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The establishment of Research and Instructional (R and I) Units is discussed in terms of their utility and applicability for research needs. These units are said to provide a propitious setting for rigorous educational research. Two experiments in R and I units are described--one dealing with ways to implement feedback to students on their school performance and another concerned with the effectiveness of older children as models for younger children of the same ethnic background. Results from these first experiments are being used to design further studies of teaching-learning theory. (NH)

# CONTROLLED EXPERIMENTATION IN RESEARCH AND INSTRUCTIONAL UNITS*

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Educational researchers have long been plagued with the problem of finding enough experimental units to conduct research in the school setting. Typically, intact classrooms are available to the researcher, and the classroom is the only possible unit of randomization. In these instances the proper unit of analysis is the mean of each classroom. Of course, a large number of classrooms involving hundreds of children is required to provide data for a sensitive statistical test.

In the event that pupils within classrooms may be randomly assigned to the experimental treatments, a different problem is encountered. Experimental arrangements, such as the process of randomization and splitting into groups, the use of different classrooms and strange teachers, may be so unusual to the pupils involved, that these arrangements interact with the treatment. Such reactive arrangements, as they are termed by Campbell and Stanley (1963), jeopardize the generalizability of results.

In response to these experimental design problems, Research and Instruction (R & I) Units were conceived and established last year in elementary schools of five Wisconsin cities. An R & I Unit is staffed by a Unit leader, 3-6 certified teachers, and several para-professionals. The Unit leader typically has some advanced training in curriculum and educational psychology, including methodology. This team is responsible



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for the education of 100 to 200 children, perhaps from two or three grade levels. While distinctive features of this organizational plan incorporate the better features of team teaching, let us concentrate on the research capability of these units.

Of major importance is the flexibility which the Unit organization permits. Teachers and pupils typically change rooms as pupils are regrouped for instruction throughout the day. Assignment of pupils to new groups, instructors, or classrooms thus is an ordinary rather than unusual experience. Experimental arrangements requiring random assignment of pupils to groups are thus far less likely to react with the treatment than would be the case in experiments involving pupils from self-contained classrooms.

Teachers as well as pupils may be randomly assigned to treatments; furthermore teachers may be rotated among treatments so that a potential source of confounding is eliminated. In the R & I Unit staff the experimenter has persons to administer the treatments who are both qualified to teach and have some appreciation of requirements of experimental rigor. Use of teachers as experimenters not only makes the research generalizable to usual school situations where children are taught by certified teachers; it also exposes the teacher to new methods, contributing to his professional growth. Thus we may conclude that the R & I Unit provides not only a propitious setting for the conduct of educational research, in which several shortcomings of other arrangements are overcome, it also has some beneficial effects as well.

This is not to say that all the problems of conducting a true experiment in the school setting are solved. Strictly speaking, performing

the randomization on pupils is a necessary but not sufficient condition for their being treated as the unit of analysis. If the pupils are instructed as a group after randomization, then intrasession history, as well as the treatment, can affect the measurements gathered on a particular group. In several R & I Units last year, however, the experimental treatments were individually applied, and thus even this requirement for a true experiment was met.

Let us now consider two of the many experiments which were conducted last year in R & I Units. The experimental treatments in each instance were individually applied after pupils were randomly assigned to treatments. Both experiments represent attempts to translate motivational theory into practice in the school setting. The significance level for testing each null hypothesis was set prior to the experiment at .10, a level considered appropriate for preliminary research.

The first experiment was concerned with effective ways of implementing the principle that pupils should receive informative feedback relative to their school performance. Conducted in an inner-city school in Racine, Wisconsin, the experiment was designed to assess the effect of feedback on acquisition of mathematics concepts. The subjects were 72 children in a second grade R & I Unit classified as "disadvantaged" under Title I terms. The IQ's on the Kuhlman-Anderson ranged from 72-136, with a mean of 101. In October of second grade the mean grade equivalent score on the arithmetic subtest of the Stanford Achievement Test, Primary I battery was 1.6. Pupils were stratified by age--younger or older--and by sex. Twenty-four children, six from each age-sex group were randomly selected as experimental subjects. The remainder of the group served as a control.

All pupils received individualized mathematics instruction. To assist teachers in assessing each individual's progress, an individual record folder was designed. All the major concepts and subconcepts in mathematics were identified and compiled into a type of checklist in the individual folder. Beside each concept was a square to be colored in as an indication of the mastery of that concept. Diagnostic tests were developed for each main concept and subconcept. The format of the folder made it appropriate for use in parent-teacher and pupil-teacher conferences.

After each child's initial standing was determined using diagnostic tests and teacher observations, instruction was prescribed at an appropriate level. As many as four different instructional groups, each focusing on a different concept, were conducted simultaneously. Children were continually shifted among groups as concepts were mastered and new skills required. When a child appeared to have persistent difficulty in grasping one concept over a long period of time, he was allowed to go on to another group and return to the troublesome concept later. In this way, no child met consistent frustration, and individual mobility was assured.

The experimental pupils additionally met individually with a teacher for five minutes each week to discuss progress and identify goals for the following week. At this time the child was allowed to color in the square for the concepts acquired during the week and was praised and encouraged by the teacher. Each teacher met individually with six of the experimental students every week for five weeks; then teachers were rotated. In this way, the effect of a particular teacher on a child's progress was minimized. The duration of the experiment

was 20 weeks. Each pupil, experimental or control, had access to his folder at all times.

Two dependent variables were used to assess the effects of the experimental treatment--the number of concepts mastered (or squares colored in) during the experiment, and the score obtained on a teacher-constructed posttest, which sampled the tasks enumerated in the mathematics folder. The means for each group are presented in Table 1.

Table 1

Means on Dependent Variables for Experimental and Control Groups

| | Group | |
|---|---|---|
| | Experimental | Control |
| Concepts mastered | 100 | 75.0 |
| Score on posttest | 79 | 63.5 |

A multivariate analysis of variance was performed on the data. The results, presented in Table 2, indicate that the treatment was significant at the .10 level.

Table 2

Tests of Significance Using Wilks' Lambda Criterion

| | df | F | Probability |
|---|---|---|---|
| Treatment (T) | 2/51 | 2.479 | .094 |
| Sex (s) | 2/51 | 1.540 | .224 |
| Age (A) | 2/51 | 1.888 | .162 |
| T x S | 2/51 | .968 | .387 |
| T x A | 2/51 | .260 | .772 |
| S x A | 2/51 | 5.842 | .005 |
| T x S x A | 2/51 | 2.567 | .087 |

Since the superior performance of the experimental group can be attributed to social interaction, goal setting behavior, and praise, as well as to informative feedback, experiments have been designed this year to clarify the contributions of specific components of the treatment. In summary, the preliminary experimentation identified a motivational procedure which was successful in the classroom setting; thus encouraged, the teaching staff is ready to conduct more rigorous experiments which will further contribute to knowledge of the school application of theoretical constructs. Involvement of school personnel in generating the questions and executing the treatments has in this instance, made possible the iterative experimentation so necessary to learn why a procedure works. In an iterative cycle of experimentation, the results of an initial experiment are used to plan a subsequent, refined experiment in which further information may be gained.

A second experiment was planned to learn whether older children are effective models for younger children of the same ethnic background. Subjects in this experiment were educationally disadvantaged children in a Milwaukee inner-city school. The majority of subjects were Negro, and handicapped by such characteristics as short attention span, poor self-concept, inadequate motor skills and low IQ. The Pintner-Cunningham test administered in the fall to the first graders revealed a mean IQ of 81 with range being 55-105.

Fifty-seven children in the first grade R & I Unit were involved in the experiment. From these, 22 (11 boys, 11 girls) were randomly selected as experimental subjects to work with models. The remaining 35 served as the control group. Similarly, 22 sixth-graders (11 boys, 11 girls) were selected from the group of sixth-graders nominated by their

teachers to be appropriate models. The older pupils came from the same physical and socio-economic environment as the primary children.

Each sixth-grade "helper" was randomly assigned to an experimental subject of the same sex. The older-younger pairs so formed spent one-half hour per week together playing arithmetic games, manipulating concrete objects and helping with problem solving in an Instructional Materials Center environment. In order to minimize the disruption of schedules, the models reported at times most convenient to their individual timetables. Additionally, the sixth-graders were briefed for half an hour each week on appropriate activities for the younger children and reinforcement procedures. The three primary teachers each took responsibility for supervising the experimental treatment on a rotating basis.

All primary children received the same mathematics instruction four days a week. A televised mathematics program, Patterns in Arithmetic, Grade 1 was used, together with an accompanying manual and teacher-made worksheets. Large and small group instruction was used as appropriate. In addition, individual instruction was given to pupils when considered necessary.

A teacher-constructed test was designed to measure acquisition of the mathematics concepts presented during the fifteen-week experiment. The test was administered to all first graders at the conclusion of the experiment.

The means of experimental boys and experimental girls were higher than those of control groups of each sex, as Table 3 indicates.

Table 3

Means on Teacher-Constructed Test

| | Boys | Girls | Mean |
|---|---|---|---|
| Experimental | 16.00 | 21.27 | 18.63 |
| Control | 13.78 | 17.84 | 15.80 |

The analysis of variance performed on the scores indicated that both treatment and sex were significant sources of variation. The statistical analysis is presented in Table 4.

Table 4

Analysis of Variance on Scores of Teacher-Constructed Test

| Source | df | MS | F |
|---|---|---|---|
| Treatments (T) | 1 | 108.0886 | 3.3822 p <.0716 |
| Sex (S) | 1 | 295.9425 | 9.2604 p <.0037 |
| TS | 1 | 5.0827 | .1590 |
| Error | 53 | 31.9015 | |

Evaluation of the experiment also indicated that all experimental pairs were not compatible. Thus experiments in which the pairings are maximized for compatibility and model-effectiveness are a logical outgrowth of the one reported here.

Experience to date indicates that given significant results, the teaching staffs are eager to incorporate the treatment into the instructional program or to investigate further the effectiveness of the procedure. The interplay of ideas of the classroom teacher and R & D specialist--be he an educational psychologist, a curriculum expert, or

research methodologist--have resulted in empirical evidence of the applicability in the school setting of principles derived from motivational theory. That instruction has been improved simultaneously is evident from the field testing results* of schools with R & I Units.

In summary, the R & I Unit is so organized that the conduct of true experiments in the school setting is possible. Staffing and physical arrangements allow random assignment and individual treatment of pupils. Exemplars of such experiments, in which motivational theory was translated into practice, were given. Of promise for the future is the climate for iterative experimentation which has been created. Already results from initial experiments have been used to design subsequent experiments by which teaching-learning theory may be further refined.

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*Field test results may be found in either technical report listed in the references.