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The Effectiveness of Teaching Math Using Manipulatives in the Fourth Grade at Southwest Laurens Elementary

Denise D. Taylor
Georgia College & State University

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Dr. Chrispen Matsika
Faculty Sponsor

ABSTRACT

I have taught math at Southwest Laurens Elementary for the past twenty years, my first twelve years as a second, third, fourth, fifth, and sixth grade Title I teacher and my last eight years as a self-contained regular education fourth grade teacher. For all twenty years I have taught at least one math class. One concern I have often had with the math curriculum at my school was the exclusion of many math manipulatives either because of lack of funding or because of the required time for preparation of lessons and instruction when including manipulatives. In this research project, I explored the importance of manipulatives and whether they actually do make a difference in the learning of mathematical concepts. Based on my observations, I found that students tend to be motivated and enjoy math more when using manipulatives. They became actively engaged in learning new concepts. I found that there was much more communication between students instead of just between the students and the teacher. I also noticed more higher order questions being asked and/or explored. Finally, pretest and posttest scores indicated that the learning of math concepts was significantly improved when teaching using manipulatives.

CONTEXT

Southwest Laurens Elementary School (SWLE) is a public, rural school located in Laurens County, Georgia. The school has been in existence for about 50 years and serves a population of approximately 1,000 students in pre-kindergarten through fifth grade. The present facilities were built in the year 2000. SWLE is a Title I school in which 67% of its students are eligible for free or reduced lunch. The school has the lowest socioeconomic level students in the county. Most of the parents are classified as "working poor," not "welfare or government-aided poor."

SWLE's student body is 73% Caucasian, 21% African American, 3% Hispanic, and 2% multiracial. The school offers an After-School Program to help working parents of latchkey children. It also offers Saturday School to help students meet NCLB (No Child Left Behind) guidelines/standards and

also to help better prepare children for passing the CRCT. "Bubble students" (those who barely passed) and those who failed CRCT the previous year are especially encouraged to attend. The technology program at SWLE continues to advance each year. There are two computer labs, one for students to attend one period every eight days as part of their rotation classes and one that is a laptop computer lab which also includes a Promethian Board. Teachers may sign up for this when they want all students to have access to the Internet or when they have planned a lesson for the interactive board. Also, the administration have annually purchased Promethian Boards for individual classrooms. Five to ten boards have been added each year for the past three years.

Besides the computer lab, other rotation classes include music, physical education (PE), art, and counseling (character education). Other supplemental programs in the school include a migrant program, ESOL (English to Speakers of Other Languages), Gifted, and Special Education (including the county program for Severe and Profound).

In 2000 SWLE became accredited through the Southern Accreditation of Colleges and Schools (SACS). We were reaccredited in 2005 and have made Adequate Yearly Progress (AYP) each year with the exception of two since AYP has been a requirement of the state of Georgia, including this previous school year 2007. SWLE was named a Title I Distinguished School in 2004 and was recognized as a school that was "Beating the Odds" by the Georgia Partnership for Excellence in Education in 2003-2004.

I have taught math at Southwest Laurens Elementary for the past twenty years, my first twelve years as a second, third, fourth, fifth, and sixth grade Title I teacher and my last eight years as a self-contained regular education fourth grade teacher. For all twenty years I have taught at least one math class. During all those years, SWLE and my job teaching SWLE students has always been one of the greatest passions in my life. Also, the effective teaching of math has always been an important goal for me as a teacher. The math curriculum over the past 20 years has been in a cycle. When I first started teaching, math was taught in units; then it changed to scripted lessons (i.e. the textbook spelled out exactly what the teachers should do and say). Although progressive in nature, these lessons were not organized in units. Now the cycle is repeating with the emphasis on unit instruction.

DEFINING THE PROBLEM

The problem addressed in this research is to determine if using manipulatives increases the effectiveness of teaching math concepts in fourth grade. A manipulative is defined as any object that enables a student to work

hands-on to discover the answer to a problem or to understand math concept. Examples include rulers, geoboards, base ten blocks, tiles, pattern blocks, etc. Because my school, SWLE, has had very low math scores over the past several years, more effective teaching of math is a strong priority. As part of the SACS team in 2000 and 2005 and as part of the Quality Assurance Team (school improvement) in 2005, I had a part in examining our school's weaknesses and strengths and determining the areas on which our school needed to focus. After examining 4th grade math CRCT scores, our team discovered a significant weakness. Scores were lower in math than all other subject areas. This discovery lead the Quality Assurance Team to choose math as an area in the curriculum on which we needed to focus. We determined that our scores were slipping in this subject, specifically in problem solving and retention of facts. Our SACS plan for 2005 included specific strategies which would be implemented over the following five years. These strategies included the implementation of grade level fact drills to be given daily and bimonthly grade level meetings to discuss strategies for teaching math, particularly the new Georgia Performance Standards (GPS) as well as accountability for aligning lesson plans with the new GPS.

For the past seven years, our school has been using a textbook series that had scripted lessons and very little instruction with manipulatives. For the 2007-2008 school year, a new textbook series was adopted which supports the teaching of math in units and includes a set of manipulatives for each fourth grader. As lead teacher for fourth grade, I sensed a need for staff development that would help teachers make this transition between these two methodologies for teaching math. Also, I was concerned that all teachers had not "bought in" to the idea of using the manipulatives that came with new textbook curriculum.

The study will be limited to fourth graders only at Southwest Laurens Elementary (SWLE). A larger number would have given a more general understanding of the overall population. The study will be limited to a four to six week period. It is also limited in the sense that I will be doing the actual teaching instead of just supervising. Involvement in the process could cause a biased position or inability to view the situation from an objective point of view.

With my 20 years of experience in teaching Mathematics, I believe that the fourth graders in the study will be fundamentally ready for learning new concepts. I also am assuming that the teacher's personality and teaching style will remain the same for teaching with or without manipulatives. My final assumption is that math manipulatives will be available for each student.

I believe this research is very significant because it will personally help me become a more effective math teacher for my own students at SWLE. Even

though I often used manipulatives in my own classroom when I first started teaching, the math program which I have taught over the past seven years did not include the use of many manipulatives.

At SWLE, the percentage of fourth grade students who met or exceeded standards in math on the Criterion Referenced Competency Test (CRCT) in 2005 was 76. All other subject percentages were at least ten percentage points higher. As a matter of fact, for the past five years, the math percentage for meeting or exceeding the standard has been the lowest percentage of all the other subjects, including Reading, English Language Arts, Science, and Social Studies (SWLE, 2006). Our school, SWLE, needs to change its teaching strategies for teaching mathematical concepts. Based on test scores, the current method used to teach math is failing. Therefore, this research will motivate all parties involved, including students, teachers, parents, administrators and board members, to use the results to develop more effective teaching of math concepts. This motivation may lead to more resources for teachers and students, more time for teacher training and planning, more coordination between involved parties, more participation by other teachers and higher test scores on the CRCT.

Discovering the best way to teach math has always been important. Math is an integral part of each person's life and is a necessary life skill, especially in today's fast-paced world of technology, finance, and science. It recently became even more important in Georgia as the new Georgia Performance Standards (GPS) were implemented in fourth grade math during the school year 2007-2008. Another reason this research needs to be addressed became apparent after the latest national test scores were published. According to the 2005 National Assessment of Educational Progress (NAEP), 24% of tested Georgia students were less than basic in math, 47% were at the basic level, 26% were at the proficient level, and 4% were advanced. Thirty-three other states had higher scores than Georgia (U. S. Department of Education, 2005). Based on these results, Georgia students are behind in the area of mathematics and effective teaching of mathematics is an important concept that needs to be explored again and again.

LITERATURE REVIEW

The use of manipulatives, or concrete materials, has been debated for decades. The debate continues to this day. With our nation in need of more effective teaching practices in America's math classrooms (Carlson, 1992), with the state of Georgia ranking in the bottom twenty percent in the nation on the National Assessment of Educational Progress (NAEP) in fourth grade math (U. S. Department of Education, 2005), and with my own school's fourth

grade math scores on the CRCT being lower than all other subjects for the past five years (SWLE, 2005), I feel that more research is necessary and teachers, particularly at my school, need to take note of this research.

Manipulatives in the mathematics classroom include such items as base-ten blocks, counters, three-dimensional geometric models, tangrams, geoboards, spinners, and fraction rods (NCTM, 2000). One math program that makes strong use of math manipulatives is the Mathematics Their Way program. Author of this program, Mary Baratta-Lorton (1995), believes in using manipulatives to demonstrate a concept and allowing the students to perform the concept. Only after the concept is understood does the teacher demonstrate the symbolic notation of the concept with the students. According to Baratta-Lorton (1995), by giving the students a hands-on form of the problem, the students have a method to relate the math to real life. Students are no longer just working with numbers or with a formula that they really do not understand. The teacher is helping students build real life experiences that allow the student to work out problems himself and, therefore, understand the concept behind the symbols and/or numbers.

Like Baratta-Lorton, I too believe that manipulatives are the key to connecting abstract mathematical concepts and real life experiences. Based on my experience in the classroom with my fourth graders, I have found that when children are introduced to a new concept and make a connection in their minds with their own lives, the concept becomes real and useful and is assimilated for use. This theory of learning is best explained by Jerome Bruner.

Jerome Bruner (1992), greatly influenced by the work of Piaget, provided evidence suggesting the need for firsthand student interaction with the environment. He believed that students should be developers of their own knowledge, not passive recipients of the teacher's knowledge. Bruner saw that learning the structure of knowledge helps students develop memory, comprehension, and transfer of learning. "The idea of structure in learning leads naturally to a process approach in which the very process of learning (how one learns) becomes as important as the content of learning (what one learns)" (Post, 1992, p. 11). Content knowledge is important, but there needs to be a balance between the teaching of content and the teaching of process.

Bruner (1992) suggests an important model for demonstrating modes of representational thought: enactive (hands-on or direct experience), iconic (use of visual aids), and symbolic (use of abstract symbols). He believed these modes should be interactive in nature, with the child freely moving from one mode to another. He also felt that a key to readiness for learning was an enlarging perspective of how a child views the world. He often referred to Piaget, saying that children need to be helped to progressively pass from concrete thinking (i.e. manipulatives) to the use of more conceptually adequate

thought. To summarize his ideas, he believed "a rich and meaningful learning environment coupled with an exciting teacher who involves children in learning as a process that creates its own excitement" (Post, 1992, p. 12) is the key to readiness for learning.

Based on Piaget's and Bruner's theories for learning, most commercial textbooks will never provide enactive experiences. They are exclusively iconic with pictures of objects and tasks and symbolic with the symbols to be associated with those objects or tasks. Post states:

> Mathematics programs that are dominated by textbooks are inadvertently creating a mismatch between the nature of the learner's needs and the mode in which mathematical content is to be assimilated or learned…This evidence suggests that children's concepts basically evolve from direct interaction with the environment. This is equivalent to saying that children need a large variety of enactive experiences. Yet textbooks, because of their very nature, cannot provide these. (Post, 1992, p. 12)

Post (1992) also points out that manipulatives are just one part of a complete program for effective teaching of mathematical concepts. Other modes are also important, including pictorial, verbal, symbolic, and real-world situations. As a mathematics teacher for the past twenty years, I agree with this philosophy of teaching math. Also, like Heddens (n.d.) and Post (1992), I also believe teachers must be careful to use manipulatives properly so that students make connections to the one real world and do not learn that there are two mathematical worlds, one that is manipulative and one that is symbolic. Heddens (n.d.) stated, "All mathematics comes from the real world. Then the real situation must be translated into the symbolism of mathematics for calculating." Manipulatives and symbols are in the same world expressing the math concept in different ways. They should be used to bridge the gap from the concrete to the abstract, not separate the two (Riverdeep Interactive Learning Limited, 2001).

Bratina (n.d.) warns that manipulatives should complement, not replace, other teaching strategies. He also warns that manipulatives should not interfere with learning mathematics. He believes that overuse of manipulatives at the expense of other strategies will not help students understand abstract concepts but may lead them to avoid learning them. His main concern was for upper grades.

In another report, Marlow and Inman (1997) 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." They emphasized the importance of direct experiences in a child's understanding of new materials and indicated the need for change in teacher

education. In other words, they felt that all math teachers should receive inservice or advanced courses on "hands-on learning" (Marlow and Inman, 1997). Until teachers are taught what they should be doing, conducted studies and documented research will not change their teaching methods. My position, like Bratina, Marlow and Inman, is that manipulatives can be a very important part of an academic program; however, they must be a complement, not a substitution, and they must be used correctly and with the right purpose.

Sowell (1989) combined the results of sixty studies to compare the effects of using more abstract instruction with the effects of using manipulatives. His conclusion is that "mathematics achievement is increased through the long-term use of concrete instructional materials and that students' attitudes toward mathematics are improved when they have instruction with concrete materials provided by teachers knowledgeable about their use" (Sowell, 1989). In other words, "students' attitudes toward mathematics" are their motivation toward learning and enjoying mathematics and is an important part of being able teach math more effectively. One possible solution to our problems with motivation in math is the addition of manipulatives. According to Heddens (n.d.) and Sowell (1989), interest in mathematics is aroused when students become actively involved in manipulating materials. I wholeheartedly agree with this sentiment since I have seen for myself the excitement in my classroom when manipulatives are being utilized.

The National Council of Teachers of Mathematics (NCTM) has recommended the use of manipulatives since the publication of the NCTM standards in 1989. However, studies have found that teachers are still limited in their use of manipulatives and this use diminishes even more as students enter higher grades (Hatfield, 1994). When asked why manipulatives were not being used, teachers cited a lack of materials, discipline problems, and lack of preparation time for teaching using manipulatives (Marlow and Inman, 1997). I agree that these are hurdles for many teachers; however, teaching math concepts more effectively has become such a critical issue for my school, my state, and my country that these hurdles must be jumped and more effective teaching practices of mathematics must be put in place for our children to make gains in this very important and critical subject.

METHODOLOGY

I collected data in two ways for my action research: classroom observations and pretest/posttest. Each of these methods gave me different insights about the use of manipulatives in my fourth grade classroom. The use of observations helped me to see the motivational and social aspect of using manipulatives. While teaching the lessons with and without manipulatives,

I made observations to determine differences in class atmosphere, inclusion of real world concepts, student involvement, engagement in the lessons, and overall communication, including comments, questions, gestures, and body language by students. The use of a pretest and posttest helped me to calculate the effectiveness of manipulatives on learning math concepts, specifically geometry concepts. The effectiveness of teaching was measured based on how much the students learned.

I divided my classroom of twenty-six students into two equal groups with thirteen in each group. (I ended up with twelve in each group because one student did not return his parent permission form and one student was not present during the instruction time for the units in the research project.) One group was taught with the addition of manipulatives; one group was taught the same material but without manipulatives. While each group was taught, the other group was out of the room reading in the school library. Students were grouped as evenly as possible according to ability based on previous test scores. The current fourth grade standard math curriculum was used, the specific content being geometry. The assessment was a teacher-made short-answer test that served as both the pretest and postest (see appendix). After administering the pretest, both groups were taught a chapter on lines, angles, and rays. During this chapter, students in the manipulatives group worked with a variety of manipulatives for the various lessons including clay to demonstrate vocabulary, rulers and protractors to draw and measure angles, clocks, etc. The group without manipulatives was taught the exact same lesson but without the use of manipulatives. After one and one half weeks of instruction the posttest was administered and recorded. Next, a second pretest was given and a second chapter was taught. This chapter focused on plane and solid figures. The group with manipulatives used geoboards, construction paper, rulers, etc. while the group without manipulatives did not. After about one and one half weeks of instruction, the posttest was given. A comparison of the results of the pretest and posttest for both chapters was analyzed to see if the addition of manipulatives to the math curriculum made a significant difference in the learning of math by students.

RESULTS AND ANALYSIS

Classroom Observation Results

The first method I used to collect data for my research was daily classroom observations, which I made while teaching the math units. Class atmosphere, inclusion of real world concepts, student involvement, engagement in the lessons, and overall communication, including comments, questions, gestures, and body language by students.

1. Group without manipulatives
   Summary of observations: Overall this group of students was quieter, more sedated, and had fewer questions than the group with manipulatives. When they did have questions, they were mostly directed to me, with little discussion going on between students. Most questions were "yes/no" type questions and involved little higher order thinking. Examples of a few of the questions that were asked included "Mrs. Taylor, what's the difference in a parallellogram and a rhombus?," "A square is a rectangle?," and "Do I have to use capital letters when I name a line?" Overall, fewer comments were made. Body language was more sedated with less movement and noise in the classroom. Class atmosphere as well as student attention was positive, with no problems in the area of discipline. Students paid attention and seemed to be engaged mentally but not physically or socially.

   Analysis of observations: The lessons taught without manipulatives were teacher-centered lessons. I was in control the entire time and my students were mimicking or following my lead. I had all the answers, and they were "sponges" soaking up that information. Because the information was delivered to them, they simply had to memorize it, and not think critically about it. The class was more organized with little disruptions. Students stayed in their desks mostly and were able to focus on the teaching and their own work without distraction, which would be a positive point for this type of teaching.

2. Group with manipulatives
   Summary of observations: This group of students was much more talkative, excited, and inquisitive than the group without manipulatives. Although some questions were directed at me, a lot of questions, suggestions, comments, and discussion took place between the students as well. Examples of these questions include "Do you know how to make a parallelogram?," "Why wouldn't this be a rhombus?," "Watch how I can make two quadrilaterals from one rubber band," "I wonder what shape I could make on this geoboard if I had three (rubber bands)," and "Hold this so that I can fold it into that shape." Conversation was common between teacher and student and between student and student. Often these conversations involved more higher order thinking based on Bloom's Taxonomy. Body language was often active and animated with much more noise and movement in the classroom.

Analysis of my observations: The lessons taught using manipulatives forced students to have to think more about the new concepts. They not only took in the information but then had to assimilate and apply that information to a concrete activity. Because they were forced to apply the new information, more questions came up and therefore more conversation took place. These questions were higher order because when new ideas were applied to concrete activities, new problems arose that needed to be addressed. The questions and comments between students as they worked using the manipulatives helped students to learn from each other, not just from the teacher. As students worked with the manipulatives and each other, additional meanings of the new concepts were developed and assimilated in the students prior knowledge. For example, after the lesson on polygons, groups of two used rubber bands and geoboards to make different shapes of octagons. I overheard one student exclaim to the another as he watched her, "Oh! So that's an octagon, too? I thought all octagons looked like stop signs." That student had just added a new meaning to the concept of polygons and had assimilated that new meaning into his prior knowledge about octagons.

Pretest/ Posttest Results

The Tables 1 and 2 show the results of the pretest and posttest of the groups with and without manipulatives, respectively (see Appendix and Figures). There were a total of forty-eight items on two tests (twenty-three items on the test over lines, rays, and angles and twenty-five questions on the test over solid and plane figures). There were twelve students in each group. I recorded what each student did on each question, including correct, partially correct, wrong, and blank.

By multiplying the number of test items by the number of students in the group, I got a total of 576 attempted questions. For each group I got the total number, divided by 576, and got the percentage of questions that were answered that way. I followed the same procedure for correct, partially correct, wrong, and blank. This procedure was followed identically for both groups and for both pretest and posttest results. Table 3 shows my findings (see Appendix and Figures).

After analyzing my data located on Table 3, I found that both sets of students (those with and those without manipulatives) drastically improved between the pretest and the posttest. The most dramatic change was in the number of correct answers. Both groups demonstrated great improvement in the number correct, but the group with manipulatives improved two percent more. The number of partially correct answers decreased 5.6 percent more for students without manipulatives. The number of wrong answers decreased

by 1.8 percent more for students with manipulatives, and the number of blank answers decreased by 6.4 percent more for students with manipulatives. This last difference was the greatest and indicates a greater confidence in the subject matter on the posttest than on the pretest.

For the final results, the correct and partially correct answers were combined as well as the wrong and blank answers so that I could get an overall comparison of the right and wrong answers between the two different groups. These results (see Table 4) indicated that students who had manipulatives incorporated in their lessons answered 8 percent more correctly and 8.2 percent less incorrectly than students who had not had manipulatives incorporated into their lessons.

CONCLUSION

Based on my results and analysis of those results, I conclude that the addition of manipulatives to math instruction in fourth grade at SWLE does have a significant positive impact on the effective learning of new math concepts. This conclusion was reached based on the overall higher percentage of correct and partially correct test items and lower percentage of wrong and blank test items for students who had been taught with manipulatives versus those students who had been taught without.

Teaching with manipulatives did require more preparation time by the teacher and more instruction time for the students. Also, when students were working with manipulatives, there was more noise and movement in the classroom. However, I also concluded that the addition of manipulatives in math instruction did help students to become actively engaged in their learning. This conclusion was reached based on observations made during instruction. Students with manipulatives showed more excitement, asked more higher order questions, discussed concepts more with each other as well as the teacher, and were actively involved during the instruction time. Comments and observations demonstrated students assimilating the new concepts into their prior knowledge as well. Although I did not test retention, I believe this active engagement in the learning process will also increase retention of new concepts for students because of the better assimilation of those concepts in prior knowledge.

Therefore, I conclude that incorporating the use of manipulatives in the fourth grade math instruction at SWLE will likely improve our CRCT scores and will better prepare our students for future instruction in fifth grade.

RECOMMENDATIONS

As a veteran teacher of math in the elementary classroom for twenty years, I have always held the belief that the more students participate in hands-on activities, the more likely they are to get real-life meaning from new concepts and, therefore, the more likely they are to effectively learn those concepts and assimilate them into their knowledge base. After reviewing the literature on manipulatives and their part in the effective teaching of math, I believed even more in the practice of using manipulatives. And now after accumulating and analyzing my own data from my own classroom and forming some conclusions based on that data, I have reaffirmed my original belief in the use of manipulatives for the effective teaching of math. Therefore, based on all of this data, I recommend the following:

First, the information I have gathered in this research project needs to be made known to the teachers and administrators at Southwest Laurens Elementary. These teachers need to accept and "buy in" to the idea that the time, effort, and expense required to incorporate manipulatives into the math curriculum at our school is well worth it all. I plan to share this research with my administration and hopefully they will agree to share it with the other teachers. Because using manipulatives would be considered by most to require more planning and more expense, many teachers will need encouragement and evidence of success before they will actually try to implement the use of manipulatives more in their classrooms.

Second, as was mentioned in the review of literature, teachers must understand that the use of manipulatives is not to replace any other methods but is to supplement those other methods. Therefore, there may be a need to change scheduling to include more math time. As I taught the two groups for my research, I found that I needed much more time for my students working with manipulatives than I did for my students not working with them. I recommend that our administration examine our schedule for the next school term and allow or require more time in math to accommodate the inclusion of manipulatives.

Third, I am now interested in the retention of math concepts and am curious to see if retention improves when students use manipulatives as one method of learning new concepts. Therefore, I am recommending that this research project be continued. I would like to retest the concepts covered in my research later on in the school year in order to see the rate of retention in both groups.

My final recommendation is for me personally. Now that I have seen firsthand how adding manipulatives to my math instruction can make a positive difference in the learning of new math concepts for my fourth graders, I

must continue to use this method of instruction whenever possible. I do not intend to replace any of my other instruction; however, I would like to use manipulatives as a supplement to help students get a concrete understanding of new concepts before moving on to abstract understanding. I intend to add math centers in my classroom to help with the organization and time factors that have been named as problems when using manipulatives. It is my hope that this research project will significantly affect me as a teacher and positively influence my teaching strategies and my students' success in the math classroom.

APPENDIX AND FIGURES

Appendix A: Pretest and Posttest

Pretest / Posttest I **Lines, Rays, and Angles** **Name** _____
Date _____

Draw and label an example of each.

1. Line segment DC
2. point J
3. ray JK
4. plane RST
5. line segment AB
6. line GH

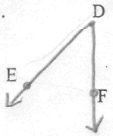
7. Give some examples of lines that you see every day.

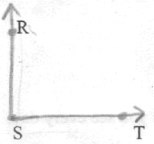
8. Name an object in your classroom that is like a line segment.

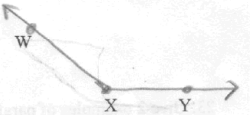
9. The unit used to measure an angle is called a _____.

10. The angle measure of a _____ is 180 .

Measure each angle with a protractor and write the measurement. Then write *acute, obtuse, right, or straight.*

11. 

12. 

13. 

Draw and label an example of each.

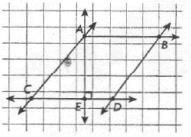
14. obtuse angle MNP
15. acute angle B
16. straight angle DEF

Use the drawing at the right for 17-19.

17. Name two parallel lines.

18. Name two intersecting lines.

19. Name two perpendicular lines.



20. Draw a rectangle with a diagonal line. What types of angles are formed by the diagonal line and the sides of the rectangle?

21. Kyle needs directions to Taylor's new house. Taylor drew a map for Kyle to use. Starting from Kyle's house, go 4 blocks south and then 2 blocks west. Turn left. Go 5 more blocks south. Taylor's house is the first house on the right. Make a diagram of Taylor's map.

22. From her apartment, Ellie walks 5 blocks north and 3 blocks west. Then she turns right and walks 1 more block to the library. How many blocks is the library from Ellie's apartment?

23. Give 2 examples of parallel lines you see every day.

Pretest / Posttest II **Plane and Solid Figures** **Name** _____
Date _____

1. A parallelogram with 4 equal sides is a _____ or a _____.

2. A _____ has 6 faces, 12 edges, and 8 vertices.

Name the polygon. Tell if it appears to be *regular* or *not regular*.

3. 

4. 

5. 

6. 

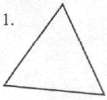
Classify each triangle by the lengths of its sides. Write *isosceles, scalene,* or *equilateral.*

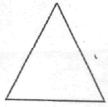
7. 17 ft, 22 ft, 16 ft

8. 5 cm, 5 cm, 5 cm

9. 11 mm, 11 mm, 8 mm

10. 

11. 

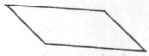
12. 

13. 

Classify each figure in as many ways as possible. Write *quadrilateral, parallelogram, rhombus, rectangle, square,* or *trapezoid.*

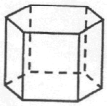
14. 

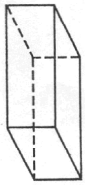
15. 

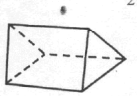
16. 

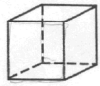
17. 

Write the names of the plane figures that are the faces of each solid figure. Then write the name of the solid figure.

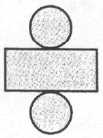
18. 

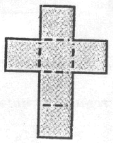
19. 

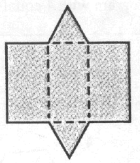
20. 

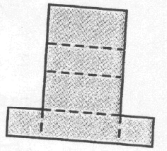
21. 

Write the letter of the figure that is made with each pattern.

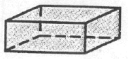
22. 

23. 

24. 

25. 

a. 

b. 

c. 

d. 

Table 1: Results of Pretest/Posttest I and II for Students Without Manipulatives

Results of Pretest / Posttest I and II Students Without Manipulatives								
Student #	Correct		Partially Correct		Wrong		Blank	
	Pretest	Post test	Pretest	Post test	Pretest	Post test	Pretest	Post-test
1	1	29	8	9	11	9	28	1
2	2	22	4	5	9	21	33	0
3	9	32	11	8	21	6	7	2
4	2	35	8	6	11	7	27	0
5	5	38	14	5	6	5	21	0
6	12	45	9	1	7	1	20	1
7	11	40	13	4	12	4	12	0
8	9	42	11	2	9	4	19	0
9	5	38	11	6	9	4	23	0
10	4	44	9	3	5	1	30	0
11	2	32	12	5	8	9	26	2
12	0	31	9	10	9	6	30	1
Totals	62	428	119	64	117	77	276	7

Table 2: Results of Pretest/Posttest I and II for Students Using Manipulatives

Results of Pretest / Posttest I and II Students Using Manipulatives								
Student #	Correct		Partially Correct		Wrong		Blank	
	Pre test	Post test	Pretest	Post test	Pretest	Post test	Pre test	Post test
1	7	38	12	7	8	3	21	0
2	10	46	9	0	4	2	25	0
3	5	33	4	4	10	11	29	0
4	6	35	5	6	28	7	9	0
5	6	24	7	10	12	12	23	2
6	1	28	8	7	7	13	32	0
7	4	35	9	12	3	0	32	1
8	3	39	8	6	10	3	27	0
9	7	44	8	1	6	3	27	0
10	2	31	3	9	10	8	33	0
11	4	43	5	4	13	1	26	0
12	5	41	12	3	6	4	25	0
Total	60	437	90	69	117	67	309	3

Table 3: Comparative Results of Use With and Without Math Manipulatives

Comparative Results of Use With and Without Math Manipulatives Percentages								
	% Correct		% Partially Correct		% Wrong		% Blank	
	Pre test	Post test	Pre test	Post test	Pre test	Post test	Pre test	Post test
Students Without Manipulatives	10.8%	74.3%	20.7%	11.1%	20.3%	13.4%	47.9%	1.2%
Percentage Gain/Loss w/out Manipulatives	63.5%		-9.6%		-6.9%		-46.7%	
Students With Manipulatives	10.4%	75.9%	15.6%	12.0%	20.3%	11.6%	53.6%	0.5%
Percentage Gain/Loss with Manipulatives	65.5%		-3.6%		-8.7%		-53.1%	

Table 4: Researching the Use of Math Manipulatives to Improve Learning

Researching the Use of Math Manipulatives to Improve Learning				
Final Results				
	% Correct/Part. Correct		% Wrong or Blank	
	Pretest	Posttest	Pretest	Posttest
Students With Manipulatives	26.0%	87.9%	73.9%	12.1%
% Gain/Loss	61.9%		-61.8%	
Students Without Manipulatives	31.5%	85.4%	68.2%	14.6%
% Gain/Loss	53.9%		-53.6%	

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