion does not appear to have found wide application during the past 50 years. Studies by Borg, Kelly, Langer, and Gall (1970) and Brophy and Good (1970) indicate that teachers are often unaware of their teaching behavior. Fuchs and Fuchs (1984) observed that special education teachers tend to rely upon rather unsystematic observations of student performance, and consistently overestimate their students' achievement. It may be that teachers are less rational and less accurately informed about the processes and effectiveness of their instruction than might be hoped.

Moore and his colleagues (Moore & Schaut, 1978; Moore, Schaut, & Fritzges, 1978) implemented a teacher training program based upon Dewey's (1933) problem-solving approach to instruction and provided teachers with feedback on their performance. The procedures followed by Moore and his colleagues emphasized a rational and self-conscious approach for identifying and dealing with learning and behavior problems (see Moore, 1978 for greater detail of his procedures). Moore et al. (1978) observed that teachers who received training in the problem-solving approach and feedback demonstrated: (a) greater awareness of their own behavior during instruction, (b) greater control of the instructional process, and (c) higher proportions of on-task behavior from their students than did the teachers who did not receive the experimental training. In a one year follow-up study Moore (1979) observed that the effects were enduring.

There are three limitations to the validity of generalizations from the results of studies by Moore and his colleagues with regard to the effectiveness of preservice special education student teachers. First, the studies by Moore and Schaut (1978) and Moore et al. (1978) did not directly examine the effects of their problem-solving approach on academic achievement. Their evaluations of teacher effectiveness are, therefore, proximate. Second, although the problem-solving approach used by Moore and Schaut (1978) and Moore et al. (1978)

has much in common with the procedures advocated by classroom researchers in special education (e.g., Deno, 1985; Lovitt, 1981), the teachers in those studies were from regular classrooms, not special education programs. Third, the teachers in both studies by Moore and his colleagues were experienced nonprobationary teachers, not novice trainees.

Fuchs, Deno, and Mirkin (1984) trained a group of teachers of learning disabled students to use a data-based approach for evaluating student progress and instructional interventions in reading. Their approach emphasized frequent collection and evaluation of technically sound curriculum-based data for purposes of diagnosing learning problems, prescribing interventions, and monitoring student achievement. Fuchs et al. (1984) observed that teachers who were trained to use the data-based procedures: (a) obtained higher levels of student achievement, (b) were more aware of the instructional needs of their students, and (c) demonstrated greater control of instruction compared to the teachers who did not receive the training. Although Fuchs et al. (1984) demonstrated the effectiveness of data-based approach to instruction on student achievement in a special education context, the teachers in their study were also experienced inservice teachers - not preservice trainees. A more general limitation of the study by Fuchs et al. (1984) is that the measures of teacher effectiveness were based

only upon three or four students from each teacher's class. The students were selected by the teachers (see Fuchs, Deno, & Mirkin, 1982a). Fuchs et al. (1982a, 1984) do not provide a discussion of either the pupil selection criteria, or of whether or not the data-based procedures were used with all students in the classrooms or merely directed toward the students used in the study. A demonstration of the general effectiveness of the procedures would require the application of the procedures to the entire class. Demonstrations with only subsets of the pupils in a class are limited in their generalizability.

The procedures followed by Moore and Schaut (1978), Moore et al. (1978) and Fuchs et al. (1984) have implications for the training and evaluation of preservice teachers, however, generalizations from the three studies are limited by context differences. Furthermore, the training periods provided in those studies were longer than is generally possible in a student teaching experience. Teachers in the studies by Moore and his colleagues participated in once-a-week training sessions for six weeks, implemented the procedures, and were provided feedback for another six weeks. Fuchs et al. (1984) trained their teachers in the principles and procedures of curriculum-based program modification for approximately two months. They observed the teachers' implementations and measured pupil performances over a five month period. It has not been demonstrated that the

relationship between preservice coursework and the generally shorter period of time allowed for student teaching experiences are sufficient to allow for a demonstration of the effect of instruction by preservice teachers on pupil achievement.

The major purpose of this study was to determine whether or not student teachers who are trained and required to use a data-based problem-solving approach in the instruction of all pupils in their practicum classrooms would obtain higher levels of pupil achievement in reading and mathematics than student teachers who did not receive the training. Secondary purposes of the study were to (a) examine the relationships between the use of data-based problem-solving approach to instruction and the student teachers' allocation and control of instructional time, and (b) assess the student teachers' perceptions of the utility and acceptability of the data-based teaching procedures when applied in the context of instructing children with learning handicaps.

Method

Subjects

Twenty-eight student teachers were randomly assigned to practicum placements in elementary special education programs for pupils with mild learning handicaps. They were then randomly assigned to treatment conditions. Unfortunately it was not possible to use all of those student teachers in this study.

Because of objections by cooperating teachers or administrators in four schools, it was not possible to include three student teachers assigned to the comparison condition and one student teacher assigned to the experimental condition in the study. A fifth student teacher was dropped from this study, because her cooperating teacher was training her in the implementation of a data-based approach to instruction that very closely resembled the treatment provided in the experimental condition. Thirteen student teachers received training and supervision in data-based instruction, and 10 were assigned to a comparison condition. For all but one of the student teachers in each group, the evaluations of student teacher performance were based upon measures of achievement and behavior of pupils who had regular class placements in the third through sixth grades, and received instruction for at least four weeks. The remaining two student teachers had placements in elementary level self-contained classrooms for students with mild mental retardation. Students from those two classrooms were eligible for the study, if they could read orally at a rate of 50 words per minute from a beginning level second grade reader. The numbers of pupils in each sample ranged from three to 10 for the experimental group, and one to 10 for the comparison group. In both groups, most samples were composed of three to five pupils.

Prior to participation in the study all the student teachers had completed course work in elementary education methods and in special education methods. The instructional methods coursework in the elementary education program would be aptly described as eclectic, as would the language arts course in the special education methods block. The special education courses in math methods and behavior management were behavioral, and dealt extensively with the principles and procedures of applied behavior analysis and direct instruction.

All of the student teachers had completed short supervised practica in both regular and special education settings in conjunction with their instructional methods coursework. Half of the student teachers in each group had an additional 8-week student teaching experience in either a regular elementary classroom, a classroom for students with mild mental retardation, or in a program for students with severe mental retardation.

Measures

Several measures were used to evaluate the effectiveness of instruction by the student teachers. The instruments were not shown to or discussed with the student teachers or cooperating teachers. Pretests were given during the first week of the student teaching experience to all pupils who had regular classroom placements of third grade through sixth grades. Posttests were given at the end of the eighth week.

Passage reading test. The passage reading test was used for pre- and posttest assessments of oral reading. The test was a modified version of the one used by Fuchs et al. (1984). It was comprised of five passages from the Ginn 720 basal reading program. Two of the passages were drawn from the second grade level basal reader and the remaining three passages were drawn from the third grade level reader. Individual pupils read aloud for one minute from each of the five passages. Performance was measured in terms of the average number of words correctly read from the five passages. Previous studies cited by Fuchs et al. (1984) provided information on the adequacy of the psychometric characteristics of a version comprised of third grade passages. Test-retest reliabilities ranged from .93 to .96 (Fuchs, Deno, & Marston, 1985). Estimates of concurrent validity with the word identification and passage comprehension subtests of the Woodcock Reading Mastery Test ranged between .54 and .92 (Fuchs, 1981). Fuchs et al. (1984) observed that measures of internal consistency (Cronbach's alpha) for the three passages was between .66 and .79.

Arithmetic computation test. A test of arithmetic computations was used to measure pre- and posttest performance in computational mathematics. The test was comprised of 52 computational problems which were arranged by operation and in order of ascending difficulty according to the task analyses

developed by Silbert, Carnine, and Stein (1981). The test was administered to the entire group of eligible students in four separate timed sections according to the different mathematical operations. The pupils were told they could check their work if they completed a section before the time limit was reached. They were not permitted to proceed to the next section of the test. A KR-20 estimate of internal consistency of .96 was obtained in a pilot study.

Reading comprehension. A reading comprehension test was developed based upon procedures described by Slavin and Karweit (1984). The reading comprehension test was composed of items from two reading passages from Level 13C and three passages from Level 14C of the California Achievement Test. Every other item associated with the passages was eliminated. Additional items were eliminated, if they were items that LD students in a previous study (Jones, Barnette, & Callahan, 1983) appeared to frequently guess. The final version of the test contained one sample item and 17 test items, most of which assessed literal comprehension skills. The test was administered to the pupils as a group during the eighth week. They were allowed 30 minutes to take the test. The raw number of correct responses was used as the measure of reading comprehension.

Off-task behavior. Measures of off-task behavior were gathered through direct observations of students during the

eighth week of the study. Observers obtained a schedule from each student teacher indicating the times that they were providing teacher-led instruction to each pupil. Based upon that information they visited each student teacher's classroom at a time that allowed them to observe instruction being provided to a randomly selected pupil. Each pupil was observed for 10 minutes in both seatwork and in teacher-led instruction. Off-task behavior was defined as: walking, playing, talking to either the teacher or a classmate about matters unrelated to the instruction, waiting, looking about the room, and noncompliance. A pupil was scored as being off-task, if engaged in an off-task behavior for a whole five second interval. If the pupil was engaged in an off-task behavior for less than the full five second interval the behavior was considered to be momentary and the student was scored as being on-task for the interval. An audio cassette tape with ear plug was used to cue observers to changes in observation intervals. Neither the student teachers nor the pupils in the classroom were aware of the nature of the observations or which pupil had been targeted for observation.

Teacher questionnaires. Two questionnaires adapted from an earlier study by Fuchs, Deno, and Mirkin (1982b) were administered at the end of the eighth week of the study. The first questionnaire was administered to the student teachers in both treatment groups. It referred to the instruction provided

to a pupil picked at random by the experimenter. In every case the questionnaire referred to a child with whom the student teacher had worked for four or more weeks. Student teachers were asked to provide information on: (a) the nature of instructional materials used, (b) the amounts of time that were allocated to different instructional activities, and (c) the types of information that they found most useful for evaluating student progress. A second questionnaire on the acceptability of the data based problem-solving approach was administered only to the student teachers in the experimental condition.

Procedures for Supervision

Comparison group. Student teachers in the comparison group were supervised by faculty supervisors. Supervisors were required to make a minimum of four supervisory visits, however, depending upon the individual needs of the student teachers some supervisors made more than four visits per student teacher. Supervisors provided the student teachers with feedback based upon their observations. They also provided four seminars, during the eight weeks, for the student teachers. The seminars dealt with various issues including: instructional procedures, techniques for classroom management (e.g., Assertive Discipline) and job interviewing skills.

Experimental group. Like their peers in the comparison group the student teachers who were trained in the

problem-solving approach participated in seminars, were observed, and were provided feedback by their supervisors. However, the difference in the focus of the problem-solving approach to teacher training resulted in substantial differences in the content and processes of the supervision and training provided to the student teachers in the two conditions.

The focus of the data based problem-solving approach was primarily upon the achievement of special education pupils who received instruction from the student teachers. The development of diverse instructional aids (e.g., games, learning centers, and special media products) was given little attention, unless a logical relationship between the skills addressed by those products and the individual learning problems of the pupils could be identified. Instead, student teachers were encouraged to evaluate the effectiveness of their instruction according to observable changes in the achievement of the individual pupils.

In order to increase the probability that student teachers would be able to: (a) identify important learning problems, (b) design and implement effective instructional interventions, and (c) make valid assessments of short-term academic gains, student teachers were required to gather data on the progress of individual students toward instructional goals in reading and math. All students in the experimental condition gathered data on: (a) fluency in oral reading, (b) vocabulary skills, and

(c) reading comprehension. Student teachers were also required to make frequent observations of student performance in mathematics. The observations of academic performance were typically made three times a week, but no less than twice a week. The observational data were recorded on time-series graphs with anecdotal comments. Whenever nonacademic behaviors such as inattention, talking out, or noncompliance were believed to present significant obstacles to academic growth, data on those behaviors were gathered and used in the assessment and planning of interventions and instruction. Student teachers were required to refer to the graphs to evaluate the effectiveness and efficiency of their instructional interventions.

Student teachers in the experimental condition had three 2-hour seminars that took place during the first week and one-half of the practicum experience. The seminars were used to present the rationale and procedures for the problem-solving approach to instruction. Four major topics were addressed in the seminars: the rationale and characteristics of the problem-solving approach, data collection, evaluation of behavior change, and the principles of direct instruction.

Student teachers in the experimental condition were supervised in instruction at least once each week. Supervisory visits lasted one to two hours. The supervisors reviewed the organization and logic of instructional activities, and

frequently used behavioral observational techniques such as event recording and time sampling techniques to assess the instructional process. Feedback was provided immediately after each observation session. During the individual conferences the supervisor and the student teacher reviewed not only the observations of teaching behaviors and observed pupil reactions to those behaviors, but also the student teacher's records of pupil performance for all individual students. Thus, supervisory evaluations in the experimental condition dealt explicitly with the results of teacher interventions as well as with the inputs and processes of instruction.

The supervisory process used by Moore and his colleagues (Moore & Schaut, 1978; Moore et al., 1978; Moore, 1978) was used in this study. Feedback was presented in the context of a rational discussion. Supervisors refrained from directly offering solutions to specific problems. Instead the supervisors used probing questions to elicit the problem-solving process from the student teacher. For example, in the early part of the practicum several student teachers did not use the model-lead-test approach that is characteristic of direct instruction (see Becker & Carnine, 1981). In some of those cases the supervisor observed what appeared to be high proportions of guessed responses. In such instances he said to the student teacher, "I noticed that you always waited until the student answered your

question. How effective did that technique appear to be?" If the student teacher considered that the technique had contributed to excessively high proportions of incorrect responses, the supervisor then asked what alternative procedures might be more effective. If the student teacher indicated that responses were unprompted because the purpose of the session was to test mastery or retention of the skill and not acquire the skill, the supervisor accepted the explanation and went on to the next observation. If the student teacher could not provide a rational explanation for learning problems, or could not adequately justify or evaluate the instructional procedures being used the supervisor would take a more directive role in the feedback discussion. In those cases the student teacher was also encouraged to put more effort into developing skills of: identifying learning problems, designing instructional programs and behavioral interventions, and evaluating the efficiency of interventions in order to become more proficient at implementing the problem-solving process.

Whenever instructional interventions were made, the student teachers were required to note the change on the graph and evaluate the effectiveness of their intervention over subsequent sessions. Student teachers were expected to become independent in the problem-solving approach. They were expected to make changes in their instructional programs whenever student

perfc mance data indicated that a given change was appropriate. It was not necessary for them to wait for a conference with their supervisor.

Data Analyses

Student achievement data. Student teachers (not pupils) were randomly assigned to the experimental and comparison conditions; therefore, "student teacher" was the unit of analysis. An initial MANOVA of the pretest oral reading and arithmetic computation test scores did not reveal significant differences between the experimental and the comparison groups (see Table 1). The posttest scores for reading accuracy, reading comprehension, and the arithmetic computations were analyzed with a MANOVA. One-way ANOVAs follow-ups were used to examine the differences in reading test performances between the two groups. The reading accuracy pretest scores were used as the covariate for the analysis of reading comprehension posttest scores.

Allocated and engaged time. Self-report data on the amounts of time devoted each week to the teaching of oral reading, vocabulary, and reading comprehension were analyzed by one-way ANOVAs. One-way ANOVAs were also used to test for between-groups differences in the percentages of observed off-task intervals during (a) teacher-led instruction and (b) seatwork.

Instructional procedures. Nonstatistical comparisons were made regarding the extent to which student teachers in the two groups reported using commercially prepared versus teacher-made materials. Likewise the responses on the teacher questionnaire were compared to determine the preferences that student teachers in each group had for different procedures for planning and monitoring instructional interventions.

Results

Student Achievement

The descriptive statistics for the pre- and posttest measures are presented in Table 1. A repeated measures ANOVA revealed a significant group/test-time interaction for passage reading (df 1,19; $F=14.15$; $p < .001$). Both groups were comparable on the pretest, but the student teachers who used the data-based problem-solving approach to reading instruction obtained significantly higher levels of words correctly read per minute on the posttest than student teachers in the comparison group. There was no change in the oral reading performance over the eight week period for the comparison group. Differences between groups on reading comprehension were analyzed with an ANCOVA with oral reading pretest scores as the covariate. The analysis revealed that performance on comprehension test was significantly higher for the experimental group than the comparison group (df 1,18; $F=4.52$; $p < .05$). There was no difference between groups

nor was there an interaction for the repeated measures ANOVA for math computation.

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Insert Table 1 about here

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Allocated and Engaged Time

Student teachers in the experimental condition reported that they allocated more time for oral reading activities (df 1,13; F=4.25, p < .05). No between groups differences were found for the percentages of allocated instructional time that student teachers reported devoting to teacher-led instruction or vocabulary or reading comprehension (see Table 2).

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Insert Table 2 about here

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One-way ANOVAs of the data for direct observations of off-task behavior during teacher-led instruction revealed that student teachers who used the problem-solving approach obtained significantly lower rates of off-task behavior than student teachers in the comparison group (df 1,16; F=8.38; p < .05). Table 3 reveals a similar difference between groups for off-task behaviors during seatwork was also significant (df 1,16; F=9.18; p < .05).

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Insert Table 3 about here

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Instructional Procedures

Most of the student teachers in both groups made greatest use of the commercially prepared materials available in their classrooms. Relatively small amounts of the instructional materials used by student teachers were crafted entirely by either the student teachers themselves or their cooperating teachers.

A very clear between-groups difference was found in the proportions of student teachers who used systematic and frequent observations of pupil performance for planning and evaluating their instruction. All of the student teachers in the experimental group used the data-based instruction procedures with all of their students. None of the student teachers in the comparison group used such procedures. Informal observations appeared to be the primary source of information on pupil progress used by student teachers in the comparison group. Student teachers in the experimental condition reported that the data-based procedures were very helpful in monitoring instruction, planning interventions, and communicating with other teachers and their supervisors.

Discussion

This study provides evidence that training and supervising student teachers of pupils with mild learning handicaps in the use of a data-based problem-solving approach to instruction results in generally more effective instruction than would be observed as a result of a more conventional regimen of training and supervision. This study permits three additional observations that are of importance to the training and evaluation of preservice student teachers. First, the results obtained in this study are consistent with the results of previous studies in which inservice teachers were trained to use data-based instructional procedures (Fuchs et al., 1984; Moore et al., 1978; Moore & Schaut, 1978). This study demonstrates that the procedures for training inservice teachers, and for evaluating the effectiveness of their instruction, were generalizable to the training and evaluation of preservice teachers - despite (a) the relatively short period of time available for the student teaching practica, (b) the student teachers' lack of experience, and (c) the fact that the student teachers were required to use the data-based problem-solving approach with all pupils in their classrooms. Second, the data clearly suggest that unless student teachers are, at least initially, required to frequently and systematically gather and use data on student achievement, they probably will not do so.

Instead they are likely to rely upon informal and unsystematic observations of pupil performance--even though they received training and practice in systematic data-based procedures prior to their student teaching practicum. Third, it appears that student teachers who used the data-based problem-solving approach to instruction regarded the procedures as valuable for planning and evaluating instruction, and communicating with others about the progress of individual students.

The conclusion that student teachers who were trained and supervised in the implementation of the data-based approach provided generally more effective instruction is based upon data from two sources. The first and most direct source of information is pupil achievement data. Student teachers in the experimental group obtained significantly higher pupil achievement scores on tests of oral reading and reading comprehension. The demonstration of the relative superiority of the experimental condition did not, however, extend to arithmetic. Comparisons of pupil achievement data in arithmetic computation did not reveal a significant difference between the two treatment groups. Although the failure to observe a difference between the two groups on math achievement was contrary to initial predictions, it is not inconsistent with the general conclusion of this study or previous studies.

During the course of the study it became apparent that reading instruction received considerably more attention and energy from both the student teachers and their cooperating teachers than did mathematics instruction. It was also apparent the mathematics computation was not consistently dealt with through teacher led instruction. Computations were typically presented as seatwork tasks. Teacher-led instruction often dealt with a variety of math skills such as story problems and applications as well as computational drill and practice. Although the student teachers of pupils with IEP goals in mathematics, did gather data on pupil performance in mathematics their records tended to be disjointed because the different skill areas were not addressed on a continuous basis throughout the student teaching experience. The data-based approach would require that instruction be provided for each of those skills, and performance must be assessed on a frequent basis (about three times weekly). In summary, the data-based approach to instruction of arithmetic computation was not adequately implemented in the experimental condition and, therefore, not be expected to produce higher levels of pupil achievement in mathematics for the experimental condition than in the comparison condition. That interpretation is consistent with Coladarci and Gage's (1984) interpretation of the results of their study of the

effects of minimal interventions by observers on teacher behavior and student achievement.

It is also possible that the instrument itself was inadequate. Although it is a reliable test, it only evaluated achievement in computations and, therefore, was narrow in scope. The test was limited to computational skills, because previous experience suggested that computational skills are frequently emphasized in special education programs--almost to excess. More work should be done to develop measures of mathematics achievement that will be sensitive to small academic gains, and will also provide an assessment of a broader range of skills than computations. Such an effort would be ambitious, but it is obviously preferable to either excessive intrusions by the student teaching supervisor into the program established by the cooperating teacher, or forcing the instructional program to be responsible to the instrument used to evaluate it.

Data on (a) the allocations of instructional time, and (b) control of engaged time provide a second and more proximate indication that the data-based procedures contribute to more effective instruction. The self-report data on the proportions of time allocated for teacher-led instruction offer some support (albeit very modest support) for the notion that requiring student teachers to focus their attention on pupil achievement is apt to result in program modifications that would contribute to

improved achievement. The observations of off-task pupil behavior offer more substantial evidence that student teachers in the data-based condition exerted greater control over instruction than did student teachers in the comparison condition. Pupils in the experimental condition were off-task for significantly less time during both teacher-led instruction and seatwork than pupils in the comparison group. The limited resources available for this study did not allow for assessments of: (a) interrater agreement, (b) the development of control over the eight weeks, and (c) the relationship between the student teachers' control of off-task behavior and achievement. Although off-task behavior, as defined in this study, is not difficult to observe with high levels of interrater agreement, future investigations should assess the agreement between observers.

While it appears that the between-group differences in pupil achievement and control of instruction may be attributed to differences in treatments provided by the student teachers in the experimental and comparison conditions, it is not possible to determine precisely which variables contributed most to the relative superiority of the experimental condition. The treatment was a package. There are several variables that alone or in concert may have contributed to the observed differences.

First, in the experimental condition, the supervisors' strong emphasis on pupil achievement required that the student

teachers be consistently oriented toward academic goals. Prawat (1985) reported that teachers tend to place inordinately high priorities upon affective goals. The teachers who most consistently emphasized affective goals were less effective than either (a) teachers who demonstrated more balanced orientations of cognitive and affective goals, or (b) teachers who demonstrated relatively greater orientation toward cognitive goals. Fuchs, Fuchs, and Deno (1985) reported that the ambitiousness of goals set by teachers was positively related to achievement. This study did not assess either the relative importance that the student teachers attached to cognitive and affective goals, or the ambitiousness of their goals, but it was clear during the course of the study that the student teachers in the experimental condition displayed higher levels of concern for the academic achievement of their pupils than student teachers in the comparison condition.

Second, the systematic collection of academic achievement data by student teachers in the experimental group quite possibly improved the accuracy of their assessments, and the quality of their instructional decisions compared to the student teachers in the comparison group. Fuchs and Fuchs (1984) observed that teachers and teacher trainees generally tend to rely on unsystematic observations of student performance, and consistently overestimate the success of their instruction and

levels of student mastery. Since none of the student teachers in the comparison condition systematically gathered frequent assessments of pupil performance, it is likely that similarly inaccurate judgements were frequent and may have contributed to less effective instruction and consequently lower levels of pupil achievement than were obtained by the student teachers who used the data-based approach.

Third, the collection and frequent review of the pupil performance data may have contributed to the higher levels of pupil achievement obtained by student teachers in the experimental group by making them more reflective and thoughtful than they would have been if they had merely been exorted to increase pupil achievement. Dewey (1904, 1933) discussed the importance of reflection to effective teaching. The descriptions of procedures provided by Moore and his colleagues (Moore et al., 1978; Moore & Schaut, 1978) placed considerable emphasis on the importance of reflection and rational explanation. Discussions by Fuchs et al. (1984) seem to attach more importance to frequent and systematic collection of pupil performance data. It is clear, however, both the collection of data and reflection upon its significance were probably important to the superiority of the experimental treatments in all three studies. It would be informative to study the practices adopted by teachers and student teachers who are required to focus their attentions upon pupil achievement,

but not directed in the use of data-based problem-solving strategies.

A fourth variable that may contribute to generally more favorable outcomes obtained by the student teachers who used the data-based approach to instruction is the role of the supervisor. In the comparison condition supervisors generally based their evaluations and feedback upon informal observations of the student teacher in an instructional situation, and upon consultation with the cooperating teacher. The value of such supervision is limited because student teachers are rarely observed by their supervisors in the same context with the same pupils over the eight week period. Furthermore, the feedback they did receive may have been of dubious validity because of the data upon which it was based was apt to have been of marginal quality. Supervisors of the student teachers in the data-based problem-solving condition based their feedback primarily upon direct observations of instruction and reviews of graphed pupil performance data. Both supervisors in the experimental condition considered that they were considerably more aware of the performance levels of all of the pupils taught by their student teachers than they had been in previous experiences of supervision. It is likely that the quality of feedback was higher for supervisors in the data-based condition, because they were more accurately informed of the learning and behavior

problems of individual pupils than were the supervisors in the comparison condition. Thus, they were in the position to give better counsel to their student teachers.

The task of accounting precisely for the causal factors in this study would be a very complex and expensive process. It is probable that the contributions of the four variables discussed above interact with each other in a complex set of relationships. It would be informative to conduct a program of field research, focused on those alterable variables, to evaluate the importance of each and its relationship to the others. Such component research is suggested by Slavin (1984) as a productive approach to research-based instructional improvement.

Researchers interested in teacher education have neglected the effects of instruction provided by preservice teachers on pupil achievement. Katz and Raths (1985) identified 11 categories of variables that constitute teacher education programs, and should be studied by researchers of teacher education. Their categories of variables may be generally classified as being primarily related to either goals, inputs, processes, or products. Researchers of preservice teacher education have frequently examined relationships among variables from the first three categories. On the other hand, researchers have rarely examined the relationships among those first three categories of variables and the products of instruction provided

by preservice teachers. If the mission of preservice teacher education programs is to provide the schools with well trained teachers, then it is reasonable to include outcome measures such as pupil achievement as important indicators of successful teacher training. Certainly measures of pupil achievement gains should not be unduly emphasized in the preparation of novice teachers. Some students are very difficult to teach. For such children the task of producing academic gains would be formidable even for the most experienced and proficient teachers.

Outcome research in preservice teacher education will benefit greatly from the development of assessment devices that are valid for the assessment of relatively small academic gains. Research on the development of curriculum-based measures at the Institute for Research on Learning Disabilities at the University of Minnesota has made important contributions to the evaluation of teacher effectiveness, but considerably more research needs to be done. One issue that should be investigated is the relationship of a series of one-minute oral reading exercises to the construct of literacy. Certainly the ability to translate a passage is correlated with reading ability, but oral translation should not be considered to be synonymous with reading. Oral reading proficiency is a sign of reading ability and a very sensitive sign. The practice of observing behaviors that may best be considered as signs of a construct rather than samples of

the construct is common in behavioral research, but not without problems. Jacobson (1985, p. 305) argues:

> Unless the observational measure is demonstrably nonreactive, or at least easily distinguishable from skills taught in therapy, it will be impossible to disentangle sensitivity from demand. If clients change on both observational and alternative measures, observational measures are superfluous as outcome measures; if change is confined to observational measures, the discrepancies are usually uninterpretable.

It is doubtful that the oral reading tests used in this study could be demonstrated to be nonreactive. On the contrary, the oral reading tests appear to be reactive to demand. Their sensitivity to instruction may be, as Jacobson (1985) argues, a spurious indication of achievement.

At present the oral reading tests appear to be useful, but should be regarded cautiously. Oral reading samples should not be used as the only criterion for evaluating the effectiveness of instruction. The more traditional measures will be necessary for interpretability. If teacher trainees use oral reading samples for their assessments, they should also gather data on comprehension and vocabulary skills. Otherwise the researcher may be faced with uninterpretable data at the conclusion of the study. The advancement of research on the effects of instruction

provided by student teachers will be markedly advanced by the development of nonreactive measures that are samples of academic achievement, and are sensitive to relatively small gains. From Brophy's (1979) discussion of the importance of the instructional context, it is apparent that the task of developing such measures will be a formidable one. Researchers and test developers must pay close attention to differences in populations, subject matter, instructional objectives, and other aspects of the settings.

Future studies of teacher effectiveness should also address the issue of the acceptability of the training procedures. No matter how effective the procedures are teacher trainees will not use them any longer than they are required to do so, if they find the procedures unacceptable. On the other hand, teachers and student teachers may become committed to the use of instructional procedures after they use the procedures and observe them to be effective in raising student achievement. Gersten and Guskey (1984) observed that teachers, who initially rejected a mandate to implement the University of Oregon's Direct Instruction Follow Through Model, became demonstrably more supportive of the model after they had observed their success with the procedures. Perhaps initial coercion will facilitate later acceptance of procedures. The processes of training programs should be studied and participants should be followed-up after the completion of

the study, in order to determine which aspects of the programs are likely to contribute to the procedures being retained or dropped once the study has been completed.

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Table 1

Means, Standard Deviations and Ranges of Achievement Test Scores

	Group					
	Experimental			Comparison		
	$\bar{X}$	SD	Adjusted mean	$\bar{X}$	SD	Adjusted mean
Pretest						
oral reading	61.71	23.04	62.31	58.11	30.67	61.45
math	23.84	10.41	25.07	24.97	12.66	24.89
Posttest						
oral reading	74.64	28.98	76.19	61.13	30.63	63.98
comprehension	8.76	2.93	9.09	7.17	3.86	7.22
math	25.56	11.66	26.69	25.15	12.76	25.52

Table 2

Means and Standard Deviations of Self-report Estimates by Student Teachers of Time Allocated to Instruction in Oral Reading, Vocabulary Skills, and Reading Comprehension (minutes per week)

	Group			
	Experimental		Comparison	
	$\bar{X}$	SD	$\bar{X}$	SD
Oral reading	61.25	22.60	40.43	11.13
Vocabulary skills	51.88	28.72	26.43	22.15
Reading comprehension	41.25	23.55	32.14	7.49

Table 3

Means and Standard Deviations of Proportions of Time Off-Task for Pupils During Instruction

	Group			
	Experimental		Comparison	
	$\bar{X}$	SD	$\bar{X}$	SD
Seatwork Instruction	12.78	8.51	49.23	36.16
Teacher-led Instruction	7.78	5.52	31.62	21.44