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ABSTRACT

The purpose of this study was to examine first-grade students' achievement in mathematics and attitudes toward mathematics using different instructional approaches. Two classes of first grade students participated in this study. One class was taught by a teacher using a direct instructional approach while the other class was taught using a constructivist approach. The Metropolitan Achievement Test, interviews, student observations, and student journals were used to collect data. Results indicate that there is no significant difference on achievement tests between the constructivist approach and the direct instruction approach. Findings suggest that the method of delivery of instruction between constructivist and direct instruction classroom environments does not affect student mathematical achievement. Implications of the study and recommendations for future studies are discussed. (Author/KHR)

Attitude and Achievement Using Two Approaches for First-Grade Mathematics Instruction

By
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Introduction

International test results indicate that students in the United States are not measuring up to world standards in mathematics education (Akin & Black, 1994; Clements, Swaminathan, Hannibal, & Sarama, 1999; U.S. Department of Education, 1996). A look at the past 50 years of mathematics education provides a record of past and present reforms and the lessons learned from these efforts. The mathematics reform movement and mathematics education communities worked together to present a vision of mathematics to take the United States from the 20th century to the 21st century. Educators need to produce citizens who are able to understand the power of mathematics and work together with others to use mathematics to solve problems encountered in their personal and professional lives (Brophy & Evertson, 1976; Grady, 1984; Schmidt, McKnight, & Raizen, 1997).

The United States is in the midst of a reform movement in education, particularly in mathematics. This reform movement is, in part, a result of national and international studies showing that the majority of U.S. students are not performing in mathematics at the same level as other countries, notably Japan (U. S. Department of Education, 1996). Students in all grades are able to do low-level tasks, such as routine computations with whole numbers, and are able to solve one-step problems, but too many students cannot use these skills to solve problems involving more than one step or requiring higher-order thinking skills (Haspeslagh & Wittenauer, 1989; Perry, 2000; Schoenfeld, 1992).

The reasons for poor performance are complex, involve many factors, and point out the need for reform. This need is based on changes in society and in the workplace;

the existence of a technology capable of performing complex computations; the discovery of new mathematics through the use of this technology, and changes in educational practice and instruction (Carey, Fennema, Carpenter, & Franke, 1995; Wood & Sellers, 1997). Deciding how to teach is a problem that all teachers face throughout their careers. Ideas about how to teach often come from informal sources, such as personal experimentation and reflection, observation and dialogue with colleagues, and memories of one's own teachers (Kieran, 1998; Kline, 1973; Massell, 1993; Steele, 2000).

Numerous research findings have indicated that children enter school with a rich repertoire of conceptually based self-generated algorithms and problem-solving strategies (Baroody, 1987; Carpenter, Moser, & Romberg, 1982). However, as a consequence of direct instruction in the early grades, children have learned to rely on instrumental procedures at the expense of sense making. Children have been able to follow prescribed rules, but have not been able to give conceptually based meaning to what they are doing (Crowley, 1987; Leinhart, 1992). The problem-centered instructional activities have helped provide learning opportunities in which conceptual and procedural knowledge go hand in hand in developing better problem-solving skills. According to Leinhart, the constructivist instructional approach has led to higher achievement, which in turn has led to a more positive attitude among students toward mathematics.

Even though constructivism has appeared to be one of the more positive approaches to teaching children mathematics, research done by Rosenshine (1976) has demonstrated otherwise. In a review of several teacher effectiveness studies, Rosenshine discussed teacher behaviors that have appeared to produce greater student achievement and attitudes toward mathematics. Positive significant results were obtained for direct time, factual questions, teacher positive feedback, supervised study in groups, and attention to task. Teachers who exhibited more casual teaching techniques and allowed students to solve their own problems were considered not as productive as those who were more structured in their instruction.

Along with attitude and achievement in mathematics, another primary goal of mathematics instruction has been to assist children in developing the belief that they can do mathematics (Wheatley, 1991). Students' beliefs, feelings, and perceptions that have appeared to be related to the learning of mathematics are confidence in learning mathematics, mathematics anxiety, perceptions of the causes of success and failure in school, and learned helplessness. The self-concepts of students have been heavily influenced by those who treated them as able, valuable, and responsible--as well as by those who treated them as unable, worthless, and irresponsible (Kieran, 1998).

Studies on confidence in learning mathematics in grades K-4 have investigated the relationship between students' achievement and attitude and teacher instruction. According to Carl (1995), the mathematics classroom atmosphere should be relaxed, positive, and supportive. Students should be given successful experiences so they will feel confident. Teachers need to model problem-solving strategies rather than present a finished product. One way to do this has been to let students present suggestions, try their ideas, and let them see why they do or do not work. Students need to be able to share their strategies and their thinking processes so they do not get the idea that some students can do mathematics while others can not.

Statement of the Problem

To meet the National Council of Teachers of Mathematics ([NCTM], 2000) goals that students "learn to value mathematics" and "become confident in their ability to do mathematics," research findings must be translated into classroom practices (Willoughby, 1990). Teachers and researchers must continue to seek answers to the questions of what approach to instruction is best and how teachers can foster the development of positive attitudes and beliefs in mathematics. They can then use this information to determine how instruction, assigned tasks, and the classroom environment are influencing these attitudes and beliefs and design learning environments that encourage students to become positive, motivated, confident, and persevering learners of mathematics.

Purpose of the Study

Two types of instruction are currently employed by the majority of elementary mathematics teachers: direct instruction or a constructivist approach. Both types of instruction seem to produce desirable outcomes to some extent. The purpose of this study was to examine first-grade students' achievement in mathematics and attitudes toward mathematics using two different instructional approaches.

Significance of the Study

This study has importance in mathematics teaching and curriculum planning in light of the growing need for competent mathematics students for the 21st century. This study is significant because of the controversy over which type of instructional method in mathematics produces better achievement and attitude with students. With this need in mind, educators must try different instructional techniques to reach these children and help them develop better mathematics achievement and attitudes. Research has linked the achievement of students in mathematics with their attitudes toward the subject. It is evident that students work harder to strive to do their best if the subject is felt to be meaningful and useful. To make mathematics meaningful, teachers must examine effective instructional techniques that will benefit students, thus, resulting in student competency.

Research Questions

Research Question 1: Is there a difference in achievement toward mathematics of first-grade students who have been taught through a constructivist approach and students who have been taught through direct instruction?

Research Question 2: Is there a difference in attitude in mathematics of first-grade students who have been taught through a constructivist approach and students who have been taught through direct instruction?

Research Question 3: What is the relationship between achievement and attitude toward mathematics of first-grade students?

Methodology

Two classes of first-graders were used for this study. Each class had 22 students. One class was taught by a teacher using a direct instruction approach while the other class was taught by a teacher using a constructivist approach.

Research Question 1 was concerned with achievement of first-grade students when taught by one of two methods: a constructivist approach and a direct instruction approach. To answer this question, the Metropolitan Achievement Test (6th ed.; MAT6) was administered as a pretest and a posttest. The statistical procedure used to analyze the differences was repeated measures ANOVA.

Research Question 2 dealt with attitude of first-grade students when taught by one of two methods: a constructivist approach and a direct instruction approach. To answer this question, the Roland Attitude Scale was administered to the students by the researcher as a pretest and posttest. The statistical procedure used to analyze the differences was repeated measures ANOVA. To gather more in-depth information on attitudes of students toward mathematics, the researcher collected additional data through student observations, student interviews, and student journals.

Research Question 3 discussed the relationship between achievement and attitude in mathematics. The statistical procedure used was the Pearson r to determine whether any correlation existed.

Instruments

Metropolitan Achievement Test (6th ed.)

The Metropolitan Achievement Test (6th ed.; MAT6) continues to be a strong competitor among achievement test batteries. The developers have succeeded in achieving their primary mission of updating their materials to be better aligned with the changes in the school curriculum, in assessment trends and methods, and in providing normative information and interpretive materials (The Psychological Corporation, 1993). The mathematics section of this test was the only part that was administered for this study. It consisted of two subtests: mathematics computation and mathematics problem solving. Content validity, or the extent to which the test items reflect an appropriate sampling of the goals of instruction, is thoroughly demonstrated and presented in the

MAT6 Compendium of Instructional Objectives. The publisher reports completion rates at 100% for Grade 1. Pre-primer, Form L, was used as the pretest and the posttest.

Two measures of reliability were reported for each test. KR_{20} reliability coefficients were reported for every grade, while alternate form coefficients were reported for one selected grade within each level. Most of the subtest values were between .80 and .89.

Roland Attitude Scale

In order to determine mathematics attitude, an attitudinal instrument, the Roland Attitude Scale was used. It had been developed and validated by Leon Roland from the University of Western Oregon. The instrument, user's manual, and information regarding the validation procedures and results were obtained from the author. The instrument was developed for use in Grades 1-3 and was a primary grade revision of the Fennema-Sherman Anxiety Scale. The Roland Attitude Scale has four individual scales, Confidence in Learning Mathematics, Usefulness of Mathematics, Mathematics as a

Male Domain, and Attitude Towards Success. The scale of 44 items consisted of faces using smiles, frowns, and straight lines. The test/retest reliability scores for the scales at Grades 1 through 3 are .78, .52, and .81, respectively. The entire scale was correlated with the original Fennema-Sherman Anxiety Scale to establish concurrent validity (Roland, 1979).

Analysis of Data

This study was concerned with research findings that resulted from the comparison of attitude and achievement of first-grade students on pretests and posttests during a study of mathematics in a constructivist and a direct instruction classroom setting. Two instruments, the Metropolitan Achievement Test (6th ed.; MAT6) and the Roland's Mathematics Attitude Scale were administered to two sections of first-grade students. Interviews were conducted with 12 students (six from each classroom) with equal representation of males and females from each class. Additional data were obtained from student observations and student journals.

Research Question 1

Research question 1 sought to determine whether there was a significant difference in achievement in mathematics of first-grade students who have been taught through a constructivist approach and students who have been taught through direct instruction. A repeated measures ANOVA was conducted using $p < .05$ level of significance. The assumptions for the repeated measures ANOVA of (a) independent, random samples, (b) normal distribution, and (c) homogeneity of variance were met. The independent variables were the types of instruction (constructivist and direct instruction). The dependent variables were the achievement pre-and posttests.

Pretest and posttest scores obtained from the mathematics achievement scores of the MAT6 were used for this research question. The means and standard deviations of pre- and posttest mathematics achievement scores are contained in Table 2.

Table 2

Means and Standard Deviations for Pretest and Posttest Achievement MAT6 Scores by Types of Instruction

Types of Instruction	Mean	SD	n
Pretest			
Constructivist	85.27	12.97	22
Direct Instruction	83.55	13.12	22
Posttest			
Constructivist	85.73	9.12	22
Direct Instruction	82.64	9.79	22

Results from the within-subjects analysis of variance procedures for achievement in mathematics (Table 3) indicated there was no significant difference between the pre- and post-mathematics test scores of the constructivist classroom and the pre- and post-mathematics test scores of the direct instruction classroom ($F_{(1, 42)} = .020$; $p = .887$).

Table 3

ANOVA Summary Table of Pretests and Posttests of Achievement Scores and Types of Instruction: Tests of Within-Subjects Contrasts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Test	1.136	1	1.136	.020	.887
Test Type of Instruction	10.227	1	10.227	.183	.671
Error (Test)	2342.636	42	55.777		

Results from the between-subjects analysis of variance procedures for first-grade achievement in mathematics (Table 4) indicated there was no statistically significant difference on the achievement tests between the constructivist approach and the direct instruction approach ($F_{(1, 42)} = .626$; $p = .433$). These findings suggest that the method of delivery of instruction between constructivist and direct instruction classroom environments does not affect the mathematical achievement of the students.

Even though there was no statistically significant difference in the achievement levels of the two groups of first-grade students, there were increases in the achievement level of most students. In the constructivist classroom 19 of 22 students showed an increase of test scores, 2 students dropped in their scores, and 1 student stayed the same. In the direct instruction classroom 16 of 22 students showed an increase in test scores, 3 students dropped in scoring, and 3 showed no change. It would be expected that students would show gains in achievement over a 6-month period.

Table 4

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Types of Instruction	127.682	1	127.682	.626	.433
Error	8562.636	42	203.872		

Research Question 2

Research question 2 sought to determine whether there was a significant difference in attitude in mathematics of first-grade students who have been taught through a constructivist approach and students who have been taught through direct instruction. A repeated measures ANOVA was conducted using $\underline{p} < .05$ level of significance. The assumptions for the repeated measures ANOVA of (a) independent, random samples, (b) normal distribution, and (c) homogeneity of variance were met.

Scores obtained from the Roland Attitude Scale were used to analyze this research question. The means and standard deviations of pre- and posttest mathematics attitude scores are contained in Table 5.

Table 5

Means and Standard Deviations for Prestest and Posttest Attitude Scores by Types of Instruction

Types of Instruction	Mean	SD	n
Pretest			
Constructivist	83.09	9.15	22
Direct Instruction	84.91	9.23	22
Posttest			
Constructivist	87.09	7.50	22
Direct Instruction	85.91	8.60	22

Results from the within-subjects analysis of variance procedures for attitude in first-grade students of mathematics (Table 6) indicated there was no statistical significant difference between the pre-and post-mathematics scores of the constructivist classroom and the pre- and post-mathematics scores of the direct instruction classroom ($F_{(1, 42)} = 2.434$; $\underline{p} = .126$).

Table 6

ANOVA Summary Table of Pretests and Posttests of Attitude Scores and Types of Instruction: Tests of Within-Subjects Contrasts

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Test	80.182	1	80.182	2.434	1.26
Test Type of Instruction	96.182	1	96.182	2.920	.095
Error (Test)	1383.636	42	32.944		

Results from the between-subjects analysis of variance procedures for attitude in mathematics (Table 7) indicated that there was no significant difference between the constructivist classroom and the direct instruction classrooom ($F_{(1, 42)} = .013$; $p = .910$). These findings suggest that the method of instruction between constructivist and direct instruction classroom environments does not affect the attitude of students towards mathematics.

Table 7

Tests of Between-Subjects Effects

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Types of Instruction	1.636	1	1.636	.013	.910
Error	5286.182	42	125.861		

To further examine Research Question 2 concerning students' attitudes toward mathematics, a qualitative approach was used. Data from student observations, student interviews, and student journals were analyzed.

After analyzing the data according to procedures suggested by Lincoln and Guba (1985), the main elements, perceived to be responsible for affecting first-grade students attitude toward mathematics, emerged into two themes. Themes that were perceived to be important in creating attitudes toward mathematics during the 6-month period were confidence in mathematics and interest in doing mathematics.

Research Question 3

Research Question 3 sought to determine whether there was a relationship between achievement and attitude toward mathematics of first-grade students. The statistical procedure used was the Pearson Product Moment Correlation $\underline{r}$ to determine whether a correlation existed between posttests of attitude and achievement. There were a total of 22 students whose posttest scores for attitude ($n = 22$) and achievement ($n = 22$) were compared. The scores were correlated by classrooms.

There was no significant correlation found between the achievement and attitude of students in the constructivist classroom regarding mathematics. Specifically, the Pearson Product-Moment Correlation coefficient of $\underline{r} = -.421$, $\underline{p} = .051$. The negative correlation coefficient translates into the higher the scores for attitude, the lower the scores for achievement. However, this negative correlation is not statistically significant.

There also was no correlation found between the achievement and attitude of students in the direct instruction classroom. Specifically, the Pearson Product-Moment Correlation coefficient of $\underline{r} = .062$, $\underline{p} = .785$. It should be noted that the participants were first-grade students who enjoyed mathematics regardless of whether they perceived themselves as doing well or not doing well.

Implications

1. Teachers need to support their students and establish a nurturing classroom environment with mutual respect and acceptance whatever instructional method is used.

2. Diverse teaching methods can be effective if teachers will establish a emotional climate that is inviting and reassuring to the students in it.

3. Instructional design, presentation techniques, and organization of instruction are essential ingredients of a successful mathematics program.

4. A final implication is that teachers should design and implement effective mathematics instruction for all learners.

Recommendations for Future Studies

This study investigated the effect of mathematics achievement and attitude on first-grade students in both direct instruction and constructivist classroom settings. Furthermore, the study examined the relationship between achievement and attitude within those settings. As a result of this study, the following recommendations are offered for further research:

1. A follow-up study should be conducted with the subjects in upper-elementary grades to explore their attitude toward mathematics. (Husen, 1967; The National Research Council, 1989).

2. This study should be carried out in other school districts to validate its results.

3. A longitudinal study should be conducted of students' changes in attitude and achievement as they progress through the elementary grades.

4. Further research should be conducted in the use of journal perceptions on achievement and toward attitude.

5. Studies should be conducted to examine the antecedents responsible for the onset of mathematics attitude.

6. It is recommended that this study be replicated with data collected over a 3-5 year period with students at various grade levels.

7. Further research should be conducted to determine a more comprehensive list of variables that impact student achievement.

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