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To indicate the effects on learning of individualized instruction and motivation, the results of two controlled experiments conducted in two Janesville, Wisconsin, elementary schools during the 1966-67 school year are reported. In an experiment comparing three approaches to spelling instruction at the sixth grade level, large gains were noted for both experimental and control pupils. In an experiment comparing four approaches to mathematics instruction at the first grade level, the approach appearing to be the most effective consisted of teacher demonstrations followed by pupil manipulation of interesting concrete objects. (JK)

RESEARCH AND DEVELOPMENT ACTIVITIES IN R & I UNITS OF TWO ELEMENTARY SCHOOLS OF JANESVILLE, WISCONSIN, 1966-1967

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COGNITIVE LEARNING

Technical Report No. 45

RESEARCH AND DEVELOPMENT ACTIVITIES IN R & I UNITS OF TWO ELEMENTARY SCHOOLS OF JANESVILLE, WISCONSIN, 1966-1967

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Report from Project MODELS
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PREFACE

A major objective of the Wisconsin Research and Development Center for Cognitive Learning is to develop an environment in local school buildings and systems which facilitates both student learning and research, development, and innovative activities. This report is concerned with the description and evaluation of such facilitative organizations and their activities in two elementary schools in the Janesville Public School system. The report further demonstrates how instructional and supervisory personnel in the public schools, working with personnel at the Center who possess specialized knowledge in various disciplines, cooperate to extend knowledge and improve educational practice through research and development activities.

Many people, other than the R & D personnel and Unit leaders denoted as authors, contributed their skills in planning, executing, or evaluating the activities reported herein. Mr. Fred Holt, Superintendent, Mr. Robb Shanks, Assistant Superintendent for Instruction, and Mr. Lewis Loofboro, Supervisor of Elementary Education, gave their wholehearted support and interest to the project. Mrs. Mildred Yahnke, Reading Consultant, worked very closely with the Units in developing exemplary reading programs. Many of the accomplishments of the Units would have been impossible without the loyal support of Mr. Norman Graper, Principal, Wilson School, and Mr. Robert Cook, Principal, Adams School.

Professor Herbert J. Klausmeier, Principal Investigator of Project MODELS, initiated the idea of R & I Units, assumed primary responsibility for the conceptualization of the total R & I program and for the board implementation strategies in the local schools. He and Professor Max Goodson met with the Janesville Board of Education to present plans for the project. Mrs. Mary Quilling wrote the introductory and concluding sections of this report and served as editor. Mrs. Doris Cook assumed primary responsibility for working with the building personnel during the year. She, Dr. Tagatz, and Dr. Wardrop served as consultants for the experiments reported. Other Center personnel who assisted in data collection and analyses include Mrs. Barbara Kennedy and Mr. James Bavry. The authors acknowledge with appreciation the contribution of the above.

Thomas A. Romberg
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ABSTRACT

Activities of R & I (Research and Instruction) Units in two Janesville, Wisconsin, elementary schools during the 1966-1967 school year are reviewed. Results of two controlled experiments conducted in the Units are reported and evaluated. One study, in which four methods of teaching first-graders arithmetic were compared, led to the suggestion that techniques be selected specifically for the concept being taught. Large gains in spelling and language were noted for both experimental and control pupils participating in a spelling experiment at the sixth-grade level.

I

INTRODUCTION

Securing more efficient pupil learning in the cognitive domain continues to be the main focus of the research and development activities conducted jointly by the Wisconsin R & D Center for Cognitive Learning and several school systems as part of Project MODELS. One possible means for accomplishing this is to replace the graded, self-contained classroom with a Research and Instruction Unit (R & I Unit) in which various instructional activities may be performed more effectively. One R & I Unit was organized in each of two elementary schools in Janesville during 1966-1967. In each Unit the attempt was made (1) to provide excellent instruction for children, (2) to carry out research which is essential for improving instruction, (3) to develop new instructional procedures, materials, or ideas for improving instruction, and (4) to bring into the Unit promising educational innovations. The R & I Units are hypothesized to be more effective than self-contained classrooms in achieving these purposes. In order to be more effective, the role of the building principal, Unit leader, classroom teacher, and teaching aide are being refined, and new relationships involving representatives of the central staff, the building staff, and other agencies are being established. Thus, the concept of improving instruction through research and development in R & I Units is complex, involving an attempt to utilize time, space, equipment, supplies, instructional methods, instructional personnel, subject-matter content and sequence, and evaluation procedures in a more effective manner to achieve an efficient total educational program for each child.

When dealing with a total program, more time is required to get the various components integrated. However, the possibility for making significant improvements is also large. During the first year, the major effort is necessarily upon achieving a smooth operating instructional Unit and gaining familiarity with research, development, and innovative procedures. While this is being done, large gains in student learning should not be expected. Once the instructional staff and children operate as a unit and better materials and methods are developed, researched, and utilized, we may anticipate substantial improvement in student learning.

The two main instructional phenomena dealt with in the Units centered on individualizing instruction and motivation. Generalists from the R & D Center worked with the staff of the schools. Subject-matter consultants from the R & D Center or the central staff of the local school participated in decision-making where subject-matter specialization was called for in connection with the program of individualization.

The approach to individualization employed in the R & D Center is one of arranging a program of instruction for each child that will meet the various objectives of the educational program. This, in turn, calls for some instruction on a one-to-one basis, some small-group, and some large-group instruction.

In instruction on a one-to-one basis, the child proceeds at a rate appropriate for him. This type of individualized work with the teacher and independent study are required to meet those objectives concerned with the acquisition of independent skills. Some educational objectives require instruction in small groups. Pupils may be brought together in groups of 3 to 15 or more to work on specific activities of a fairly homogeneous type; for example, 5 to 15 children from a total group of 100 may be brought together for specific instruction related to acquisition of certain concepts or processes in arithmetic. Small groups also may be brought together to deal with the same word recognition skills. Small groups may be formed on the basis of interest, friendship, neighborhood, residence, and the like in social studies in connection with achieving certain objectives

related to communication skills and attitude development. The extent to which large groups of 75 to 150 children may be brought together effectively has not been tested systematically. It is known that large numbers of students may engage in individual study activities simultaneously in large groups. In the Units in the elementary school, the principal reason for bringing all the students within the Unit together into the same group for part of the instructional day is to achieve better utilization of teacher time. Children participating in independent study or some other large group activity can proceed without all of the instructional staff of the Unit being present. This, in turn, frees part of the instructional staff during that period of time for planning, conferring, and executing other activities essential for making the small group and one-to-one instructional activities work effectively.

Attention was also given throughout the year to research and development regarding motivation. Getting a larger number of students to want to learn and also to behave well is a continuing responsibility of R & I Units. We appear to have sufficient knowledge about the means of controlling behavior of young children so that few discipline problems should emerge in the elementary school. Devising procedures for applying this knowledge and testing out some of the procedures is a continuing activity in R & I Units. From the preceding it may be properly inferred that no systematic attempt was made to improve instruction in any one subject-matter field in each Unit. This will be done more systematically in 1967-68.

In addition to improving the instructional program, a plan for field testing the R & I Units in 1966-67 was developed by Wardrop and Tagatz and reported in Working Paper No. 4 of the Wisconsin Research and Development Center for Cognitive Learning. Only part of the total plan for field testing was executed during the 1966-67 school year. Also, the attempt was made to utilize the local resources of each school system in the field of testing, including each school's testing program; therefore, the amount of information obtained regarding the units varied within a school system and across school systems. In some of the elementary R & I Units field testing data were gathered dealing with pupil achievement as measured by standardized tests. Instruments were developed and tested to secure opinions of pupils regarding the Units, and also the opinions of teachers and principals as to how well the research, development and innovation functions were being achieved. In the main, then, field testing procedures and instruments were tried out during the year, and the data obtained yielded some preliminary information about the functioning of R & I Units.

II

RESEARCH AND DEVELOPMENT IN THE UNITS

The staff of the Janesville Public Schools expressed interest in establishing R & I Units in 1966. They had been thoroughly acquainted with teaming through participation in the Wisconsin Improvement Program. They saw, however, additional opportunities within Project MODELS to become familiar with research and development strategies. They also saw an opportunity for preservice teacher interns from the WIP program to participate in the new type of organization and in research and development activities.

THREE APPROACHES TO SPELLING, SIXTH GRADE, ADAMS SCHOOL

The sixth-grade Unit at Adams School, Janesville, Wisconsin, Mr. Robert Cook, Principal, was one of the first R & I Units to be organized. This unit has made rapid progress as can be noted by the year's activities.

The staff was composed of Dwane Kamla, Unit leader, and Mrs. Joyce Bengston and Mr. Walter Golbuff, teachers. In addition to the regular staff two interns from the Wisconsin Improvement Program were assigned to the Unit. The regular staff shared the responsibility for the instruction of 93 sixth-grade students as well as the training of the two interns.

Each certified member of the Unit had a classroom. The rooms were adjacent and large enough that all pupils could meet simultaneously in one or two of them. The typical daily pattern was for teachers and pupils to rotate from room to room and for teachers to meet with more than one group of children. Easily available instructional equipment and materials included a 35mm strip film projector, tape recorder, record player, overhead projector, textbooks and other printed materials, and teacher supplies. Less readily available equipment included a 16mm projector, records unless used for music classes, listening kits, and facilities for individual study.

The entire instructional program was cooperatively planned and taught. Planning sessions were held regularly from 8:00 to 8:45. The unit staff, in addition to its planning meetings, met with the principal 5-10 times per month. Instruction in the skill areas of reading was based upon achievement groups. Each teacher had two different level groups, for example, a high achieving group and a low achieving group. One teacher rotated among all groups and provided each group with several weeks of individualized reading.

Social studies and science are combined into what is called a Unit plan throughout the Janesville Schools. The sixth-grade staff found the R & I organization very adaptable to this because it provided so many opportunities for groupings. Large group instruction was used for film presentations, lectures, and other audio-visual materials. Varied small groups were formed on the basis of interests, sex, ability, and heterogenity.

Even though this Unit had limited physical facilities, careful planning resulted in the maximum use of both the facilities as well as the staff. A 25-minute period which alternated with physical education was set aside each day for independent study. Children were free to study what they chose. Teachers were available to supervise and give assistance as needed.

Two mathematics groups were completely individualized. The Unit leader and teachers indicated that the children reacted well to this program, also that achievement was at least as good as in the other classes, and that the children's attitudes had improved considerably.

The interns assigned to the Unit eventually taught full time, thereby giving the Unit leader adequate released time to fulfill other R & I responsibilities. A "Handbook for Interns" was compiled by the Unit staff.

The Unit leader and teachers reported that a half-time secretary proved to be helpful in re-

lieving the teachers of most clerical and housekeeping duties. She also assisted teachers in the supervision of the students.

Visitors were received from other local school systems throughout the state and nation to view this instructional program. One group came from England, Australia, and New Zealand.

This Unit is looking forward to extending their instructional program next year to the fifth grade. The R & I Unit for 1967-68 will be a fifth and sixth-grade Unit organized with the purpose of non-grading the instruction in order to arrange a better instructional program for each child.

In 1965-66, an experiment was conducted in the sixth grade in which three methods of teaching spelling were compared. Results indicated no significant differences among treatment groups (workbook, integrated, and individualized approaches) on most dependent variables. (For a detailed description of that experiment, see Klausmeier, et al., 1967.) Although there were no significant differences among the control and experimental groups, at the conclusion of the experiment, the average gain, during the four months of the experiment, was seven months on the Stanford Achievement Test.

In the 1966-67 school year, some modifications in the approaches used were developed, and a follow-up experiment was conducted. Modifications included a more detailed development of the individualized approach and the inclusion of a locally-developed method which was also designed to provide for individual differences. The experiment was designed to investigate the relative effectiveness of the three treatments over an extended period of time (seven months).

Subjects

Subjects in this experiment were 88 pupils in the sixth grade. Pupils ranged in age from 10-8 to 12-7 years, the mean age being 11-7. The mean IQ in this group was 107.5, and the mean grade equivalent score on the Spelling subtest of the Stanford (given in September) was 5.8.

Within each sex, students were stratified into three levels (high, middle, and low) on the basis of scores on the Spelling subtest of the Stanford. Within each of the sex subgroups pupils were then randomly assigned to the three treatment conditions.

In order to minimize the contamination of treatment effects by teacher-related variables, teachers taught each of the three groups for two-week blocks of time, rotating among treatments in a pattern determined by use of a Latin square.

Treatments

The traditional approach was based on a workbook entitled Spelling for Word Mastery, Book VI (Charles Merrill, Publishers). The basic sequence of steps in this method is indicated below:

1. Study: Introduction to and use of the new words.
2. Test: Trial test.
3. Study: Study the words missed.
4. Test: Final test.

The combination approach utilized both the spelling workbook (as outlined in Treatment 1), and individualized materials (SRA Spelling Word Power Laboratory). This individualized approach was designed to permit each pupil to proceed at his own rate. By means of a placement guide, each student began in the SRA laboratory at a point where he was expected to be reasonably successful. The materials were self-operating and self-correcting, and each child recorded his progress in his student record book.

The testing procedure consisted of check tests which were given after the student had completed several units of the program. A second check test was available for retesting those pupils whose initial performance indicated that further study was needed. In addition, spelling achievement survey tests were available for periodic testing of all students.

In the locally produced approach, methods and materials designed by the Unit personnel were employed. A master list of 750 spelling words was compiled in two categories:

A. Common words were defined to be those words found in both the spelling workbook and the SRA materials. Word derivatives were considered common only if the spelling of that derivative was similar to that of the base word. There were approximately 400 words in this category.
B. Unique words were words not common to both the spelling workbook and the SRA materials. Approximately 350 words chosen from the following sources comprised this group: (i) approximately 200 words from 3 well-known lists of frequently misspelled words—the famous "Jones Demons," and words from lists published by Fitzgerald (1952) and by Johnson (1950);

and (ii) approximately 50 words from each of the 3 basal reading texts used by the children in the unit.

Twenty-five of the 750 spelling words were chosen from the alphabetized master list for each unit of study. The words were used in a variety of activities designed to facilitate the learning of skills which members of the unit agreed were desirable outcomes of a good spelling program. The activities were categorized as follows:

1. Working with words
   a. identifying base words
   b. finding new words
   c. building new words
   d. using synonyms, antonyms, and homonyms
2. Dictionary usage
   a. syllabication
   b. accent marks
   c. alphabetizing
3. Learning some of the commonly accepted spelling rules
4. Sentence and paragraph construction
5. Theme writing and proofreading
6. Original projects

Data Collected

Two special measures were employed in both a pretest and a posttest. One of these was a proofreading task, in which students were to correct spelling errors in a passage in which 30 (pretest) or 19 (posttest) deliberate errors were included. (Different passages were used for the pretest and for the posttest.) Two scores were obtained from this task: "standard" errors, referring to the number of built-in errors in the passage which the student changed correctly; and "created errors" which reflected the number of errors the student created by changing an already-correct word.

The second special measure was derived from a writing assignment completed by all students. For the pretest, they wrote a theme on "The Person I Admire Most;" while for the posttest, the examiners dictated a 224-word theme. On both occasions, the measure used was the number of spelling errors made.

In addition to these measures, the following other scores were obtained as both pre- and posttest data:

1. Stanford Achievement Test, Intermediate Battery, Spelling subtest; this yielded a "recognition" score.
2. Stanford Achievement Test, Intermediate Battery, Language subtest.
3. Recall test: number of words spelled correctly on a 60-word spelling dictation test (teacher-made). Different lists were used for the pretest and posttest.
4. Attitude measures: score from a 12-item scale of attitudes toward spelling. Positive responses were assigned a value of 3. neutral responses a value of 2, and negative responses a value of 1.

Analysis of Data

All posttest data were analyzed using a 3 x 2 x 3 analysis of covariance. The factors were Treatment (Traditional vs. Combined vs. Individualized), Sex (Male vs. Female), and Past Achievement (High vs. Middle vs. Low). Each criterion measure was analyzed by covarying out the comparable pretest measure. Table 1 presents a summary of these analyses. As is indicated in this table, there was only one significant Treatment effect, on the Language subtest of the Stanford Achievement Test. This effect resulted from the superiority of the group receiving the traditional workbook. Table 2 presents the unadjusted means for the three groups, on the pretest and posttest, as well as the pretest-posttest gains. The table also points out average growth across groups of 1.3 years during a seven month period.

The significant Sex effects on the Proofreading Standard and Writing Task Errors both reflect the superior performance of females over that of males. The (unadjusted) means for the two groups on these measures are presented in Table 3.

A significant Ability effect was found on four of the measures. On the Teacher-Made Recall and the Proofreading Standard measures, the average ability group performed best, the low ability group worst, and the high ability group in between. On the Proofreading Created Errors and Writing Task Errors measures, high ability students performed best and low ability students worst. The (unadjusted) group means for these measures are presented in Table 4.

Table 1

Summary of Analyses of Spelling Data: Grade 6

Source	df	Dependent Variable													
		Teacher Recall		Proofreading "Standard"		Proofreading "Created"		No. Misspelled, Writing Task		Stanford Spelling		Stanford Language		Attitude	
		MS	F	MS	F	MS	F	MS	F	MS	F	MS	F	MS	F
Treatment	2	35.27	<1.00	15.13	2.50	0.05	<1.00	0.18	<1.00	39.03	1.51	254.61	4.59*	3.22	<1.00
Sex	1	115.67	2.56	33.93	5.62*	0.96	<1.00	34.17	9.95**	241.12	9.34**	54.54	<1.00	0.23	<1.00
Ability	2	237.60	5.26**	51.33	8.50***	15.44	4.98**	46.99	13.68***	74.53	2.89	22.16	<1.00	2.83	<1.00
T x S	2	16.46	<1.00	14.13	2.34	1.20	<1.00	0.73	<1.00	20.65	<1.00	26.66	<1.00	1.52	<1.00
T x A	4	107.66	2.38	16.17	2.68	2.82	<1.00	6.33	1.84	45.81	1.78	50.25	<1.00	13.44	2.33
S x A	2	2.92	<1.00	36.73	6.08**	21.60	6.96**	2.12	<1.00	60.12	2.33	16.88	<1.00	7.24	1.25
T x S x A	4	30.40	<1.00	3.76	<1.00	3.80	1.22	3.06	<1.00	54.96	2.13	40.83	<1.00	3.82	<1.00
Error	69	45.18		6.04		3.10		3.43		25.80		25.80		5.77	

* $p < .05$
** $p < .01$
*** $p < .001$

Table 2

Mean Grade Equivalent of Experimental Subgroups, Stanford Language Test, Fall and Spring

Group	Mean Grade Equiv. Fall	Mean Grade Equiv. Spring	Gain
Workbook	6.1	7.8	1.7
Combined	5.7	6.6	.9
Local	5.7	6.9	1.2
Mean	5.8	7.1	1.3

Table 3

Means for Males and Females for Measures Yielding Significant Sex Differences

Variable	Males	Females
Proofreading Standard	12.33	14.76
Writing Task Errors	31.86	16.92

Table 4

Ability Group Means for Measures Yielding Significant Effects

Variable	Ability Level		
	High	Average	Low
Teacher Recall	57.85	48.93	30.06
Proofreading Standard	16.93	14.80	9.48
Writing Task Errors	0.77	1.99	4.17

The only significant interactions which were relevant were the two Treatment x Ability Level interactions. If the nature of these interactions were such as to suggest that a particular approach was most effective with students of a given ability, this would be a useful finding.

For the Proofreading Standard measure, this was the case. High ability students performed best when they had used the locally developed spelling program, average ability students when they had had the combined approach, and low ability students when they had used the traditional workbook. However, this pattern was not found for the other Treatment x Ability interaction, nor were there any other interactions of this kind to support the finding just reported.

The absence of a significant Treatment effect and the lack of consistent Treatment x Ability interactions would seem to indicate that the three methods were about equally effective for the teaching of spelling. Just how effective they were can be judged by looking at the amount of improvement shown by all students during the experiment. A comparison of mean grade-equivalent scores from the fall and spring administrations of the spelling subtest of the Stanford Achievement test revealed the following gains:

Workbook approach: from 5.9 to 6.9, a gain of 1.0 years;

Combined approach: from 5.7 to 7.1, a gain of 1.4 years; and

Local materials approach: from 5.7 to 6.9, a gain of 1.2 years.

The time interval between pre- and posttests (September-April) was such as to indicate an expected gain of 0.7 years; the average gain for the students in this Unit was about 1.1 years or 0.4 years above normal. Coupled with even greater language gains the conclusion is that a significant improvement in spelling and language skills occurred beyond that commonly found.

The teachers' reactions to the experimental treatments were summarized as follows:

Treatment I appeared to become increasingly tedious as the weeks progressed. The traditional workbook was viewed as a mechanical device for rote learning. Treatment II seemed to offer a greater degree of pupil motivation and teacher interest. The Spelling Labs gave an added incentive for finishing assigned

work in the workbook so individuals could pursue activities provided. Treatment III generated the most enthusiasm for both students and teachers. The teachers felt the students especially liked the varied kinds of activities employed as well as the opportunities for individual choice and self-pacing.

Discussion

Each of the three methods employed was effective in teaching spelling. On only one variable did students using one method—the traditional workbook—significantly exceed those using another. There is no clear reason for this occurring, especially since no such differences were found on any other measures. In terms of either improvement in spelling skills or changes in attitudes toward spelling, no one method demonstrated a superiority over the others.

During a seven-month period students using the combined approach gained 1.4 years on the Stanford spelling subtest, while those in the workbook group gained 1.0 and in the local materials groups, 1.2 years. Although this difference was not statistically significant in this experiment, it is large enough to be of practical importance if it were to hold up over a longer period of time. Further, a similar large gain above expectancy was noted for the 4-month period in the second semester of the 1965-66 school year.

On the basis of the findings presented here, one concluded that all methods were effective, with the average gain being far above that expected. The students probably attended more to learning to spell correctly as a result of participating in an experiment, and the teachers probably did a better job of teaching spelling as a result of the amount of time they spent preparing for and discussing the experiment.

FOUR INSTRUCTIONAL APPROACHES TO THE DEVELOPMENT OF MATHEMATICAL CONCEPTS, FIRST GRADE, WILSON SCHOOL

A second R & I Unit was organized in 1966-67 at the first-grade level in Wilson School, with the enthusiastic support of Mr. Norman Graper, principal. Mrs. Edna Shuman, the Unit leader, was initially introduced to the program during the 1966 Summer Institute. The sharing of ideas with other Unit leaders, the organizational planning sessions with R & D staff members, and the instruction of various subject matter specialists provided the basis for many good ideas to be implemented during the school year 1966-67.

The first-grade staff consisted of, in addition to Mrs. Shuman, Unit leader, Mrs. Betty Heider, Mrs. Ruth Cornelius, and Miss Alice McCarthy certified teachers. Mrs. Ann Anderson was assigned to the unit as a teacher's aide. The staff was responsible for the instruction of 105 students, many of whom come from disadvantaged homes. The Janesville administrators and supervisors felt the additional staff plus the opportunity for experimentation could improve the instructional program for these children.

Each certified member of the Unit had a room or station and these were adjacent. Although all the pupils could meet simultaneously in two of the rooms, no one room was large enough to accommodate them all. The typical daily pattern was for pupils and teachers to be in more than one room, and for teachers to meet with more than one group of students. Easily available instructional equipment was limited to a 16mm projector of poor quality; better quality textbooks, printed materials, and teacher supplies were also available. Unavailable facilities included a 35mm strip film projector and films, tape recorder, record player, overhead projector, listening kits, and provisions for individual study. Unit personnel met frequently, on an average of eleven or more times per month, and capitalized upon meetings to discuss plans and problems with the building principal, central staff, and R & D staff. The building principal was responsible for the original formation of the Unit. Teachers were given an option regarding participation in the Unit, and 3 out of 4 of them have indicated the wish to continue working in the organization.

A highlight of the instructional program was an individualized reading program which was implemented the second semester. The teachers were enthusiastic about this program and spent many long hours consulting with Mrs. Mildred Yahnke, reading consultant for Janesville Public Schools, and with R & D staff to set up this program. They hoped that such a program would:

1. Increase interest in independent reading
2. Enrich vocabulary
3. Improve comprehension
4. Improve basic word attack skills
5. Increase fluency and rate of reading
6. Develop independence in pursuing reading activities

7. Develop an appreciation of literature
8. Increase the amount and variety of reading materials
9. Encourage children to read at home and for leisure.

Each individual child's ability level in sight vocabulary and comprehension was assessed. The Dolch Word List and the Gates MacGinite Reading Test were used.

In addition to the basic series, supplementary readers were supplied. An important activity included in this reading program was Creative Writing. Experience charts, and the children's own stories were incorporated into the reading program every day. Each group had 75 minutes of reading in the morning which was used to cover the materials in the basal text. An hour again in the afternoon was scheduled as the individualized reading. This time was used to write stories about books read, talk about books read, and do independent reading. The instructional aide assisted the teachers in taking children to the library or the reading center. Story hours were held regularly.

The instructional aide also provided a great deal of assistance in the record keeping, an essential adjunct to an individualized program.

In addition to investigating ways of individualizing reading, the Unit staff worked to explore methods and materials to use in arithmetic instruction. Contemporary mathematics programs are based on the idea that the subject matter of a good first-grade arithmetic program is a set of key mathematical concepts. These concepts are to be introduced and developed as fully as possible, so as to be a foundation for further development in succeeding years. If there is agreement as to what these ideas are, efforts to achieve an improved program should focus on new approaches and instructional materials.

Underachievement in arithmetic among the first-grade children in Wilson School prompted this investigation to determine the relative effectiveness of four approaches in facilitating the development of key mathematical ideas and student achievement in first-grade arithmetic instruction.

It was not the intention of this experiment to evaluate various commercial instructional materials but rather to look at the various ways concepts in mathematics could be presented to children to maximize attainment of the concepts.

The ten basic concepts taught in all four treatments were selected from the Mathematical Concepts Guide for "Patterns in Arithmetic", H. Van Engen.

Briefly the purpose of this study was to determine the relative effectiveness of four approaches in facilitating the development of key mathematical concepts. The four approaches were:

1. the textbook approach
2. the television approach as outlined
3. the television approach supplemented by the basic text
4. the manipulative approach

During several planning meetings the staff of the Unit and a representative from the R & D staff reviewed the objective and rationale of conceptual approach. Much discussion led to organizing the instructional program according to Klausmeier's[1] six principles for facilitating the learning of concepts. These are:

1. organize concepts into appropriate learning units
2. encourage and guide searching behavior
3. organize realistic experiences with the concept
4. give concise, clear meanings of the concepts
5. provide for application of the concept
6. aid the learner to evaluate the adequacy of his concepts.

The teachers used these principles in planning an appropriate instructional program for treatment D.

The experiment included four treatments:

Treatment A. Textbook and Workpad. This is what might be called the traditional method. The text has been used for several years in the Janesville schools, but this was the first year for using the workpad. With this method, the teacher followed the sequence and procedures outlined in the text. (Seeing Through Arithmetic 1, published by Scott, Foresman and Co.) The workpad (Practice Tablet 1, designed to accompany Seeing Through Arithmetic 1) was used to supplement the text.

Treatment B. "Patterns in Arithmetic." This method included the weekly TV program (Patterns in Arithmetic)—one 15-minute video lesson per week—and materials which accompanied the program: a teacher's guide and, for each child participating in this treatment, a

[1] Klausmeier, H. J., & Goodwin, W. L. Learning and Human Abilities. New York: Harper & Row, 1966.

a pupil exercise book.

Treatment C. "Patterns in Arithmetic" supplemented by textbook (Seeing Through Arithmetic 1, published by Scott, Foresman and Co.) This approach included the weekly TV program and materials which accompanied the program. The teacher used the textbook to supplement the program, following the same sequence as "Patterns in Arithmetic."

Treatment D. Manipulative approach. The teacher used the Scott, Foresman text as a guide, following the sequence of the TV program. This method included teacher demonstrations, followed by active pupil participation, with the children manipulating interesting concrete objects. The children used Practice Tablet 1. Immediate reinforcement was provided through self-checks on answer sheets which the teacher made available to the children.

Procedures and Design

The four treatments were administered for 30 minutes each day, beginning September 26. The experiment continued through May 20 (24 weeks). Each child participated in only one treatment. To control the teacher variable, the teachers rotated every four weeks. Each teacher chose the treatment she wished to begin.

The design utilized a stratified random sampling procedure. The pupils in the experiment were separated by sex and then randomly assigned to one of the experimental groups.

Data Gathered

One measure of concept attainment was administered. It was a final (post) test, constructed and administered by the Unit leader. The concepts and abilities tested were:

1. Writing numerals
2. Ordering
3. Number words
4. Relation (Greater than, less than, equal to, between)
5. Ordinals
6. Measuring
7. Geometry
8. Money
9. Number sentences
10. Addition and subtraction facts

Because of the amount of missing data for concept six—measuring—it was omitted from the analysis. Since the sequences of the four approaches were not identical, only concepts which had been developed in all four treatments were included in the test.

Analysis of Data

An analysis of covariance was performed on the total test scores. Scores on the Metropolitan Readiness Test were used as the covariate. The results of the analysis are presented in Table 5. Since the treatment effect was significant at the .10 level, the mean total score for each group (Table 6) is of interest.

Table 5

Analysis of Covariance Performed on Total Scores for Teacher-Constructed Test

Source	SS	df	MS	F
Treatments	468.127	3	156.042	2.536 $p < .10$
Sex	34.898	1	34.898	0.567
Treatments x Sex	155.356	3	51.785	0.842
Error	3875.919	63	61.523	

Table 6

Group Means for Metropolitan Readiness and Teacher-Constructed Test

Treatment	Metropolitan Readiness	Teacher-Constructed Test
A. Traditional	16.21	87.85
B. TV only	16.52	82.78
C. TV and text	15.85	88.17
D. Manipulative	15.51	88.47

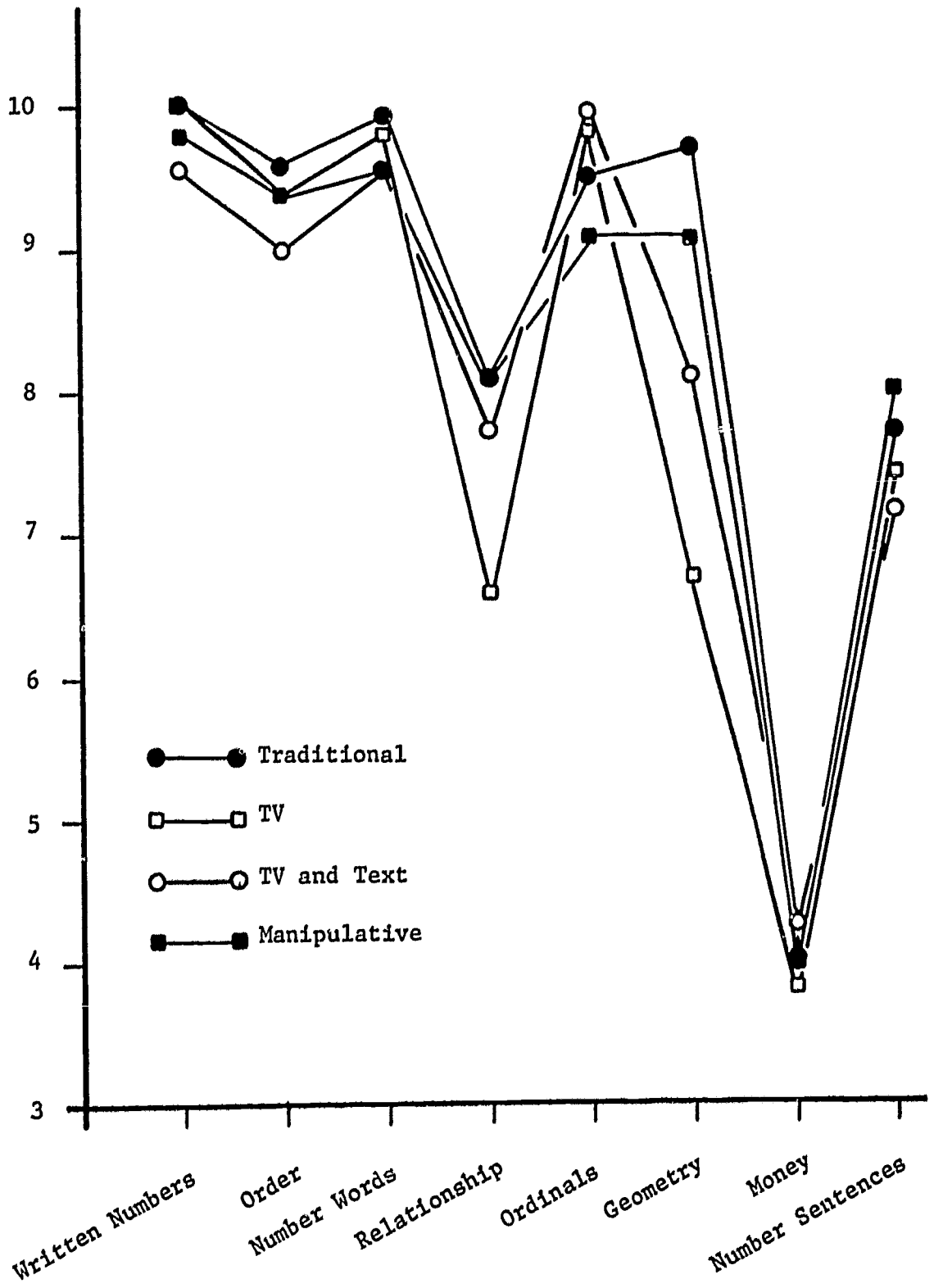

Fig. 1. Profile of Group Scores on Subtests of the Teacher-Constructed Test Grade One, Wilson School, Janesville

Even though the "television only" group had the highest readiness score, its mean on the teacher-constructed test was markedly below other group means. The inverse relationship between scores on the readiness and teacher-constructed test would, furthermore, have assured an even greater difference between the adjusted scores on the teacher-constructed test. In other words, since the "manipulative" group was initially slightly inferior to the other treatment groups, its mean score would be adjusted upward to account for this fact. It is these adjusted scores on which the analysis of covariance was based.

Since it is conceivable that certain treatments were more appropriate for a particular concept or skill, a profile of group means on subtests is presented in Figure 1. Number facts have been omitted from the profile because of the large number of items included in this subtest. Again, the relatively lower performance of the "television only" group is noted in relations and geometry.

On the other hand, while the manipulative group performed best on "number sentences," it did comparatively poorly, in comparison with both television groups, on "ordinals." These results suggest that the teachers should select methods most appropriate for the concept being taught.

Discussion

Results of the statistical analysis suggest that treatment had a differential effect on the performance of the students with the "television only" treatment being less effective than other treatments overall. It is probable however, that a particular treatment was more effective in teaching certain concepts and less effective for other concepts. The profile, for instance, suggests that both of the television approaches were superior for teaching ordinals, whereas the manipulative and traditional approaches were more effective for teaching relationships and geometry.

The teachers felt that the rotating among treatments gave them an opportunity to improve their knowledge of mathematics skills as well as techniques for teaching the various concepts. They had opinions about the various approaches which might be summarized as follows: The manipulative approach was more exciting and interesting to teach; the children seemed to have a better understanding of the concepts in the manipulative. This opinion concurs with the test results, for the students in the manipulative group perform best in spite of having the lowest readiness score.

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III

FIELD TESTING THE R & I UNITS

Plans for analysis of field testing in Janesville were altered following the publication of Working Paper No. 4 (Wardrop et al., 1966). The first-grade Unit at Wilson School was eliminated from field testing because posttest data were not available from the control group. The proposed analysis of covariance technique was rejected since inspection of baseline data revealed that the assumption of homogeneity of regression, necessary for that analysis, had been violated.

Control schools were selected by the staff of the Janesville Public Schools. Two control schools were identified for the sixth-grade Unit at Adams School: one school was organized within a team-teaching framework, while at the other school the organizational pattern was the traditional self-contained classroom. Baseline data were collected in September and October, 1966, and criterion data in May, 1967. Table 7 indicates baseline and criterion tests employed.

Table 7
Achievement Testing, Janesville

Pretests	Posttests
Lorge - Thorndike Stanford Achievement	Stanford Achievement (Spelling & Language subtests)

SIXTH-GRADE UNIT, ADAMS SCHOOL

Since the criterion data consist of Spelling and Language subtest scores on the Stanford Achievement, only the corresponding pretest data are reported. The group means are indicated in Table 8.

The initial superiority of both control groups can be taken as evidence that their rate of advancement has exceeded that of the R & I Unit in the past. Consequently, it would be expected that similar differential gains would occur during the 1966-67 school year.

Table 9
Group Gains (Grade Equivalents)
Stanford Achievement Tests Subtests

	Spelling	Language
R & I Unit	1.1	1.3
Team Teaching	1.2	1.2
Self-Contained Classroom	1.1	.9

Thus, although the self-contained classroom retained its group superiority, it failed to outgain the R & I or team teaching groups. Gains made by the R & I group during a seven-month period in both cases exceed one year, indicating the success of this organization in achieving its instructional objectives.

Table 8
Group Means
(Data from the Stanford Achievement Test reported as grade-equivalents.)

	Pretest			Posttest	
	Lorge-Thorndike	Stanford Spelling	Stanford Language	Stanford Spelling	Stanford Language
R & I Unit	107.44	5.8	5.8	6.9	7.1
Team Teaching	110.77	6.2	6.2	7.4	7.4
Self-Contained Classroom	111.44	6.5	6.7	7.6	7.6

TEACHER OPINION SCALE

The Opinion Scale was administered to Unit leaders and teachers of R & I Units, teachers in classrooms designated as controls for field testing purposes, and building principals of schools containing R & I Units and control classes. The discussion is limited to learning specialists and teachers since incomplete data were available for the principals. To obtain a fairly large sample, data from Madison & Racine R & I Units and Control schools were combined for purposes of analysis.

TABLE 10

Mean Scores

GROUP	TOTAL SCORE	Instruction	Research	Development	Innovation	Effect on Teachers	Effect on Students	Utilization
Learning Specialists	113.85	23.38	9.96	15.54	19.69	17.04	26.50	6.46
R & I Teachers	105.55	22.08	10.58	14.55	17.88	16.02	24.02	4.98
R & I Total	108.82	22.60	10.34	14.94	18.60	16.42	25.00	5.56
Control Teachers	95.89	17.86	8.54	13.54	16.36	16.04	23.32	3.82

Table 10 indicates the mean total scores and subscores for various divisions of the questionnaire. For each item, the statement which presented the most favorable alternative was scored highest, with decreasing scores representing less favorable statements, and a score of 0 or 1 indicating the least favorable. Each subscore is a sum of scores for the items related to that area of measurement. Maximum possible scores for each subdivision are as follows: Instruction 34, Research 14, Development 17, Innovation 22, Effect on Teachers 21, Effect on Students 39, and Utilization 8.

In every case, the scores for the R & I Unit personnel are greater than those for the control teachers, indicating the superiority of this organization according to these areas of measurement. Substantial differences exist between total scores and instruction subscores for these two groups. The latter indicates that R & I instructional staff noted the value of designing a model instructional program, of involvement in research projects, and of team planning. They were also more satisfied with their total instructional program.

The data were analyzed using a frequency count procedure. A sum of scores for each alternative was obtained and the percent of each group choosing each alternative was determined. Many noteworthy differences were found between the R & I and control groups.

Student behavior, achievement, motivation, and attitudes were reportedly better in R & I classes than in control classrooms. Moreover, greater satisfaction with student behavior and motivation was expressed by R & I Unit personnel than by control teachers.

Opportunities for initiating new procedures and innovations were more marked in the R & I situation than in the control classrooms. A substantially greater number of R & I staff felt that the instructional materials available to them were of superior quality.

Teachers in R & I Units felt they had made greater use of their system's consultant and service staff and also placed greater value on consultant help from outside the school system. Learning specialists, particularly, utilized the services of these consultants.

Another important difference was that 89% of the learning specialists and 54% of the R & I teachers felt that their professional growth was greater than normal in their current position, while only 35% of the control teachers reported this growth.

IV

CONCLUDING STATEMENT

The main purposes of R & I Units are to provide excellent instruction for children, and to carry out research and development activities that are essential to improving instruction. An additional R & I Unit was started in Janesville during the 1966-67 school year to achieve these purposes. The major emphasis was on identification of effective instructional procedures including individualization.

The first-grade staff at Wilson School investigated ways of individualizing reading and performed a controlled experiment on four approaches to teaching arithmetic concepts. Children whose instructional program emphasized manipulative objects performed best overall. The strengths and weaknesses of treatment for teaching specific concepts were noted. While the experimental results did not suggest that one treatment be adopted exclusively for teaching first graders arithmetic, the results encourage teachers to select techniques specifically for a concept being taught.

At Adams School, where a controlled experiment in spelling was conducted, treatment differences were inconsistent. However, the average student gains across treatments in a seven-month period were 1.1 and 1.3 years for spelling and language respectively on the Stanford achievement. These gains were at least as great as those made by control students in other schools. The preceding results provide evidence that the R & I Units performed both their instructional and research functions well.

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