# How Effective Is a Student Goal Determined Course in Mathematics Education?

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***Studied here is the effectiveness of a student-centered approach in teaching basic concepts of mathematics needed by the elementary school teacher.***

FROM the embryonic beginnings of the elementary school, educators have not been satisfied that each child has been dealt with in the most effective manner for ensuring full utilization of whatever potential the child possesses. This dissatisfaction on the part of educators has led to many changes within the structure of the elementary school. Some of the earlier experiments in school organization were: the St. Louis Plan (1868), Multi-Track Grouping (1889), the Dalton Plan (1919), and the Winnetka Plan of the 1920's. Today, schools such as the Oak Leaf School in Pittsburgh, the Nova School of Ft. Lauderdale, and many others are continually experimenting with school curricula and administration.

In some parts of our nation, nongraded schools, individualized reading programs, linguistics, I.P.I., self-directed programs, television teaching, and other innovative techniques designed to deal more effectively with the individual are much in evidence.

Two of the questions asked by educators as well as by critics outside the profession seem appropriate: Are the end products of teacher education programs prepared to (a) utilize the ground work that these and other innovative programs have developed, and (b) continue to modify the school environment so as to more adequately meet individual needs?

As educators we are continually striving to provide children with the resources for individual and independent study. If we ac-

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cept this philosophy, then teacher education programs must be taught in such a way as to allow the participants a chance to experience personally the behaviors they are expected to develop in children.

The current literature on teacher education describes many innovative and experimental programs in teacher education. While many of these programs are improvements over what generally exists, this author believes that these programs lack the ingredient necessary to develop teachers that will be capable of guiding children in goal setting and independent learning; namely, direct experience in these activities by the prospective teachers themselves.

This investigator believes that one of the most promising experimental programs in teacher education, both innovative in terms of structure and realistic in terms of goals, is the Mid-Career Training for Partnership Teaching (MTPT). This program was created with funds supplied by the New York State Education Department and is sponsored by the Syracuse University School of Education in cooperation with University College of Syracuse University.

The emphasis of the MTPT program differs greatly from the typical predesigned teacher education program. One of the first tasks for each participant of the MTPT program was to write a goal paper stating her personal educational goals. By periodically reviewing, reevaluating, and rewriting the goal paper, each participant of the MTPT defines what her "education" is to consist of and in behavioral terms specify the criterion she seeks. The staff members of the MTPT then attempt to provide the students with a realistic method of reaching their goals.

An underlying assumption of the MTPT program is that student determined goals are more effective as motivators and should result in more efficient and pointed training than should teacher determined goals. Therefore, by allowing each student to define her goals, a more worthwhile and meaningful experience should take place.

A detailed description of the first year of the program, from the selection of the students to the goal setting procedures for the second year may be found in "The Mid-Career Teaching Education Study—Its First Year" by Newman and Pearson.[1]

## Problem

This study is designed to determine the effectiveness of utilizing a student centered approach as a means through which teacher preparation students acquire the basic concepts of mathematics needed by the elementary school teacher. These basic concepts of mathematics are defined by and to be measured with the Callahan Test of Mathematical Knowledge.[2]

The three questions to be specifically studied are:

1. Do the students enrolled in the MTPT show significant growth in the knowledge of elementary school mathematics needed by today's elementary school teacher?

2. Does the relative growth of mathematical knowledge possessed by the MTPT students compare favorably with the relative growth of mathematical knowledge demonstrated by students in a more typically formal preservice and in-service teacher education program?

3. Does the level of mathematical knowledge possessed by the MTPT students compare favorably with the general population of elementary school teachers?

## Design and Procedures

### Subjects

*MTPT students.* These students were enrolled in the Mid-Career Teacher Education Study at Syracuse University. The typical

[1] Robert Newman and Richard Pearson. "The Mid-Career Teacher Education Study—Its First Year." Report to the New York State Education Department, 1968.

[2] Leroy G. Callahan. "A Study of Knowledge Possessed by Elementary School Teachers, In-Service and In-Training, of the Cultural, Psychological, and Mathematical Foundations of the Elementary School Mathematics Program." Unpublished doctoral dissertation, Syracuse University, 1966.

student was female, approximately 34 years of age, married, and possessed a B.S. or B.A. degree from an accredited institution. These students were enrolled in a Student Goal Determined Course in mathematics education.

*Preservice students.* These students were enrolled in an Instructor Goal Determined Course at the undergraduate level. The typical student was female, 22 years of age, single, and had not completed requirements for a B.S. or B.A. degree.

*Normative group.* A random sample of elementary school teachers who were teaching in New York State during the 1965-1966 school year.

### Definitions

As previously mentioned, each MTPT student had defined her general educational goals. In the majority of these goal papers a concern about mathematics education was clearly evident. A brief chronologically-ordered description of the evolution of the Student Goal Determined Course, the major focus of this study, is as follows.

During April 1968, the first general meeting concerning mathematics was held and dealt with the students' expressed anxieties about mathematics. The students decided to observe the teaching of mathematics in the public schools, which they did during the months of April and May 1968.

In mid June, the MTPT students asked for "help." This led to the hiring of a mathematics consultant. The students conferred with the consultant and as a group decided to establish 15 one-hour periods to pursue the study of mathematics. These sessions were to begin in September 1968 and end in January 1969.

It was also agreed at this time that the 15 sessions were to be used to react to the students' questions. These questions were to be relayed to the mathematics consultant by means of weekly reaction sheets. Hence, it should be noted that the topics and sequence of the topics treated by the consultant were to be determined by the MTPT students rather than by the consultant.

Attendance at the instructional periods was to be optional for each student. However, all instructional periods were tape-recorded to provide the information for those students who might miss the sessions.

It was also decided by the MTPT students that no grades were to be given at the completion of the course. It was believed by the students that by not having to "work" for a grade the individual needs and interests of the students could be more fully met.

*The Student Goal Determined course* (SGD) as operationally defined by the MTPT students was one in which the students' reactions and suggestions set the major goals and determined the content, sequence, time, and evaluation procedures for the course.

*The Instructor Goal Determined course* (IGD) as operationally defined in this study is a course in which the major goals for the course were determined by the instructor with no prior consultation with the students. Hence, the instructor's goals determine the topics and sequence of the course. The instructor determined goals are, of course, strongly influenced by state certification and university requirements as well as his professional judgment. As with most such courses, attendance was required, class time was predetermined, and tests were used for evaluation and grading.

*Instructional time* as defined in this study consists of only prescheduled instructional hours.

The *independent variable* in this study was course structure. More specifically, the two types of structure studied were the Student Goal Determined course and the Instructor Goal Determined course. The major difference between these courses is considered to be the source of the goals for the course.

The *dependent variable* was mathematical knowledge. However, this investigator was not only interested in the final level of mathematical knowledge of the subjects but also in their growth. Growth is defined as post-test score minus the pre-test score. The final level of mathematical knowledge is defined as the post-test score. The dependent variable was measured by the Callahan Test of Mathematical Knowledge.

### Procedures

The experimental groups were randomly selected from the available populations. For the IGD, one of four scheduled sections was selected. For the SGD there was only one section of 33 people available, of these 25 were randomly selected for the experimental group.

The experimental groups were instructed during the fall semester 1968-1969. The SGD students had 15 one-hour sessions, while the IGD students had 30 one and one-half hour sessions.

Both groups were administered the Callahan Test, Form A, at the first meeting as the pre-test and the Callahan Test, Form B, as the post-test at their last session.

The instructors for the experimental groups had doctorate degrees with specialties in mathematics education and had taught similar content courses at the undergraduate level previously.

### Results

As these experimental groups are non-random populations, it is not appropriate to use inferential statistics in analyzing the data gathered during this study. Therefore, descriptive statistics will be used to support or negate the hypothesis previously stated.

Table 1 presents the comparison between the pre-test and post-test scores of the SGD students and IGD students.

As the results of Table 1 indicate, the growth (percent of pre-post test mean difference) for each experimental group is greater than 10 percent, which according to Brownell,[3] is educationally significant.

| Group | Pre-Test Mean | Pre-Test S.D. | Post-Test Mean | Post-Test S.D. | Mean Diff. | Mean Difference as Percent |
|---|---|---|---|---|---|---|
| SGD Students | 24.0 | 4.16 | 31.48 | 4.96 | 7.48 | +17.25 |
| IGD Students | 28.05 | 4.01 | 34.90 | 3.30 | 6.85 | +15.87 |

Table 1. Comparison of the Growth Between the Pre-Test and the Post-Test Scores of SGD Students and IGD Students on the Callahan Test of Mathematical Knowledge*

* The Callahan test consists of 44 test items.

| Group | N | X | S.D. | Median | Range |
|---|---|---|---|---|---|
| SGD Students | 25 | 31.5 | 4.96 | 31.25 | 22-41 |
| IGD Students | 20 | 34.9 | 3.30 | 34.66 | 26-39 |

Table 2. Post-Test Results of the Two Experimental Groups on the Callahan Test of Mathematical Knowledge

| Group | X | S.D. | Normative Group X | Normative Group S.D. | Mean Difference | Mean Difference as Percent |
|---|---|---|---|---|---|---|
| SGD Students | 31.5 | 4.96 | 20.43 | 7.24 | 11.17 | 25.76 |
| IGD Students | 34.9 | 3.30 | 20.43 | 7.24 | 14.47 | 33.15 |

Table 3. Post-Test Results of the Two Experimental Groups Compared with the Normative Group on the Callahan Test of Mathematical Knowledge

As noted in Table 2, the means, medians, standard deviations, and range of the two experimental groups are different. However it should be noted that although differences between the groups exist, these appear to be minimal in terms of practical significance.

Table 3 presents the post-test results of the two experimental groups compared with the normative group.

As the results of Table 3 indicate, the percent of mean difference between each of the experimental groups' post-test scores and the normative groups' scores was of considerable magnitude. From this evidence, one can conclude that the experimental groups were substantially more prepared in regard to mathematical knowledge than was the normative group.

The results of this study indicate that: (a) there was growth in mathematical knowledge for both the SGD and IGD students, (b) the two experimental groups, while being different statistically (from a descriptive point of view), did not appear to be educationally different, and (c) the experimental groups at the end of the course in mathematics education were substantially more knowledgeable regarding mathematics than was the normative group of teachers.

In view of the above, the SGD course in mathematics education seems to be as effective as an IGD course in mathematics education.

[3] William A. Brownell. *Arithmetical Abstractions: The Movement Towards Conceptual Maturity Under Differing Systems of Instruction.* Cooperative Research Project No. OE2-10-103. Berkeley, California: University of California, 1964. pp. 53-55.

### Discussion

An important criterion for the evaluation of any educational program is the amount of time required for the presentation of any given topic. In this study, the instructional time varied greatly from one group to another due to the goal setting procedures utilized. The SGD students received 15 hours of instruction while the IGD students received 45 hours of instruction.

At the end of the course in mathematics education, the SGD students were asked to make the following statement: "Counting seminars, class participation, observations, etc., I spent ____ hours studying mathematics last semester."

The mean hours spent studying mathematics reported by the SGD students was 33.72 hours. This is roughly one hour of outside work for each hour of scheduled classroom instruction.

It is interesting to note that although the SGD students' average *total* hours of mathematics education was 11 hours less than the IGD *instructional* time, the two experimental groups do not appear to be practically different regarding mathematical knowledge as measured by the Callahan instrument.

It is this researcher's belief that the main reason for this non-difference is that the environment provided the SGD students met an *immediate* and *indicated* need for these students and therefore the experience itself was meaningful. In other words, the conditions for effective learning appear to have been met and compensate for the shorter length of instructional time of the SGD course.

As the student goal determined course was one in which the students' reactions and suggestions led to the content, it is possible that there may be some topics which would not be introduced during their instructional periods.

In evaluating the reaction sheets submitted by the SGD students, it was found that no reference to geometry was made by any student, therefore, no instruction on the topic was given. Table 4 presents the item analysis of the five geometry test items on the Callahan instrument.

| Percent of Students Missing Item | | |
|---|---|---|
| Item Number | SGD Students | IGD Students |
| 87 | 76 | 35 |
| 88 | 84 | 25 |
| 89 | 56 | 35 |
| 90 | 76 | 30 |
| 91 | 24 | 35 |

Table 4. An Item Analysis of the Two Experimental Groups' Post-Test Responses to the Five Items on Geometry

As Table 4 illustrates, the percent of SGD students missing these items was much greater than the IGD students on four of the five items.

One conclusion which may be drawn from this evidence is that although a course is student goal determined, it sometimes might become the *responsibility* of the instructor to intervene in the selection of the topics to be discussed.

It is evident from reviewing current research that mathematics education is in need of change. While the findings of this study do not provide empirical evidence to support a specific direction for this change, it does offer some highly tentative patterns that are in need of more rigorously controlled research.

Some of the important questions left unanswered by this study include the following:

1. Will the SGD approach produce students more knowledgeable in mathematics than will the IGD approach given equal time?
2. What are the relationships between an SGD course and teaching competency?
3. Does participation in an SGD course in mathematics have any effect on the participants' attitudes toward arithmetic?
4. Is the SGD approach an effective procedure in content areas other than mathematics?

As some of these questions are answered by further research, we must be prepared to justify and evaluate future changes in curriculum and methodology in light of these and other related findings. □