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An Investigation of the Effects of Using Literature to Promote the Understanding of Mathematical Concepts in Children with Learning Disabilities

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AN INVESTIGATION OF THE EFFECTS OF USING LITERATURE TO PROMOTE THE UNDERSTANDING OF MATHEMATICAL CONCEPTS IN CHILDREN WITH LEARNING DISABILITIES

By

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Abstract

This study was designed to test the hypothesis that including children's literature in the mathematics curriculum improves understanding of math concepts for children with learning disabilities. The subjects included 47 third grade students from a suburban school district outside of Rochester, New York. The children were divided into experimental and control groups. The control group received their regular mathematics curriculum, while the experimental group received the addition of children's literature to the regular curriculum. No statistical significance was noted quantitatively, while qualitatively, improvements were noted in children's attitudes and involvement with the curriculum.

CHAPTER I

Statement of the Problem

Purpose

The purpose of this study is to evaluate whether using children's literature is an effective method of helping children with learning disabilities develop an improved understanding of mathematical concepts.

Overview

There have been many attempts at encouraging mathematical reform in recent years. One such effort has been by led the National Council of Teachers of Mathematics (NCTM). The NCTM standards (1989) suggest changes in classroom instructional activities which would allow time for more open ended problem solving, communication and reasoning, and connecting mathematics to the outside world.

In greater numbers, children with learning disabilities are being educated in general education classes. Research has shown that including students in regular education can be beneficial to students with and without learning disabilities (Backus, 1995; Odom & McEvoy, 1998). "Children with disabilities in integrated classes make gains in language, cognition, and motor development that are comparable to peers in self-contained special-education classes" (Fewell and Oelwin, 1990). These benefits, however, do not change the fact that children with learning disabilities have significant needs and require additional support in the classroom, including the area of mathematics.

One strategy that teachers have found to be successful when teaching concepts in content areas is the implementation of children's literature. "Through literature, young children's oral and receptive language can be broadened" (Dwyer, 1978, p. 33). There is growing evidence of its effectiveness in the math community.

The present study investigated the effectiveness of incorporating children's literature into the *Investigations in Number, Data, and Space* curriculum.

Research Question

What are the effects of using children's literature to promote the understanding of mathematical concepts in children with learning disabilities?

Need for the Study

Current educational practice in many school districts across the country is to include children with learning disabilities in a general classroom setting to the greatest degree possible for each individual child. Studies have shown that this policy of inclusion has great benefits for children with learning disabilities, as well as their non-disabled peers (Backus, 1995; Odom, S. and McEvoy, M., 1998).

At the same time, many districts across the country are trying to achieve the goals set by new local and national standards for each curriculum area. Mathematics is one such field. One suburban school district just outside of Rochester, NY is implementing a new math program aimed at helping students to reach those new standards by becoming better thinkers and problem solvers.

The *Investigations in Number, Data, and Space* program is a hands-on, inquiry-based program, with a strong language component. To succeed in this program, students need to be able to read and understand mathematical language, and communicate both verbally and in written form, usually with numbers, pictures or words. While this philosophy can provide a challenge for most children until they become familiar with the program, it is one that is especially difficult for students with learning disabilities to face, as language is typically an area of weakness.

It has been demonstrated that using literature in content areas aids in promoting the understanding of concepts. It is important to learn whether this technique is effective with a learning disabled population.

This study will focus on the implementation and student learning of the group exposed to children's literature, and the group that is not. Information gained will be useful to teachers currently employing the program in the school where the study is conducted, and can be useful to other teachers considering incorporating children's literature into their mathematics curriculum.

Definitions

TERC- group formerly known as Technical Education Research Centers, responsible for designing *Investigations in Number, Data and Space* Curriculum

Math Solutions®- inservice program designed to help teachers improve how they teach math in kindergarten through Grade 8. A division of Marilyn Burns Education Associates.

Tangram- ancient Chinese puzzle that uses seven pieces cut from a square: two small triangles, one medium-sized triangle, two large triangles, one square, and one parallelogram

Limitations of the Study

Time constraints allowed for only one full mathematics unit to be completed.

Summary

The primary focus of this study was to determine the effectiveness of the incorporation of children's literature into a math program, specifically with regard to helping children with learning disabilities develop a better understanding of concepts.

CHAPTER II

Review of the Literature

Mathematical Literacy

In today's world, there has been a major emphasis on the state of our schools, and how the schoolchildren of the United States fare when compared to the schoolchildren of other nations. Much attention has been paid to the areas of literacy, mathematics, and science. What has been neglected however, is the idea that literacy does not only refer to the reading ability of today's youth, but that being literate across all academic areas, including math and science, is equally important.

The idea of mathematical literacy needs to be examined in a variety of ways. Mathematical literacy encompasses more than having the ability to solve calculations and algorithms. "Mathematics can be regarded as a form of language, developed by humankind in order to converse about the abstract concepts of numbers and space"

(Bullock, 1994, p. 735). Mathematics "involves natural thought and language processes" (Fuentes, 1998, p. 81).

Being literate in spoken and written language does not guarantee that one will be successful in developing his or her mathematical literacy. In fact, children develop reading and mathematical skills at very different rates. A child who is able to read and comprehend storybooks, may be able to solve simple algorithms as well, but stumbles when faced with word problems. Before a child can solve the word problem, he or she must analyze and comprehend the language involved, both the language they are familiar with as well as a series of mathematical terms that have not yet been internalized (Fuentes, 1998). "A child cannot be expected to learn to read in a language he does not speak and comprehend efficiently" (Dwyer, 1978, p. 33).

How then do we enable children to internalize language? Vygotsky (cited in Steele, 1999) believed that this process occurs when children actually use new terms and ideas in their own spoken language. Children learn new words by reflecting on, and picturing the meanings of the words as they interact. "Language and meaning develop together only when new vocabulary is presented in a meaningful context" (Steele, 1999, p. 39).

Making Mathematics Meaningful

There have been many attempts at encouraging mathematical reform in recent years. One such effort has been by led the National Council of Teachers of Mathematics (NCTM). The NCTM standards (1989) suggest changes in classroom instructional activities which would allow time for more open ended problem solving, communication and reasoning, and connecting mathematics to the outside world.

One common thread in a search for a new method of mathematics instruction, is that in order for the children of the United States to remain competitive with the rest of the world, we need to provide children with opportunities to learn mathematics in the context in which problems arise in daily life (Goldman, Hasselbring, and the Cognition and Technology Group, 1997). Fortunately, this approach correlates strongly with how children learn language—by applying it and using it in daily communication.

Mathematics Learning in the Inclusive Classroom

In the past, mathematics instruction for children with learning disabilities has centered on teaching the procedural steps for computation, with little regard to the development of concept understanding. Still, students with learning disabilities continue to experience greater difficulties than their non-disabled peers with computation and word problems (Cawley & Miller, 1989).

In greater numbers, children with learning disabilities are being educated in general education classes. Research has shown that including students in regular education can be beneficial to students with and without learning disabilities (Backus, 1995; Odom, S. and McEvoy, M. 1998). "Children with disabilities in integrated classes make gains in language, cognition, and motor development that are comparable to peers in self-contained special-education classes" (Fewell and Oelwin, 1990). These benefits, however, do not change the fact that children with learning disabilities have significant needs, and require additional support in the classroom, including the area of mathematics.

In some cases, the way to best accommodate children with disabilities in a classroom was to lower expectations for those students. Lowering expectations however, is not the answer. The NCTM's position in their *Principles and Standards* (2000) document is that:

> Schools have an obligation to ensure that all students participate in a strong instructional program that supports their mathematical learning. High expectations can be achieved in part with instructional programs that are interesting for students and help them to see the importance and utility of continued mathematical study for their own futures (p. 13).

Children's Literature in the Content Areas

One strategy that teachers have found to be successful when teaching concepts in content areas is the implementation of children's literature. "Too often, math learning is relegated to practice with textbook and workbook exercises, which cannot spark children's imagination in the ways that literature does" (Burns, 1992, p. 1).

"Within various texts and illustrations . . . there are various opportunities to involve children in problem solving, pattern and order activities, and classification, as well as other mathematical skills" (Griffiths and Clyne, 1998, p. 5). "Through literature, young children's oral and receptive language can be broadened" (Dwyer, 1978, p. 33).

There is growing evidence in the math community of the effectiveness of using children's literature in mathematics instruction. Supporters of this teaching philosophy believe that children's literature is particularly valuable when it is integrated with skills instruction (Morrow, 1992, as cited in Barnitz, Gipe, & Richards, 1999). Hong refers to the work of several educators to support his statement that children's literature can be used to:

> provide a context for an activity with mathematical content, to introduce manipulatives that can be used in a variety of ways, to inspire a creative mathematics experience for children, to pose an interesting problem, to develop and review a mathematical concept or skill, to demonstrate the use of mathematics, and to introduce vocabulary associated with mathematical concepts (p. 479).

"Children with more exposure to the language of books have more advanced language development than children with little or no exposure" (Barnitz, Gipe, & Richards, 1999, p. 529). Hong (1996) states, "The storybook can act as a catalyst to motivate children because storybooks mostly deal with situations that can touch on their interests and experiences, and provide contexts that engage them" (p. 480).

> Tying mathematics to stories humanises[sic] the activity and also gives purpose and meaning to mathematics for both teacher and children. Literature can then provide a link between the complexity of the world around us and the highly structured discipline of mathematics (Griffiths and Clyne, p. 5).

In their 1992 study, Jennings and Jennings set out to determine how using children's literature to teach math concepts to kindergarten students improves their math achievement test scores, increases their interest in mathematics, and increases the frequency that children use mathematical vocabulary during their free play. The results of this study demonstrate that using children's literature had a positive effect on the kindergartner's understanding of math concepts. Qualitative measures reflected an increase in math achievement test scores and an increased frequency of math vocabulary usage during free play; quantitative analysis revealed that the children involved in the study reflected an increase in their interest in math, as evidenced through their comments and actions.

Hong (1996) implemented a similar study, which also attempted to measure students achievement and disposition toward math after being exposed to children's literature which involved math concepts. The results of this study identified that students expressed an improved attitude toward mathematics instruction after being exposed to the literature. Although Jennings' study (1992) demonstrated an increase in mathematics achievement, Hong's results indicated that there was no significant difference in overall math achievement between the control group and the experimental group. However, after further examination of the students work, Hong found that the *quality* of the experimental group's math work may have indicated more advanced thinking when problem solving.

The meaningful engagement with and connection of real life situations to mathematical concepts are exactly what the supporters of math reform mentioned previously are recommending. Remember too, Vygotsky's assertion (1994 as cited in Steele, 1999) that children internalize language when they use it in meaningful situations.

CHAPTER III

Design of the Study

Introduction

The purpose of this study is to evaluate whether using children's literature is an effective method of helping children with learning disabilities develop an improved understanding of mathematical concepts.

Research Question

What are the effects of using children's literature to promote the understanding of mathematical concepts in children with learning disabilities?

Methodology

Subjects

The subjects of this study consisted of a control group and an experimental group. The control group, Group A, is a heterogeneous third grade classroom of 25 students, with five students classified as having a learning disability. The experimental group, Group B, is a heterogeneous third grade classroom of 23 students, with five students classified as having a learning disability.

Group A is comprised of students whose reading abilities range from the mid-fourth grade to approximately early first grade. Seven students in this group are considered to be reading below the third grade level.

Group B is also comprised of students whose reading abilities reflect a wide range. These students' reading levels vary from mid-fourth grade to late Kindergarten. Seven students in this classroom are reading below the third grade level.

The subjects from this study are third graders in a large suburban school district outside of Rochester, NY. The students' teachers are both in their fourth year of teaching, and have received professional development training in the Math Solutions® program offered by their school district.

Materials

A baseline score was obtained prior to the beginning of each unit using a teacher-designed pretest (Appendix A) to evaluate the depth of students' background knowledge of the mathematical concepts to be studied. The score was based on a teacher-designed rubric (Appendix B). All of the students participated in the same general math curriculum, using the *Investigations* series. The experimental group received exposure to mathematical literature in addition to the regular curriculum. At the end of the unit investigation, the students were reassessed using the same test as the pretest. The students' knowledge of the concepts was reevaluated through the use of the 4-point rubric.

Throughout the study, this researcher kept anecdotal notes while working with the students. In doing so, the notes provide a greater record of the children's depth of understanding of the math concepts.

Procedures

Before beginning the unit of study called *Flips, Turns, and Area*, a unit that focuses on 2-D geometry, a teacher-designed pretest was administered to the students. The pretest was administered to both groups using the same format: all students were told that they would be completing an assessment designed to measure what they already knew about the topic; all students were told that this was to be done completely independently, to the best of their own ability; the entire pretest was read aloud to the whole class, so that the students would all experience the same pronunciation; students were told that if they didn't know the answer to the question, they could guess; the students were allotted 60 minutes for their pretest—an amount of time equivalent to their daily math instruction.

In the weeks following the administration of the pretest, mathematics instruction for the control group continued as usual, participating in 60 minutes of mathematics instruction each day, until the unit was completed. The experimental group received regular mathematics instruction as well, with the addition of children's literature where appropriate. During this unit, three children's books were included: A Cloak for the Dreamer, Grandfather Tang's Story, and Three Pigs, One Wolf, and Seven Magic Shapes.

A Cloak for the Dreamer is a story about a tailor and his three sons. Though all of the sons are being instructed in the fine art of tailoring, the youngest son tends to spend most of his time dreaming about traveling around the world. The time arises for the boys' talent to be put to the test. The king needs some new cloaks for his travel, and it is of utmost importance that the cloaks will protect him from the harsh weather. The tailor assigns each of his sons the task of creating a cloak for the king. The first son fashions a cloak out of square pieces of cloth; the second chooses hexagons to create the cloak and fills in the empty spaces with triangles; the third son uses circles (which to him, represents the world). When the boys show their work to their father it becomes apparent that the youngest son's cloak is full of holes, as a circle has no angles to fit together.

While the teacher read A Cloak for the Dreamer aloud, the teacher asked students to make and evaluate predictions about the potential problem in the story. When the story was over, the students participated in a teacher-guided discussion about what happened in the story. The students were able to use math manipulatives such as pattern blocks to visually demonstrate their ideas.

Grandfather Tang's Story was read to the students at the end of their unit as an extension. This story is about a Chinese grandfather who is telling his granddaughter a story using a tangram set to create images. As each new character enters the story, grandfather Tang rearranges the tangrams to create the image of that individual or creature.

After experiencing the story through listening and viewing the pictures, the students were asked what this story had in common with what they had been learning in math class. Students were then exposed to tangrams, and asked to find the area of each piece given that the square was equivalent to one square unit.

Three Pigs, One Wolf, and Seven Magic Shapes was read as an additional exposure to tangrams. The students participated in a discussion about how this story is similar to Grandfather Tang's Story. The children were then given two sets of paper tangrams, and instructed to create an object using as many or as few tangram pieces as they wanted. Students were directed to then make a poster, illustrating their object, telling how many square units their object was equivalent to, and explaining how they figured out the total number of square units.

At the end of the unit, students were reassessed using the posttest, which was comprised of the same questions as the pretest. The posttest was administered using the same format as the pretest.

CHAPTER IV

Analysis of Data

Purpose

The purpose of this study is to evaluate whether using children's literature is an effective method of helping children with learning disabilities develop an improved understanding of mathematical concepts. Students' progress was assessed through a pretest and posttest, as well as through daily observations of students' work in class.

Findings

Overall, a p value of .655 indicated that there was no statistically significant difference found between the control and experimental groups. There was also no significant difference found between the progress of students with learning disabilities and their nondisabled peers, after having been exposed to children's literature.

Pretest/Posttest Scores

Control Group	Unit 3 pretest-part 1	part 2	"baker" pretest	total
1A	11	1	3	13
2A (Kelly)	7	1	2	10
3A	8	1	3	12
4A	9	1	3	13
5A	11	1	4	16
6A	11	1	4	16
7A (Ben)	7	1	4	12
8A (Dylan)	8	2	3	13
9A	10	1	2	13
10A	9	1	3	13
11A	11	2	3	16
12A	9	1	3	13
13A	15	1	4	20
14A	8	2	3	13
15A	12	2	2	16
16A	10	1	3	14
17A	9	1	3	13
18A	11	1	3	15
19A (Kara)	8	1	2	11
20A	9	1	3	13
21A	11	1	3	15
22A (Alison)	7	1	2	10
23A	13	1	4	18
24A	8	1	2	11
	28 possible points	4 possible points	4 possible points	36 possible pts.

(Students with learning disabilities have been identified with a pseudonym.)

Control Group	Unit 3 posttest-part 1	part 2	"baker" posttest	total
1A	16	2	3	20
2A (Kelly)	19	4	2	27
3A	14	2	4	18
4A	20	4	3	28
5A	25	4	4	33
6A	21	3	4	27
7A (Ben)	16	2	4	20
8A (Dylan)	10	2	3	14
9A	23	4	1	31
10A	17	1	3	19
11A	26	4	3	34
12A	13	4	3	19
13A	17	4	4	25
14A	13	3	1	19
15A	23	4	1	31
16A	19	3	3	25
17A	16	3	2	22
18A	18	3	2	24
19A (Kara)	9	1	1	11
20A	22	2	3	26
21A	27	4	3	24
22A (Alison)	10	2	3	14
23A	20	4	3	28
24A	16	3	3	22
	28 possible points	4 possible points	4 possible points	36 possible pts.

1A	7	2	4	13
2A (Shanna)	10	1	2	13
3A	11	1	3	15
4A	10	1	3	14
5A	7	1	3	11
6A (Adam)	7	1	2	10
7A	8	1	3	12
8A	12	1	3	16
9A	15	2	3	20
10A	11	2	3	16
11A	10	1	4	15
12A	13	2	3	18
13A (Kyle)	8	1	2	11
14A	7	1	2	10
15A	14	1	4	19
16A	12	1	2	15
17A	7	2	3	12
18A (Mark)	8	1	2	11
19A	8	1	2	11
20A	7	2	3	12
21A (Shelly)	12	1	2	15
22A	8	2	1	11
23A	8	1	4	13
	28 possible points	4 possible points	4 possible points	36 possible pts.

Experimental Group	Unit 3 posttest-part 1	posttest part 2	"baker" posttest	total
1A	19	4	4	27
2A (Shanna)	15	3	3	21
3A	21	3	3	27
4A	22	3	3	28
5A	18	2	3	23
6A (Adam)	15	3	3	21
7A	19	3	4	26
8A	19	3	4	26
9A	15	3	3	21
10A	24	4	3	31
11A	20	3	4	27
12A	15	2	4	21
13A (Kyle)	14	2	1	17
14A	18	3	3	24
15A	17	4	4	25
16A	25	4	3	32
17A	17	3	4	24
18A (Mark)	13	4	3	20
19A	15	3	2	20
20A	17	3	4	224
21A (Shelly)	11	3	3	17
22A	17	4	4	25
23A	28	4	4	36
	28 possible points	4 possible points	4 possible points	36 possible pts.

Anecdotal Observations

Although the statistical analysis did not demonstrate that exposure to children's literature had a positive effect on children's understanding of math concepts, as both the researcher and the teacher of the experimental group, I found that the numbers did not reflect the learning that was occurring in the classroom each and every day.

Shortly after beginning the unit described in the study, I was dismayed that the learning disabled students in the classroom displayed many of the same attitudes toward math as they had in the past. Some students felt defeated, others confused, while at the same time embarrassed that they needed so much individual attention while their non-disabled classmates seemed to be able to grasp the meaning of the concepts easily. However, when I began to incorporate children's books into the lesson, I started to detect a change in some of the children's demeanors.

Suddenly, for one child in particular, math began to make sense. Kyle (not his real name) was able to draw connections between what we had been studying in class, and the story, which illustrated the same concepts, but in a way that was more true-to-life for him.

The fact that Kyle was recognizing connections between what he was doing, and what he was hearing in a story was invaluable—for both him and me. Kyle began to view himself as a learner, and I was able to provide him, and my other students with a new context for learning.

It is not possible for these insights to be measured in a quantitative manner.

CHAPTER V

Implications of the Research

Discussion

It was hoped that the results of student performance on posttests would demonstrate significant improvement after being exposed to children's literature that complemented the current curriculum. However, the statistical results of this study did not indicate that the experimental group's performance showed any vast improvement. There are a number of plausible explanations for the lack of quantitative growth.

First, the sample size was relatively small. There were only a total of 47 students involved in the study. Just ten of these students were students with learning disabilities.

Second, the length of the study was short. Due to time constraints, it was only possible to investigate the effects after merely one unit, which lasted over a period of approximately four weeks. A longer study, which involved a larger number of math units, may have produced more positive results.

Third, the study took place during the winter months, at a time when many of the children were frequently absent from school as a result of illness. The experimental group suffered a rather large number of absences in particular. During one week of the study, an average of five children were absent each day, with two children absent for longer than a week. The absences created a lack of continuity, which may have also negatively affected the results of the study.

Despite the lack of apparent quantitative growth, a qualitative analysis depicts a contrasting view. A review of anecdotal records and classroom observations reflect a number of incidents in the classroom during which growth was observed.

First, the self-esteem of the children with disabilities made a marked improvement on days that literature was read. The children expressed more confidence in their ability to explain what was happening in the story mathematically, as opposed to their confidence level when asked to explain the mathematics involved in the classroom activity the day before, even when the concept was exactly the same.

Second, when the children who were exposed to the children's literature became faced with the concept later in the unit, perhaps as a review, perhaps as a scaffolding activity, they were able to point out the connection of the activity with the story shared in class. This provided a level playing field, in a sense, so that if a child's partner was having trouble with the activity, the students were able to refer back to the book for a real life context.

Third, even though the growth on the posttest for the experimental group looked small in number, for specific children, the small growth was momentous. In Adam's case, an overall 21-point growth was shown. This number is largely significant in Adam's case, because of his usual tendency to give up. Adam generally relies on his partner to complete all of the work for the two of them, and to provide an explanation. During this unit, Adam's personality changed. He seemed invested in his learning, and made use of vocabulary terms during discussions. Adam began to participate more often, and looked forward to math class.

Conclusions

The quantitative data in this study did not point to a statistically significant difference between the posttests of the experimental group and the control group. In contrast, the qualitative results indicated significant benefits for the group who had received exposure to the children's literature. The exposure to literature provided children with an increased self-esteem, similar background knowledge, and meaningful connections to real life, all very important outcomes that cannot be reflected through quantitative measures.

Recommendations for Further Study

It is recommended that this topic be studied further, with the elimination of the limitations. One suggestion to teachers or other researchers who want to repeat or extend the study, is to complete a long-term study of half a school year or more, with an increased sample size, and an increase in the number of units covered. Longitudinal studies and larger sample sizes help to strengthen data, and result in more accurate data findings.

Further studies on the effects of literature exposure to children's understanding of math concepts might include a sample of students who all share the same type of disability, rather than a sample of children with varying disabilities.

Also, studies could investigate the impact of incorporating children's literature in math concepts, with other content areas, such as the possibility of improving reading, writing, and speaking skills in Language Arts.

Finally, an investigation of how including mathematics literature in the curriculum affects children's affect and attitude toward math is a worthwhile venture.

Appendix A

Name: Unit 3 Pretest/Posttest

Date: Teacher:

Part 1: Vocabulary

Tell what you think these words mean:

congruent:

slide:

flip:

turn:

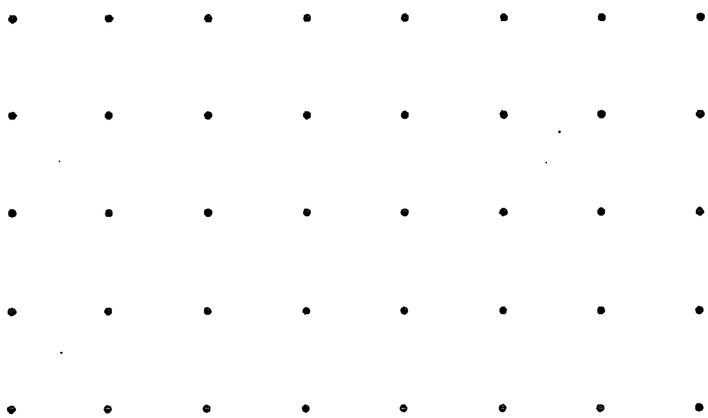
tetromino:

grid:

area:

Part 2: Make a Shape

Make a shape with an area of 5, 6, or 7 square units.
Draw it on the dot grid.
Use both squares and triangles in your shape.



What is the area of your shape? ______________________
Write how you know your shape has that area.

____

____

____

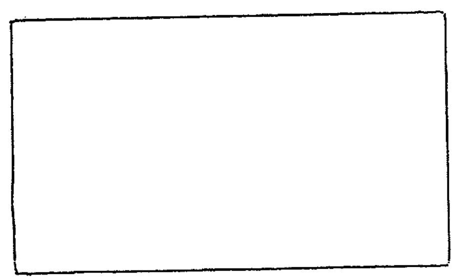
____

____

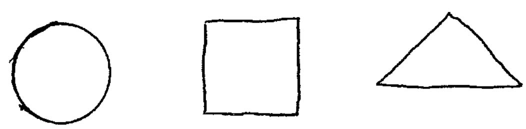
____

Part 3

Imagine that you are a baker. You have a piece of dough this size:



What shape would you make your cookies in order to use up the most dough?



Explain your answer in numbers, pictures, or words.

Appendix B

Pretest/Posttest Scoring Rubric

Part 1:

4 definition is written with clearly defined mathematical terminology

3 definition is generally on the right track mathematically, but missing some key information

2 definition makes sense, but not in mathematical terms

1 word is used in a sentence, but not defined; definition makes no sense; is illegible

Part 2:

4 made up of 5, 6, or 7 units
uses squares *and* triangles
explanation is clear, complete, and accurate

3 made up of 5, 6, or 7 units
uses squares *and* triangles
explanation *not* clear, complete, accurate

2 *not* made up of 5, 6, or 7 units

or

uses squares *or* triangles

or

explanation not clear *or* not correct

1 completely incorrect; illegible

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