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An Experiment in Improving the Attitude and Achievement of Students in Mathematics by Using Behavioral Objectives

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24

AN EXPERIMENT IN IMPROVING THE ATTITUDE AND ACHIEVEMENT OF STUDENTS IN MATHEMATICS BY USING BEHAVIORAL OBJECTIVES

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TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Since the beginning of formal instruction teachers have been trying to change attitudes of pupils toward particular school subjects. They have done this because it is generally agreed that pupil interest in a particular school subject may be a major factor in his success in that subject (6:44-5).

In recent years the writing of behavioral objectives has been tried in the hopes of increasing achievement and involvement. Some believe that writing behavioral objectives creates a better learning situation because the learner knows exactly what is expected of him, and the teacher and others can observe if the student has achieved the stated behavior. The student will also be able to evaluate his own progress (19:3-4).

There has been some speculation as to whether or not the writing of behavioral objectives could also be a significant factor in attitude development (18:13-15). The writer's view is that stating objectives behaviorally could be a major factor in the development of favorable attitudes toward particular school subjects.

Behaviorally stated objectives based on the developmental level of the learner might help develop a more favorable attitude by enabeling the learner to achieve greater success in that particular subject. This would be done by identifying a goal that would be within the range of ability of the pupil. This goal would then be stated behaviorally. The student upon being shown the behavioral objective would have it's meaning explained to him by the teacher. If the pupil accepts this goal as a worthy one, he will probably achieve the objective. James stated that success in a topic and attitude towards that topic are positively correlated (35:186). Behavioral objectives should be both challenging and within the ability range of the student. After success, not failure, has become the pattern, it seems reasonable to believe that the student will have a favorable attitude toward this subject. Pupils could enjoy mathematics more because it is a generally accepted idea that pupils tend to like to be engaged in those subjects in which they do well (18:11, 28).

I. THE PROBLEM

Statement of the problem. The purpose of this study is to determine if pupils who have been engaged in an individualized mathematics program in which goals have been stated in behavioral terms and explained individually to the pupils have a significantly more favorable attitude towards mathematics than pupils who have been engaged in an individualized mathematics program. Measuring of attitude would be done by placing the pupils in a series of situations in which they were forced to make an individual choice between a mathematical activity and a nonmathematical activity. For example, a pupil must choose between viewing a film on mathematics or a film on reading. In choosing, he is showing a preference for that one over the other.

An additional purpose is to determine if pupils who engage in an individualized mathematics program, in which goals have been stated in behavioral terms and explained individually to pupils, will achieve significantly greater scores in mathematics than pupils who engage in an individualized mathematics program in which there are no behavioral stated goals. Measuring would be done by administering the Iowa Test of Basic Skills, Form A in mathematics as a pre-test and the Iowa Test of Basic Skills, Form B in mathematics as a post-test.

Significance of the study. The significance of this study lies in determining if known behavioral objectives can be a significant factor in effecting attitudinal change and/or achievement of pupils in mathematics. This knowledge could be an important contribution to the field of education by giving teachers a research based factor upon which to build a theory of instruction in, not only mathematics, but all curricular areas.

Hypothesis. In this study the following null hypothesis will be tested:

> There will not be a significant attitudinal difference towards mathematics between a group of pupils who engage in an individualized mathematics program and a group of pupils who engage in an individualized mathematics program in which individual pupil goals have been stated behaviorally and explained to the pupil.

A second null hypothesis will also be tested. This hypothesis is:

> There will be no difference in achievement in mathematics between a group of pupils who engage in an individualized mathematics program and a group of pupils who engage in an individualized mathematics program in which individual pupil goals have been stated behaviorally and explained to the pupil.

Limitations of the study. The population for this study did consist of twenty-eight ten and eleven year old pupils in a self-contained, nongraded classroom at Hebeler Elementary School in Ellensburg, Washington. It is not known if this population is representative of the ten and eleven year old population in the United States.

The "Hawthorne Effect" could enter into this study. The control group could find out that the experimental group is experiencing a variable that the control group is not. This could influence the attitudes of both groups and invalidate the data. Separation of the two groups during mathematics will minimize this factor.

Another limitation could be the time limit of the experiment. Too little is known about the length of time that it takes for attitudes to develop and change. The nine weeks of study could be too short in time for attitudes to change.

Changing procedures from a previously developed classroom procedure could also initially inhibit growth. Again, the length of time is a definite limitation of this study.

II. DEFINITIONS OF TERMS USED

Behavioral objective. A behavioral objective is defined as being a written statement that states the visible behavior that will be exhibited by the learner at the completion of the task. It includes (1) the behavior expected; (2) conditions under which the behavior is to occur; (3) minimum acceptable performance criteria.

Favorable attitude. For the purposes of this study favorable attitude shall be interpreted as a way of acting in which the pupil shows a preference for one thing over another thing and/or idea.

Experimental group. The experimental group is that group for which one factor is varied while the others remain constant. In this study the variable factor is the writing of individual pupil behavioral objectives for pupil performance while explaining each of the objectives to each pupil. The experimental group had individual behavioral objectives for mathematics while the control group did not have any behavioral objectives written for them.

Control group. The control group is that group which did not experience the variable factor of having behavioral objectives written and explained to them.

III. ORGANIZATION OF REMAINDER OF THE THESIS

The remainder of the study enlarges upon the following material:

Chapter II presents a review of the research concerning the relationship of attitude toward achievement. The role of behavioral objectives is also discussed.

Chapter III deals with a detailed discussion of the procedures employed in this study.

Chapter IV reports the findings of the study and the analysis of the data.

Chapter V summarizes and presents conclusions based on the findings drawn from the study. Implications relevant to the study are presented as well as suggestions for further research.

CHAPTER II

REVIEW OF RELATED RESEARCH

Need for study in mathematics. New programs have been developed, initiated, examined, and studied. Most of the research has measured the achievement of the students. Some of these investigations have emphasized the importance of studying factors other than achievement in these new programs.

Poffenberger and Norton (23) indicate from their survey that we should focus some intensive research upon the development of attitudes by pupils toward mathematics. Also emphasizing the idea that attitude and its relationship to mathematics should be explored extensively is Hungerman (14).

In another vein, Suydam in 1967 (24) declared that educators should consider the idea that research could be used in developing a theory of instruction. "Our greatest need," reported Glennon (25), "for the improvement of the elementary school mathematics program is a theory of instruction implemented in the form of worthwhile research carried out and reported adequately by workers of integrity."

<u>Relationship between achievement in mathematics and attitude toward mathematics</u>. Many people believe that factors other than intelligence have an important effect upon achievement in mathematics. Many recent studies have attempted to investigate the importance of attitude in relation to achievement in mathematics.

Dickey and Taylor (30:181-3) in summarizing studies done by Brown in 1933, Dutton in 1951, Dutton in 1956, Chase in 1956, Rogers in 1957, Johnson in 1957, Cooke in 1954, Stone in 1958, and Clark in 1951, state that the major conclusion seems to be that "attitudes must be considered in a successful arithmetic program." They also point out that there are superior methods of teaching that establish a better learning environment for the pupil in mathematics.

Concluding that studies show that "liking of arithmetic is closely associated with success or failure" in arithmetic were Marks, Purdy, and Kiney (19). How "popular" a subject is with a student does not determine how well he will achieve in that subject but Fledjake (11) believes that achievement in a subject and "reasonable acceptance" are highly and positively correlated. Agreement with this emerged in a study done in 1964 that investigated attitude toward problem solving in mathematics. It was concluded that favorable attitudes toward problem solving were significantly and positively correlated to arithmetic achievement. At the same time there was found to be no correlation between attitudes and I.Q. or socio-economic status (17).

Furthermore Chrislantiello (8) came to the conclusions that it was more difficult to predict mathematics achievement test scores for students who had a less favorable attitude toward math than it was to predict math achievement test scores for those students who had a neutral attitude toward mathematics.

In addition, Neidt and Hedlund (21), concluded from their study that "student attitudes toward a particular learning experience do become progressively more closely related to achievement in learning experiences as the period of instruction progresses. Lundgren also states that attitudes toward problem solving in mathematics was found to be significantly and positively correlated to mathematics achievement in fourth grade pupils in Brazil (17).

On the other hand, in an investigation involving a fourth grade classroom in California, Abrego (1) found that there was little positive relationship between attitudes and achievement. But she warns that generalizing from her study may not be valid because of the high percentage of above-average subjects in the group sampled. While the majority of the research does indicate a high positive correlation between attitude and achievement, there still seems to be some doubt.

The role of behavioral objectives. Objectives have always been an important part of the teaching process, but objectives stated behaviorally are at the present time just becoming known to educators (19:v). As a consequence of this "newness" no research, as far as this writer is able to ascertain, has been conducted testing the effect of behavioral objectives on achievement or whether they will bring about a different attitude toward a psychological object.

It is the investigator's desire to examine behavioral objectives in terms of its effect upon achievement and attitude change before they become a standard classroom procedure for him. In this way a theory of instruction can be built upon a foundation of tested research.

Robert Mager introduced the educational community to behavioral objectives with his book Preparing Instructional Objectives in 1962 (19). "If you are interested in preparing instruction that will help you reach your objective, you must first be sure that your objectives are clearly and unequivocally stated" (19:1). Mager stated further that evaluation cannot be done when clearly defined objectives are not present. It isn't fair or practical to expect a student to achieve a goal that he is unaware of. Both the teacher and the student must have the goal firmly fixed in their minds (19:3-4).

"Another additional advantage of clearly defined objectives is that the student is provided the means to evaluate his own progress at any place along the route of instruction and is able to organize his efforts into relevant activities." To accomplish the goal he must know what the goal is and what behavior shows that the goal has been reached. Then the student and teacher can both clearly see if the goal has been attained (19:3-4).

In our previous discussion on attitude development and summarized here by James, he says, "We are usually interested in topics which are relevant to ourselves, and which we understand and appreciate." Having a favorable attitude toward a subject is basic to being successful in that subject (35:207). Furthermore, Sanford (39:369) explains that a person's attitude can hinder a pupil in his search for a solution to a problem even though he consciously desires to solve the problem.

There is also evidence, according to McKeachie and Doyld, that it is possible to change a person's attitudes and beliefs by associating an object with pleasantness or unpleasantness (36:579). "A prolonged series of striking favorable or unfavorable experiences can effect a change in attitude (38:528).

Mager in a second book, Developing Attitudes Toward Learning printed in 1968, implies how behavioral objectives can be helpful in developing and changing attitudes.

To help a student develop a positive attitude toward a subject he must have a positive or successful association with this subject. Perhaps the best way to achieve this is to spell out the objective clearly in terms of behavior. The goal must be within the range of ability of the student. In helping the student to be successful the positive conditions are accentuated and the negative conditions are minimized (18:12).

Fear of the subject is then eliminated. Frustration and boredom are not felt toward this subject. The student then is relatively comfortable in the presence of this subject. "A subject least favored tends to get that way because the person seems to have little or no aptitude for it, because . . . being in the presence of the subject is often associated with unpleasant conditions (18:37).

Summary. Most educators feel that attitude toward a subject plays an important part in helping students perform near their potential in that subject. Research tends to back this up, but the correlation is not felt to always be so strong. As indicated by Mager, a way to improve a student's attitude toward a subject is by helping him to achieve behaviorally stated objectives. In this way a positive association toward this subject is likely to be made by the student. The possibility could be maximized that he will remember what he has been taught. This further increases his achievement and success, becomes associated with the subject, and thus improves his attitude toward this subject (35:158).

CHAPTER III

PROCEDURES USED IN THE STUDY

Population. From the twenty-eight students enrolled in Dr. Sheridan's class at Hebeler Elementary, an experimental group and a control group were established. The population of the control group and the experimental group was determined by alphabetically assigning each of the twenty-eight students a number and then, using a table of random numbers, assigning the first fourteen numbers encountered to one group and the remaining fourteen to the other group. A toss of a fair coin determined which was the experimental group and which was the control group. A second toss determined which group had mathematics during the first period of the morning and which had it during the second period of the morning for the first part of the study.

For the first half of the study, four and one-half weeks, the experimental group had mathematics during first period and language arts second period while the control group had a language arts class during first period and mathematics second period. At the end of approximately fourty-five minutes the two groups switched classes.

At the midpoint of the study the two groups switched mathematics times. The control group then had mathematics first period and language arts second and the experimental group had language arts class first period and mathematics second period. This exchanging was done to eliminate the variable of time of day being a factor in achievement or attitude development.

Instruments and procedure. The Iowa Test of Basic Skills, Form A in mathematics was administered after the experimental and control groups were established. This was a pre-test to determine if there was an apparent difference in achievement between the control group and the experimental group. The *t*-test was used to determine if this difference was significant.

Following completion of the Iowa Test of Basic Skills, Form A in mathematics, the experimental mathematics program was begun.

The control group continued with the individualized mathematics program which they had engaged in since the beginning of the school year. This program consisted of students individually working at their own rates in basal mathematics materials. The teacher served in several capacities: (1) helping students to clarify the textbook; (2) teaching individually the mathematical processes and skills; (3) providing directions; and (4) providing encouragement.

The experimental group continued with the individualized mathematics program they had been engaged in since the beginning of the school year. They used the same series of textbooks as the control group. Each student worked at his own rate individually. In addition to (1) clarifying the textbook; (2) teaching individually the mathematical processes and skills; (3) providing directions; (4) and providing encouragement; (5) the teacher wrote, with the individual student's help, behavioral objectives for each individual student. (See the appendix for actual behavioral objectives written for these students.) The same teacher also worked with the control group.

On completion of the nine weeks of the experiment, the twenty-eight pupils were administered the Iowa Test of Basic Skills, Form B in mathematics to check the achievement of the pupils in mathematics. According to the null hypothesis, it was predicted that there would be no significant difference in achievement in mathematics between the experimental group and the control group. The *t*-test was again used to determine if there was any significant difference in achievement.

To test attitudes toward mathematics, the twenty-eight pupils were forced to make a series of choices in which they had to choose between a mathematics activity and a nonmathematics activity. These activities occurred at times other than during the regular mathematics time. The series of mathematical and nonmathematical choices were as follows:

1. Helping younger children with mathematics or writing.
2. Playing an arithmetic game or a spelling game.
3. Watching a mathematics film or a reading film.
4. Constructing a mathematics corner or a science corner.
5. Working in a mathematics corner or a science corner.
6. Visiting a computer or a newspaper printing plant.
7. Working a mathematics puzzle or a social studies puzzle.

The students were individually handed a dittoed form upon which they were to mark their preference of activity. Each pupil made his choice without knowing what the other pupils' choices were. The pupils had to make no more than two decisions per day. Five days were used in conducting the seven activities. The activities took place as soon as possible after the choices were made. In most cases it was immediately. Those that were scheduled later were done so because of the nature of the activity. By making a preference, the student showed a favorable attitude toward the mathematical or nonmathematical activity. The teacher kept tally of those individuals who engaged in the mathematical and the nonmathematical activities.

The null hypothesis stated that there would be no significant difference in attitude toward mathematics between the control group and the experimental group. No significant difference was found in numbers of pupils selecting math or nonmath activities by one group over the other group.

The Chi square was used to determine if there was any significant difference in the number of times pupils from the control group or the experimental group engaged in mathematical or nonmathematical activities.

CHAPTER IV

RESULTS OF THE STUDY

I. ACHIEVEMENT TEST RESULTS

Mean scores of control group and experimental group in mathematics achievement pre-test. Table I presents the mean raw scores of the experimental group and the control group on a pre-test (the Iowa Test of Basic Skills, Form A in mathematics) given to check the difference in achievement in mathematics between the two groups. It further shows a value of *t* to indicate whether or not there is a statistically significant difference between the scores of the two groups.

TABLE I

COMPARISON OF MEAN SCORES ON THE PRE-TEST FOR THE CONTROL AND THE EXPERIMENTAL GROUP

Group	N	Mean	Obtained *t*
Control	14	30.357	.35*
Experimental	14	29.0	

Required *t* to be significant = 2.048
*Not significant at the .05 level of confidence

Table I shows that there was no significant difference in achievement level in mathematics of the control group and the experimental group. The two groups were approximately equal in mathematics processes and skills at the .95 level of confidence before the experimental program began.

<u>Mean scores of control group and experimental group in mathematics achievement post-test</u>. Table II presents the mean raw scores of the experimental group and the control group of a post-test given to check the difference in achievement between the two groups after an experimental mathematics procedure involving behavioral objectives had been conducted. The test given to measure achievement was the Iowa Test of Basic Skills, Form B in mathematics. The table also gives a value of *t* to show if a significant difference is present.

Table II on page 22 indicates that after nine weeks in the experimental program there was no significant difference in achievement test scores between the two groups. The control group's mean score was higher, but not significantly higher. The null hypothesis of no difference is supported.

TABLE II

COMPARISON OF MEAN SCORES ON THE POST-TEST FOR THE CONTROL AND THE EXPERIMENTAL GROUP

Group	N	Mean	Obtained *t*
Control	14	36.357	.74*
Experimental	14	33.74	

Required *t* to be significant = 2.048
*Not significant at the .05 level of significance

II. ACTIVITY CHOICES

Number of students from control and experimental groups that chose mathematics activities. Table III on page 23 presents the number of students from the experimental group and the control group who chose the mathematics activities over the nonmathematical activities, thereby displaying a preference for the mathematical activity. Activity choice number one was presented to the pupils Monday morning, March 10. The choices were to view a film on mathematics or to view a film on reading. The second activity choice was presented to the pupils on the same Monday afternoon. Constructing a mathematics corner or constructing a science corner were the two choices for

TABLE III

NUMBERS OF STUDENTS CHOOSING THE MATHEMATICS ACTIVITY OVER THE NONMATH ACTIVITY

Activity Choice	Group	Number	Chi Square
1	Experimental	6	
	Control	6	
2	Experimental	2	
	Control	0	
3	Experimental	4	
	Control	6	
4	Experimental	6	
	Control	6	
5	Experimental	5	
	Control	9	
6	Experimental	11	
	Control	11	
7	Experimental	7	
	Control	6	
	Total Experimental	41	.10*
	Total Control	44	.10*

Required Chi square to be significant = 3.84

*Not significant at the .05 level of confidence activity number two. The next morning on Thursday, the third activity choice was given to the pupils. The two choices were to play a spelling game or to play a mathematics game. Two more activity choices were placed before the pupils on Wednesday, March 12. The first of these, activity choice number four, had two alternatives. They were to work a social studies puzzle or to work a mathematics puzzle. The fifth activity choice again had two possible choices. The first was to work with younger children in mathematics and the second was to work with younger children in writing. On Thursday the following choices made up the sixth activity choice: visit a computer or visit a newspaper printing plant. The last activity choice was placed before the pupils on Friday, March 14, with the choices of working in the mathematics corner or working in the science corner.

Table III, page 23, also displays a Chi square value to show if there is any significant difference in the number of students from the experimental group over the control group in choosing the mathematical activities over the non-mathematical activities.

Table III indicates that there was no statistically significant difference in the number of students from the experimental group who chose the mathematics activities as compared to the number of students from the control group who chose the mathematics activities.

CHAPTER V

SUMMARY AND CONCLUSIONS

I. SUMMARY

The purpose of this study was to test whether behaviorally stated objectives would effect a change of attitude toward mathematics while improving students' achievement in mathematics. The investigation was conducted by means of a comparison of an experimental group that received individually written behavioral objectives in mathematics and a control group.

The study was conducted in the Hebeler Elementary School located on the campus of Central Washington State College, Ellensburg, Washington, during the school year 1968-1969.

The two groups were the twenty-eight pupils from a self-contained classroom that were randomly assigned to either the experimental or control group.

The achievement pre-test was administered prior to instruction. Following nine weeks of instruction, the post-test in achievement was administered to determine the degree in difference in achievement between the experimental group and the control group.

As a means of evaluating attitude toward mathematics, students were placed in situations in which they had to choose between participating in a mathematics activity or a nonmathematics activity. By making a preference for that activity they were showing a more favorable attitude for it over the other activity.

A _t_-test was applied at the .95 level of confidence to determine if there was a statistically significant difference in the achievement scores. A Chi square was used to determine if there was a significant difference in the numbers choosing the activity choices.

II. CONCLUSIONS

When the pupils from the experimental group, who received the mathematics behavioral objectives, are compared with the pupils from the control group, which did not receive the behavioral objectives, there was no significant difference in mathematic achievement test scores.

The findings substantiate the original null hypothesis:

> There will be no difference in achievement in mathematics between a group of pupils who engage in an individualized mathematics program and a group of pupils who engage in an individualized mathematics program in which the teacher, with the pupil's help, has stated the goals behaviorally.

Thus the null hypothesis was accepted in that there was no significant difference based on whether or not behavioral objectives were used in mathematics. It is interesting to note that the control group's mean achievement score on the post-test was higher, though not significantly, than the experimental group's mean score.

In the activity choices, testing attitude toward mathematics, there was no statistically significant difference in the number of pupils from the experimental group who chose the mathematics activity and the number of pupils from the control group who chose the mathematics activity. As indicated by the table, the differences in the numbers from the two groups was due purely to chance. This study supports the second hypothesis:

> There will be no difference in attitude toward mathematics between a group of pupils who engage in an individualized mathematics program and a group of pupils who engage in an individualized mathematics program in which the teacher has, with the pupil's help, stated the goals behaviorally.

It is the writer's belief that behavioral objectives do have a potential to increase achievement and change attitudes. This study fails to support this statement for the following reasons:

1. Nine weeks may be too short a time to change an attitude that could have been developing for ten or eleven years.
2. The students' attitudes toward mathematics may have been more strongly pronounced than is generally so. The pupils appeared to either strongly like or dislike mathematics. A psychologist (38:372) has stated that people with strongly felt attitudes are more likely to resist changing them.
3. The experimental group deviated from previously established procedures which could have been confusing, thereby causing a drop in achievement and/or a partial change in attitude toward mathematics. It could have taken considerable time during the nine weeks for the experimental group to become accustomed and adjusted to the new procedure of the teacher and student cooperatively writing

behavioral objectives. The control group was unaware of and was not subject to this possibly disruptive or disturbing factor.

III. RECOMMENDATIONS

Recommendations for further research. The following questions, as indicated by this investigation, need to be studied further:

1. Is nine weeks too short a time to change pupils' attitudes toward mathematics? In experiments involving attitudinal change, the writer recommends that the experiment run for at least six months and preferably the entire school year. This may give students adequate time to modify their attitudes and become fairly comfortable and stable with this new attitude.
2. Does a deviation from previously established procedure cause a drop in achievement and/or a partial change in attitude toward mathematics? The writer recommends, in similar studies, that the experiment begin at the start of the school year before procedures are established. Then

both of the groups would be simultaneously making adjustments to different procedures established by their new teacher.

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APPENDIX

EXAMPLES OF BEHAVIORAL OBJECTIVES USED IN THE EXPERIMENTAL MATHEMATICS GROUP

Student A, after demonstration by the teacher and completing pp. 60-62, will demonstrate his understanding of fractional remainders by solving the division problems on p. 63 by Feb. 3, with less than 6 wrong.

Student B, after demonstration by the teacher and completing the fraction problems on pp. 66-67, will demonstrate his understanding of adding and subtracting fractions by completing pp. 70 and 71 by Feb. 10, with less than 5 wrong.

Student C, after completing problems 1-12 with teacher help, will demonstrate his understanding of division by two digets by solving the division problems on pp. 13-14 by Feb. 5, with less than 5 wrong.

Student D, after completing pp. 31 and 32, which demonstrate the solving of unknown factors, will demonstrate his understanding of unknown factors by solving the problems on p. 23 concerned with unknown factors by Feb. 19, with less than 2 wrong.

Student E, as a result of teacher demonstration and practice on the board will demonstrate his understanding of multiplying by two digets by solving the multiplication problems on p. 29 by Feb. 14, with less than 1 wrong.

Student F, with teacher help, will complete pp. 31 and 32 and as a demonstration of her understanding of unknown factors, she will solve the problems on p. 33 concerned with unknown factors by Feb. 11, with less than 4 wrong.

Student G, with practice and as a result of demonstration by teacher, will demonstrate her understanding of division by solving the division problems on p. 44 using the short method and completing this goal by Feb. 18, with less than 1 wrong.

Student H, as a result of his spending 15 minutes daily working on his multiplication facts, will increase his score on a three-minute timed test by Friday, Feb. 7, by 12 points.