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ABSTRACT

This study attempted to determine which teaching method, mainly manipulatives or the standard curriculum, best allowed the students to learn first grade math concepts. The manipulatives consisted of objects such as unifix cubes, personal chalkboards, work mats, and various other articles, which allowed the students to see the math that they were calculating. These students did not use any of the standard workbook pages. The standard curriculum used was the Mathematics Plus workbook by Harcourt Brace Jovanovich. This book does use manipulative concepts, but it was not supplemented with anything extra. Both methods of instruction were used with one first grade class. The methods were both used simultaneously but with different concepts; for example, the students were taught one concept using manipulatives and the second concept using the math workbook. Two methods of assessment were used during the study. The Knox County Math Skills Test was the first test given, and the second test was a Teacher Checklist Manipulative Evaluation that one of the teachers performed orally with each student. The Knox County test was a pencil and paper test that did not use any hands-on manipulatives. The Teacher Checklist was a test that was developed using solely the manipulatives that the students used during their manipulative concept. The students were asked to "show the teacher" each skill using the manipulatives. The concepts tested by the Teacher Checklist followed those tested by the Knox County Skills Test, but the student demonstrated them physically with the manipulatives used for learning. (Contains 16 references.) (CCM)

A STUDY OF THE BENEFITS OF MATH MANIPULATIVES VERSUS STANDARD CURRICULUM IN THE COMPREHENSION OF MATHEMATICAL CONCEPTS

An Action Research Project

Presented to

the Department of Teacher Education

of Johnson Bible College

In Partial Fulfillment

of the Requirement for the Degree

Master of Arts in Holistic Education

by

Amanda L. Rust

July 19, 1999

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This study attempted to determine which teaching method, mainly manipulatives or the standard curriculum, best allowed the students to learn first grade math concepts. The manipulatives consisted of objects such as unifix cubes, personal chalkboards, work mats, and various other articles, which allowed the students to see the math that they were calculating. These students did not use any of the standard workbook pages. The standard curriculum used was the Mathematics Plus workbook by Harcourt Brace Jovanovich. This book does use manipulative concepts, but it was not supplemented with anything extra. Both methods of instruction were used with one first grade class. The methods were both used simultaneously but with different concepts; for example, the students were taught one concept using manipulatives and the second concept using the math workbook.

Two methods of assessment were used during the study. The Knox County Math Skills Test was the first test given, and the second test was a Teacher Checklist Manipulative Evaluation that one of the teachers performed orally with each student. The Knox County test was a pencil and paper test that did not use any hands-on manipulatives. The Teacher Checklist was a test that was developed using solely the manipulatives that the students used during their manipulative concept. The students were asked to "show the teacher" each skill using the manipulatives. The concepts tested by the Teacher Checklist followed those tested by the Knox County Skills Test, but the student demonstrated them physically with the manipulatives used for learning.

When using the Knox County Math Skills Test significance was found between the book teaching and the manipulative teaching. The scores showed that the students learned more through the book teaching than they did with the manipulative teaching. The Teacher Checklist Manipulative Evaluation however did not show any statistical significance. The researcher noted that although the students learned the materials no matter which way it was taught there were definite differences in student enjoyment. The students seemed to enjoy the manipulative and hands on learning more than the bookwork. This enjoyment however, was not directly evaluated.

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APPROVAL PAGE

This Research Paper by Amanda Rust is accepted in its present form by the Department of Teacher Education at Johnson Bible College as satisfying the research paper requirements for the degree of Master of Arts in Holistic Education.

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Chapter 1

INTRODUCTION

Statement of the Problem

This study attempted to determine which teaching method, mainly manipulatives, or the standard curriculum; best allowed the students to learn first grade math concepts. The manipulatives consisted of objects such as unifix cubes, personal chalkboards, work mats, and various other articles, which allowed the students to see the math that they were calculating. These students did not use any of the standard workbook pages. The standard curriculum used was the Mathematics Plus workbook by Harcourt Brace Jovanovich. This book does use manipulative concepts, but it was not supplemented with anything extra. Both methods of instruction were used with one first grade class. The methods were both used simultaneously but with different concepts; for example, the students were taught one concept using manipulatives and the second concept using the math workbook. Concepts were chosen that were assumed to be along the same cognitive ability functioning. Many times teachers use one particular method rather than another to teach the students as a whole class although some of the students may not learn well that particular way. It will benefit many teachers to see, in research, which method worked better in this particular situation. Teachers will be encouraged to use the method that has been shown through research to be a more effective method of teaching.

Definition of Terms

Math manipulatives Math manipulative refers to any hands-on object that the student can physically move in order to discover the solution to a problem.

Standard curriculum For the purpose of this study standard curriculum is used to define the textbook Mathematics Plus workbook by Harcourt Brace Jovanovich, which has been adopted by the county that the research was conducted in for this grade level.

Knox County Math Skills Test The Knox County Math Skills Test is the test developed by the county to score the math skills of each student at their grade level.

Teacher Checklist Manipulative Evaluation The Teacher Checklist Manipulative Evaluation was a test written by the researcher to measure the learning using manipulatives.

Assumptions

There are four concepts chosen for this study. They include addition, subtraction, fractions, and measurement. The researcher assumed that addition and subtraction are of the same cognitive ability functioning. Fractions and measurement were also considered to be of the same cognitive ability functioning. Assuming this enabled the researcher to pair two concepts and use the two styles of teaching, one on each. For example, addition and subtraction were taught at the same time.

Limitations

There were two limitations in conducting this research. One limitation was that the

researcher was doing the actual procedure of the study rather than simply supervising. Involvement in the process could have caused a biasness or inability to view the situation from an objective point of view. A second limitation is that the study was limited to one particular first grade class. There were twenty-one students who were involved, but a larger number would have given a more general understanding of the overall population.

Hypothesis

For this research there are four hypothesis. There will be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience addition and subtraction as measured using a t-test method when measured by the Knox County Math Skills Test. There will also not be any significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience addition and subtraction as measured using a t-test method when measured by the Teacher Checklist Manipulative Evaluation. The third hypothesis is that there will be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience fractions and manipulatives as measured using a t-test method when measured by the Knox County Math Skills Test. The final hypothesis is that there will be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance

in those students who experience fractions and measurement as measured using a t-test method when measured by the Teacher Checklist Manipulative Evaluation.

Chapter 2

REVIEW OF RELATED LITERATURE

Call for Reform

The majority of the research and information available today about the teaching of mathematics in the United States calls for reform. It has been obvious through studies and standardized test scores that American students are not doing well. A study called the International Assessment of Educational Progress (IAEP) reported that American students 9 years of age scored below students in 11 of 14 nations and the students in the 13-year-old bracket scored below 10 of the 14 nations (Carlson, p. 4). This was just one of numerous studies conducted over the past 50 years showing that the nation's math performance is deteriorating (Carlson, p. 4). Many causes have been cited for this deterioration such as underprepared teachers and students, outmoded textbooks and curricula, uninspired teaching methods, inadequate administrative support, uninterested parents, and complex social problems (Carlson, p. 5).

In a report on teaching in the elementary school, Marlow and Inman state that "teaching in the elementary school often suffers from two conditions: (1) a lack of time spent on the subject and (2) passive teaching strategies which rely on textbook use" (Marlow, Inman, p.2). They also emphasize that hands-on or direct experiences are considered vital to a child's understanding of new materials. Marlow and Inman indicate that the need for change "implies re-education of teachers through in-service/staff

development programs and advanced level courses which promote hands-on learning" (Marlow, Inman, p. 2). Without re-educating the teachers of today, this reform will not come about. Studies can be conducted and research documented, but until the teachers are taught what they should be doing, their teaching methods are not going to change. The training must also be coming from the colleges preparing new teachers.

As one educator stated, "So really, what we're arguing for is that math should be in context, that it should involve manipulable materials, that people should learn to think through problems that no one showed them how to do" (Carlson, p. 11). Students should be learning not just because the teacher tells them that it is this way but they should be working out the problems and solving them on their own. This learning ensures they understand why a problem is solved in this manner, not just that 'this is the way it is figured' (Carlson, p. 13). The students of today are 'bottle fed.' They are used to being given the answers. Many times in a classroom if students are asked to solve a problem that they have not been directly taught to solve, they state that they do not know how to do it. They may have the ability, but because they were not fed the particular equation and repeatedly drilled on the system they do not believe they can. The students must be taught to solve problems on their own if they are expected to apply their learning throughout life. They will not be given an equation each time they have a problem to solve in life. As has been stated, "Certainly no one showed me anything about refinancing a mortgage" (Carlson, p. 12). One call for reform is that students must be taught how to learn. If they are taught how to learn, they can continue through life

learning. If they are only taught a certain set of materials then they only have that set of information to use.

A study conducted by Peterson, Putnam, Vredevoogd, and Reineke surveyed teachers and divided them into clusters of teaching styles based on a six-page questionnaire that each teacher filled out (Peterson, et. al., p. 13). There were 15 total clusters defined but only 5 contained 10 or more teachers (Peterson, et. al., p. 13). These five clusters were researched to define the methods of teaching being used today. Cluster A used primarily manipulatives; cluster B used a math program called Math Their Way that also uses primarily manipulatives. The main difference identified by Peterson was that the 'cluster A' teachers used more teacher explanation whereas 'cluster B' teachers allowed more time for the students to discuss problem solving. Clusters C and D were both primarily drill-and-practice with cluster C being a much-softened version of drill and practice. Finally, cluster E was identified as containing three expert teachers who used a modified version of the methods used by the manipulative using and problem solving teachers (Peterson, et. al., pp. 13, 14). The teachers identified as experts had been identified as such in a previous study (Peterson, et. al., p. 22).

It is interesting to note that 'cluster B' teachers along with 'cluster E' teachers rated themselves highest in teaching mathematics. 'Cluster D' teachers rated themselves as least effective in teaching mathematics compared to the other teacher's answers in their questionnaires (Peterson, et. al., pp. 13, 14). Also, many of the teachers identified as 'expert,' "had either used or were using one of a variety of 'distinctive' mathematics

programs including *Math Their Way, Real Math,* or *Comprehensive School Mathematics Program*" (Peterson, et. al., p. 15). Many times drill and practice is the direction that the standard curriculum takes, whereas the mathematics programs such as noted above take a more problem solving or manipulative approach.

The expert teachers were interviewed, and comments taken from their philosophies were included in Peterson's study. The first expert teacher believed that, "schooling should be interdisciplinary, relevant, and appealing" (Peterson, et. al., p. 23). The second teacher believed that "thinking, problem solving, and sense making should permeate the whole elementary school curriculum including mathematics" (Peterson, et. al., p. 24). The third teacher had three major goals for her students,

> First, she wants to empower students to think mathematically....Second, she wants her students to see mathematics as useful...Finally, Ms. Rodriguez wants to communicate to her students a sense of wondering and sense making through her own attempts to learn and understand mathematics...(Peterson, et. al., p. 25, 26).

The points of view given demonstrate an understanding of the outlook that Peterson and her colleagues had when choosing the experts for their study. This study may give reformers hope in that there are teachers teaching as the experts identified (Peterson, et. al., p. 28). This style of teaching has been repeatedly called upon as the hope for reform.

National Council of Teachers of Mathematics

This call for reform has brought about many efforts from different perspectives. Kennedy states that, "Although the United States does not have a national curriculum, many organizations are working together to achieve an agreed-upon set of goals for science and mathematics teaching and learning" (Kennedy, p. 249). One such effort that has made a strong impact on the education of mathematics in the way of national

standards has been the National Council of Teachers of Mathematics. In 1989 and 1991 the council took initiative by defining curricular standards and professional teaching standards (Kennedy, p. 250). The main goal behind these standards was that in defining a set of ideas or 'standards' there would be guidelines for texts, tests, and other educational rules to be based on (Kennedy, p. 250). When written the standards were said to be,

> based on the most current research on educational and work force needs...realistic and applicable to students of all ages, nationwide...endorsed by 15 math associations, societies, conference boards, councils, institutions, etc. and supported by 25 professional organizations...and have the potential, if effectively employed, to level the playing field for minorities and women, who perform poorly in traditional mathematics course work (Carlson, p 5).

Some of the goals for students in mathematics included in the standards are that students "learn to value mathematics, that they become confidant in their ability to do mathematics, that they become mathematical problem solvers, that they learn to communicate mathematically and that they learn to reason mathematically" (Carlson, p. 6). The standards also emphasize that the central focus of teaching should be on problem solving (Carlson, p. 6).

Carlson states that in order for the standards to complete all of these goals they call for classes that,

> are creative; emphasize comprehension and problem solving, not just memorization; train students to use calculators or computers effectively to enhance, not replace, knowledge of basic skill; and use manipulative materials to promote maximum comprehension (Carlson, p. 7).

Carlson went on later in her study to discuss a report called Everybody Counts which indicated that much of the problem in school mathematics is the fact that the traditional methods of teaching do not teach toward the way that most students learn (Carlson, p. 9). The report went on to say that students need to be able to understand the

mathematical rules and to link those rules with reality rather than simply memorizing them as a bunch of rules (Carlson, p. 9). Without that link, students are more prone to forget the rules. When they can link them to what they already know and understand they actually 'learn' them. This can also be called "reality-based mathematics." Reality-based mathematics is not a new concept. It is the goal of the NCTM standards, to train students for creative problem solving rather than simply working figures on a work sheet (Carlson, p. 10).

Mathematical Manipulatives

Mathematical manipulatives can include any type of object that is used in teaching math to help the students see and understand the concepts being taught. One math program that makes strong use of math manipulatives is the *Mathematics Their Way* program begun by Mary Baratta-Lorton. This program uses a variety of objects such as unifix cubes, pattern blocks, mirrors, tiles, plain wooden cubes, toothpicks, geoboards, junk boxes and a variety of other household materials such as beans (Baratta-Lorton, p. 2). The teacher can then use the objects to demonstrate a concept and allow the students to perform the concept. When the concept is understood the teacher can demonstrate the symbolic notation of the concept with the students, as well as help them understand how to record what concepts they perform with the objects. By giving the students a hands-on form of the problem, the teacher has given them a way to relate the math to real life. The student is no longer simply throwing around numbers or working out a misunderstood formula. With the manipulatives, the teacher can build up real life experiences and situations allowing the student to work out the problems himself tactually. Corneille, an elementary teacher, stated,

> Over the years, I had grown aware of the power of manipulatives to convey math concepts to young children. I felt that children's experimentations with manipulatives...would create in youngsters a sound understanding of the number system and show the connection between concrete materials and algorithms (Corneille, p. 6).

Many teachers have found that if they can show their students why one performs the math equation a particular way they understand it more easily. Corneille went on to say,

> Although I used a basal textbook as part of my mathematics program, I found that children's conceptual understanding came from their explorations with manipulatives and from the decisions they made as they solved problems with those tools (Corneille, p. 6).

Corneille encouraged her students to use the basal textbook as a resource and reinforcement for skills (Corneille, p. 6). She said that once her students understood the concept they enjoyed demonstrating their knowledge through certain exercises in the workbooks.

Corneille also pointed out that concrete materials have been used since ancient times (Corneille, p. 7). Using manipulatives is not a new concept. Even early humans used sticks and stones to represent quantity (Corneille, p. 7). Corneille stated that, "Working with manipulatives helps children move from the concrete to the pictorial to the abstract, or symbolic" (Corneille, p. 8). Manipulatives can also help people who learn better in a different method of teaching rather than simply through the traditional method. Gardner and Hatch identified seven intelligences that people learn through (Smith, 10). Generally people have a strength in one area or another so using the manipulatives can help a teacher teach each child to their strengths.

Burns is also a current educator who rallies for the use of manipulatives. She defines seven 'musts' for using manipulatives that include teaching the students how to

learn with manipulatives as well as setting ground rules for using the manipulatives (Burns, p. 1). Other 'musts' that she includes are setting up a system for storing the materials, giving the students time for free exploration, giving writing assignments for math and even allowing the parents to work with the manipulatives so that they understand why the approach is being used with their child. Burns says that better math students need the manipulatives just as much as the slower learners do. Many times this type of approach is taken with students who are struggling, but all students can benefit just as much (Burns, p. 1). Burns is careful not to undermine the importance of linking the manipulative concrete experiences with the symbolism that is essential. She believes that manipulatives are a wonderful tool, but they cannot simply take the place of the problems themselves. She uses manipulatives as a support for teaching the math topics that are in the curriculum.

One research project on manipulatives was completed by Chester, David, and Reglin at the University of North Carolina at Charlotte. These researchers completed a project they titled Math Manipulatives Use and Math Achievement of Third Grade Students. They had three hypotheses within this project. The first two hypotheses stated a significant difference would be found between the pretest and posttest scores of the experimental group and of the control group. The third hypothesis stated a significant difference would be found between the posttest scores of the control group and the experimental group. In 1988, the National Council of Teachers of Mathematics suggested a greater emphasis be placed on problem solving, mathematical reasoning, measurement, geometry, estimation, statistics, and probability within their standards for teaching school mathematics (Thompson, Rathwell, pp. 348-351). They proposed teachers accomplish this by de-emphasizing paper and pencil activities and focusing on

the exploration of mathematics through manipulatives, measuring devices, models, calculators, and computers. Based on this information, Chester, David, and Reglin set up a research project to examine two third grade classrooms. Their study was conducted using the non-equivalent pretest-posttest control group design (Chester, David, and Reglin, p. 13). The two classes were taught the same geometry unit using the textbook pages for independent practice. The control group used only drawings and diagrams to teach the concepts, while the experimental group used math manipulatives to teach the concepts (Chester, David, and Reglin, p. 15).

Chester, David, and Reglin found a significant difference between the pretest and posttest scores of the control group as well as the experimental group to prove their first two hypotheses correct. They also found a significant difference between the adjusted posttest scores of the control group and the experimental group showing that the class that was taught using the manipulatives scored better on the posttest than the control group using drawings, diagrams. These hypotheses proven correct show that "the use of math manipulatives will increase the achievement of third grade students" (Chester, David, and Reglin, p. 16,17).

Another research project dealing with teaching using manipulatives was completed through Talladega College in conjunction with high schools within a forty-mile radius. This project was developed to "enrich algebra and geometry programs through the utilization of manipulatives" (Ernest, p. 2). This program involved teachers participating in a weeklong intensive training workshop and yearlong follow-up activities. The workshop provided the teachers with the training that they needed to use manipulatives in their teaching. The teachers then met to participate in a follow-up program to identify and discuss specific strategies and problem areas. Two assessment

techniques were utilized to evaluate the program. The first technique was based on perceptions of the participants as well as observations by the project staff in an on-site immediate mode. The second involved comparing and discussing the "effectiveness of the instruction based on degree and success of implementation and impact on students throughout the school year" (Ernest, p. 3). These two assessments were evaluated using the Evaluation of Eisenhower Workshop, Math Manipulatives Observation, and the Math Manipulatives Workshop Follow-up. Within these assessment forms the researchers gained an understanding of the teacher's views of the workshop, their use of the materials in their classroom as well as the students improvements and responses. The Math Manipulatives Observation showed that students enjoyed using the manipulatives, improved in their 'on-task' involvement, seemed to comprehend tasks with accuracy, and overall exhibited an excitement about learning (Ernest, p. 7). The Math Manipulatives Follow-up indicated that teachers noted that more time was needed for planning and class time, but that their students enjoyed more and had a desire to participate. Improvement on local tests was noted by 46% of the teachers (Ernest, p. 2-8). It is evident through the research project that manipulatives made a positive difference with the teachers as well as the students.

The SouthEastern Regional Vision for Education (SERVE) sponsors a program called the Sharing Success program which recognizes exemplary public school programs and practices in six different states (SouthEastern Regional Vision for Education, p. iii). In their 1992 program, they identified six different programs as Programs of Excellence. Of those six, three directly involved the use of manipulatives and a fourth involved learning the student's individual learning styles and working to teach toward a student's style in the instruction (SouthEastern Regional Vision for Education, p. 11-16). One such

learning style involves hands-on learning. This program shows that the use of manipulatives is important in programs that are viewed as being excellent.

Manipulatives allow students an extra dimension to their learning. They can use objects to demonstrate or set up the problem in order to manipulate them and find an answer. Teachers must be cautious not to allow the manipulatives to take the place of everything else. The manipulatives can not do the teaching either, however they can allow the students to experience the problems and see the solution.

Standard Curriculum

In 1987 the Second International Mathematics Study (SIMS) results were announced and the American SIMS researchers "pointed an accusing finger at our 'underachieving curriculum'." For many years the curriculum that public school systems use has been under attack. Until the curriculum changes, the education will not improve (Driscoll, p. 6). Many math reforms have been attempted over the years as well. They are considered a waste. One educator pointed out however that many of the reform efforts have been successful in those situations where they were carried out as intended (Carlson, p. 15).

The reforms taking place today are supposed to be more effective than those made in years past. One statement was that the present reforms have been worked on and have built a broad consensus throughout educators (Carlson, p. 15). Not one or even two educators who worked out the present reforms including the NCTM standards, but a whole cluster worked together (Carlson, p. 15). More time and effort was taken to ensure that people were informed. The reforms are being introduced into curricula slowly as well. Another reformer stated, "If it happens too quickly then there's a problem" (Carlson, p. 14).

Research has played an important part in the reform efforts for standard curriculum as well. One important argument based on research is that "students learn by doing math" (Driscoll, p. 4). It can no longer be assumed that students learn well by listening and memorizing then putting into practice what they have learned (Driscoll, p. 4). It has been shown in research that the majority of the math curriculum is made up of repetition (Driscoll, p. 5). By working out some of the repetition, there is more room for active learning and applying it to life (Driscoll, p. 6). Students enjoy the math and learn more when there is a reason for learning (Boaler, p. 42). The more students can work to figure out the math themselves and the learning becomes a discovering process, the more they will remember (Driscoll, p. 6). Other projects have shown that in "real-world mathematical situations, adults and students do not use school-learned mathematical methods or procedures" (Boaler, p. 41). The more 'situated learning,' or learning applied to life, that teachers can use in the classroom, the more the students will retain (Boaler, p. 41). Various mathematics educators have suggested that students are unable to use school-learned methods and rules because they do not fully understand them (Boaler, p. 42). Boaler argued that "teaching methods that focus on standard textbook questions encourage the development of procedural knowledge that is of limited use in nonschool situations" (Boaler, p. 42).

Research, such as the Status Report on Teaching in the Elementary School: Math, Science, and Social Studies, has played an important part in the reform efforts for standard curriculum as well (Marlow, Inman, p. 1). In the report Marlow and Inman

stated that teaching in the elementary school often suffers from two conditions, one of which are the passive teaching strategies which rely on textbook use. One important argument based on research by Romberg is that "students learn by doing math" (Romberg, p124). It can no longer be assumed that students learn well by listening and memorizing then putting into practice what they have learned (Driscoll, p. 4). It has been shown in research by McKnight that the majority of the math curriculum is made up of repetition (McKnight, p. xi). By working out some of the repetition, there is more room for active learning and applying it to life (Driscoll, p. 6). Students enjoy the math and learn more when there is a reason for learning (Boaler, p. 42). The more students can work to figure out the math themselves and the learning becomes a discovering process, the more they will remember (Driscoll, p. 6). Other projects have shown that in "real-world mathematical situations, adults and students do not use school-learned mathematical methods or procedures" (Boaler, p. 41). The more 'situated learning,' or learning applied to life, that teachers can use in the classroom, the more the students will retain (Boaler, p. 41). Various mathematics educators have suggested that students are unable to use school-learned methods and rules because they do not fully understand them (Boaler, p. 42). Boaler argued that "teaching methods that focus on standard textbook questions encourage the development of procedural knowledge that is of limited use in nonschool situations" (Boaler, p. 42).

Chapter 3

METHODS AND PROCEDURES

Selection of Subjects

The subjects involved in this study includeed twenty-one first grade students in a self-contained classroom . There were eight females and thirteen males. The class was a well-balanced class with a range of abilities. The students were from mostly middle class families. Three students in the class qualified for a fee waiver. The students all ranged in age from six to seven. Three students took a year of transition class after kindergarten before coming to first grade. Two students were immature and could have benefited by attending a transition class. Five students could read already and were excelling in other areas as well. There was also one student mainstreamed from a CDC class who had a physical disability and problems following directions but was achieving at grade level up to the point of research.

Research Design

The study began about the end of September and carried through approximately an eight-week period. There were four math concepts taught for the research, addition, subtraction, measurement, and fractions. The first two units, addition and fractions, were taught over approximately the first four weeks and the second two, subtraction and measurement, were taught the last four weeks. The class was divided into two groups and worked on two concepts simultaneously. The groups were divided the first day of

testing by the manner in which their desks were arranged. The left side of the room was called group A while the right side was called group B. The seating arrangement had been developed taking into consideration students personalities so the groups worked well together when needed in their manipulative class. Levels of achievement were not taken into consideration. Half of the group met with one teacher for one of the first concepts that was being taught while the other half met with the second teacher for the second of the first concepts, then the students switched groups. For example, group A met with teacher #1 while group B was meeting with teacher #2 for the first half-hour of the math hour. Group A would work on addition with teacher #1 while group B worked with teacher #2 on fractions. The groups then switched for the second half hour enabling group B to work with teacher #1 on addition while group A worked on fractions with teacher #2. The two teachers each taught three days of the concept and then switched throughout the research to balance any personality differences or teaching abilities.

The workbook used was the Mathematics Plus workbook by Harcourt Brace Jovanovich. The regular workbook pages were used with the concepts addition and fractions. The manipulative lessons for subtraction and measurement were developed using the concepts covered on the workbook pages but in a manipulative format.

Testing Procedures

Two methods of assessment were used during the study. The Knox County Math Skills Test was the first test given, and the second test was a Teacher Checklist

Manipulative Evaluation that one of the teachers performed orally with each student. The Knox County test was a pencil and paper test that did not use any hands-on manipulatives. The Teacher Checklist was a test that was developed using solely the manipulatives that the students used during their manipulative concept. The students were asked to "show the teacher" each skill using the manipulatives. The concepts tested by the Teacher Checklist followed those tested by the Knox County Skills Test, but the student demonstrated them physically with the manipulatives used for learning. The Knox County Skills Test was given for all four concepts as both a pretest as well as a posttest. The Teacher Checklist Manipulative Evaluation was given solely as a posttest for all four concepts due to a lack of time in the classroom. Both tests were used as posttests for each concept regardless of the method of instruction they received for that particular concept. The data were then compiled and using a t-test method, the means of the pre-test and the post-test were compared to determine the level of learning on each unit. Each individual student's test scores were then used to determine which method of teaching promoted more learning for them personally. The information was then compiled to allow others interested an opportunity to benefit from the research.

Chapter 4

RESULTS

The data collected showed a statistical significance between the post tests of the Knox County Math Skills Test. The mean scores of the post tests using the Knox County Math Skills Test were compared using a paired samples test between the addition taught with the book and the subtraction taught with the manipulatives. See Table 1. The test showed the 2-tailed significance as 0.004. The hypothesis stated that there would be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience addition and subtraction as measured using a t-test method when measured by the Knox County Math Skills Test. The hypothesis was rejected at the .05 level of significance.

Table 1

Comparison of Post Test Means Between Addition (Book) and Subtraction (Manipulatives) Using the Knox County Math Skills Test

Groups	N	Mean	Mean Difference	Std. Error of Means	t ratio	Sig. 2-tailed
Control	21	87.38				
			8.95	2.77	3.232	.004*
Experimental	21	78.43				

*Significant < .05

The mean scores of the post tests using the Knox County Math Skills test were compared using a paired samples test between the fractions taught with the book and the measurement taught with the manipulatives. See Table 2. The test showed the 2-tailed significance as 0.027. The hypothesis stated that there will not be any significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience addition and subtraction as measured using a t-test method when measured by the Teacher Checklist Manipulative Evaluation. This hypothesis was rejected at the .05 level of significance.

Table 2

Comparison of Post Test Means Between Fractions (Book) and Measurement (Manipulatives) Using the Knox County Math Skills Test

Groups	N	Mean	Mean Difference	Std. Error of Means	t ratio	Sig. 2-tailed
Control	21	95.00				
			6.38	2.67	2.386	.027*
Experimental	21	88.62				

*Significant < .05

In both hypothesis the book method produced significantly greater results than using manipulatives. The mean scores of the post tests using the Teacher Checklist Manipulative Evaluation were compared using a paired samples test between the addition taught with the book and the subtraction taught with the manipulatives. See Table 3.

Table 3

Comparison of Post Test Means Between Addition (Book) and Subtraction (Manipulatives) Using the Teacher Checklist Manipulative Evaluation

Groups	N	Mean	Mean Difference	Std. Error of Means	t ratio	2-tailed
Control	21	91.43				
			2.86	3.46	.826	.419*
Experimental	21	88.57				

*Significant > .05

The test showed the 2-tailed significance as 0.419. The third hypothesis is that there will be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience fractions and manipulatives as measured using a t-test method when measured by the Knox County Math Skills Test. This hypothesis was retained.

The mean scores of the post tests using the Teacher Checklist Manipulative Evaluation were compared using a paired samples test between the fractions with the book and the measurement taught with the manipulatives. See Table 4.

Table 4

Comparison of Post Test Means Between Fractions (Book) and Measurement (Manipulatives) Using the Teacher Checklist Manipulative Evaluation

Groups	N	Mean	Mean Difference	Std. Error of Means	t ratio	2-tailed
Control	21	89.95				
			-2.00	2.86	-.699	.492*
Experimental	21	91.95				

*Significant > .05

The test showed the 2-tailed significance as 0.492. The final hypothesis is that there will be no significant statistical difference between teaching using the workbook and teaching using primarily manipulatives at the .05 level of significance in those students who experience fractions and measurement as measured using a t-test method when measured by the Teacher Checklist Manipulative Evaluation. This hypothesis was retained.

Both hypothesis with the Knox County Math Skills Test were rejected showing that there was significant statistical difference. The students scored better on the Knox County Math Skills Test when taught with the book than they did when taught with manipulatives. The two hypothesis with the Teacher Checklist Manipulative Evaluation were retained. There was not significant statistical data to show any improvement or otherwise on the Teacher Checklist Manipulative Evaluation.

Chapter 5

SUMMARY, CONCLUSIONS, RECOMMENDATIONS

Summary

When using the Knox County Math Skills Test significance was found between the book teaching and the manipulative teaching. The Teacher Checklist Manipulative Evaluation however did not show any statistical significance. The researcher noted that even though the students learned the materials no matter which way it was taught there were definite differences in student enjoyment. The students seemed to enjoy the manipulative and hands on learning more than the bookwork. This enjoyment however, was not directly evaluated.

Conclusions

The statistical evidence showed that the teaching using the book and tested with the Knox County Math Skills Test showed more learning than the teaching with the manipulatives and tested with the Teacher Checklist Manipulative Evaluation. There are a few possibilities why the Knox County Math Skills Test showed significance and the Teacher Checklist Manipulative Evaluation did not. One possibility could be that students are more accustomed to testing with pencil and paper rather than with actual manipulative objects. Another reason could be that some students seemed to learn better by manipulating the objects where as others did not necessarily need the hands on help. All students are different and respond better to different teaching.

Recommendations

The different styles seemed to help the students in different ways. A well-balanced classroom where both methods are used equally would benefit the students along both the level of learning as well as the level of interest. The researcher suggests that more research be performed on this subject to better define the area. The researcher recommends a larger sample size and more time to evaluate more students learning. She also suggests the next researcher evaluate the enthusiasm of the students to show which method, primarily book work or primarily manipulatives, is better in areas other than just the actual learning.

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APPENDICES

KNOX COUNTY SCHOOLS
ANDREW JOHNSON BUILDING

Allen Morgan, Superintendent

September 29, 1998

Ms. Amanda L. Rust
7900 Johnson Drive
Knoxville, Tennessee 37908

Dear Ms. Rust:

You are granted permission to contact appropriate building-level administrators concerning the conduct of your proposed research study entitled, "A Study of the Benefits of Math Manipulatives Versus Standard Curriculum in the Comprehension of Mathematical Concepts." In the Knox County schools final approval of any research study is contingent upon acceptance by the principal(s) at the site(s) where the study will be conducted.

In all research studies names of individuals, groups, or schools may not appear in the text of the study unless *specific* permission has been granted through this office. The principal researcher is required to furnish this office with one copy of the completed research document.

Good luck with your study. Do not hesitate to contact me if you need further assistance or clarification.

Yours truly,

Samuel E. Bratton, Jr.

Samuel E. Bratton, Jr., Ed.D.
Coordinator of Research and Evaluation
Phone: (423) 594-1740
Fax: (423) 594-1709

Project No. 914

Dear Parents,

As I stated at the parent teacher meeting I will be doing a research project over the course of this year to fulfill a requirement for my graduate work at Johnson Bible College. I am planning to do a study based on the teaching of Mathematics in the classroom. Kathy Duggan, my mentoring teacher, and I will be teaching math units using two different teaching methods. One method will consist mainly of the book and the standard curriculum. The other method will be solely using manipulatives and the students work on their chalkboards, etc. The students will then be tested to determine which way their learning is most productive. We will be using this information throughout the rest of the year to guide our teaching habits in order to best fit the students. I need permission for your child to be a part of my research. I would greatly appreciate having the whole class participate. This will increase our knowledge of your child and how he or she learns as well. Thank you in advance for your cooperation!

Amanda Rust

I give permission for my child, _____, to be a part of Amanda Rust's research in the classroom. He/She will participate as needed during regular class times.

Signed, _____

Date, _____

Addition Manipulative Test

Teacher: Give student a variety of unifix cubes. Read each question to student. Observe whether student demonstrates mastery and check correct box. If teacher is not sure of mastery she can give another example worded just as the first simply changing the variables.

Question	Mastered	Not Mastered
1. Show me 3+5		
2. Is that more or less than 4?		
3. Show me 6+3		
4. Is that more or less than 3?		
5. Ted has 2 mice. His friend gave him 2 more mice. Does Ted now have more than 2 mice or less?		
6. Giving student a handful of unifix cubes as him/her to graph them on the chalkboard.		
7. How many yellow cubes are there?		
8. Which color has the most?		
9. How many more red are there than blue?		
10 How many colors does this graph show us?		

Subtraction Manipulative Test

Teacher: Give student a variety of unifix cubes. Read each question to student. Observe whether student demonstrates mastery and check correct box. If teacher is not sure of mastery she can give another example worded just as the first simply changing the variables.

Question	Mastered	Not Mastered
1. Show me 4-2		
2. Is that more or less than 3?		
3. Show me 5-3		
4. Is that more or less than 1?		
5. Sam has 3 pencils. He gives Ed 1 pencil. Does Sam now have more than 3 pencils or less?		

Fractions Manipulatives Test

Teacher: Give student a variety of unifix cubes. Read each question to student. Observe whether student demonstrates mastery and check correct box. If teacher is not sure of mastery she can give another example worded just as the first simply changing the variables.

Question	Mastered	Not Mastered
1. Divide these unifix cubes between you and I fairly. (6 cubes total)		
2. Divide this set in half. (4 cubes total)		
3. Show me _ of your chalkboard.		
4. Show me _ of this set. (8 cubes total)		
5. Divide these cubes into 3 equal parts. (6 cubes total)		
6. Divide these cubes into 4 equal parts. (4 cubes total)		
7. Is this set _, 1/3, or _ of the total group? (1 of 3)		
8. Is this set _, 1/3, or _ of the total group? (1 of 4)		

Measurement Manipulative Test

Teacher: Provide student with needed materials. Read each question to student. Observe whether student demonstrates mastery and check correct box. If teacher is not sure of mastery she can give another example worded just as the first simply changing the variables.

Question	Mastered	Not Mastered
1. Estimate how many toothpicks long this book is.		
2. Now measure the book with the toothpicks.		
3. Using an inch ruler measure this pencil.		
4. Using a centimeter ruler measure this crayon box.		
5. Which of these two containers holds more?		
6. Which of these two containers holds less? (different containers from q. 5)		
7. Using our scale, which of these two objects is heavier?		
8. Using our scale, which of these two objects is heavier? (different objects from q. 7)		
9. On this thermometer, which would be hotter, 90 or 40?		
10. Make me a graph with these pattern blocks.		
11. How many red and blue are there?		
12. How many more yellow than green?		
13. Which set has the fewest?		

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