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ABSTRACT

A study examined the effect of manipulative instruction on the acquisition and maintenance of perimeter and area problem-solving skills by students with learning disabilities in math. Three rural students with learning disabilities in mathematics in grades 7-10 participated in the study. All training was conducted daily for 15-20 minutes on a one-on-one basis by a certified special education teacher using a geoboard. The procedures for teaching perimeter and area problem solving are detailed. None of the students could solve the problems presented to them during the baseline condition. With each intervention, there was a marked increase in problem-solving ability. Using the geoboard, the students reached performance criterion (at least 80 percent of problems solved correctly on 3 or more consecutive days) in the two types of problem solving after 5-7 days of practice. Maintenance checks performed in each of 3 consecutive weeks following treatment revealed that all students solved all area and perimeter problems correctly when using the geoboard. Immediately following Christmas vacation, the students were given four area and four perimeter problems and asked to solve them using only paper and pencil. They scored 90-100 percent. The findings revealed that the use of concrete manipulatives promotes the maintenance of skills. (Contains 16 references.) (TD)

Facilitating Adolescents with Disabilities Understanding of Area and Perimeter Concepts via Manipulative Instruction

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FACILIATING ADOLESCENTS WITH DISABILITIES UNDERSTANDING OF AREA AND PERIMETER CONCEPTS VIA MANIPULATIVE INSTRUCTION

Mtetwa and Garafalo (1989) found that the majority of students at the secondary level listed mathematics as their least favorite subject. Further questioning of the students revealed the following student beliefs concerning math: (a) math requires memorization and practice for success, (b) problems in computation always require formulas, (c) problems only have one correct answer, and (d) people who are considered good at math are geniuses. If this is the belief of students at the secondary level without disabilities, then students with learning disabilities in math are at a greater disadvantage in math when these prevalent attitudes are wedded with the math disability.

Reports from the National Council of Teachers of Mathematics (1989, 1991) indicate that to function in life, students need to become capable, confident problem solvers. Both reports stress the importance of concrete experiences and materials to aid students' understanding of math skills and principles. Students as a whole must see and believe that mathematics makes sense, is useful, and understandable to them personally before mathematics will be used readily and confidently in their lives.

Manipulative materials, such as geoboards, pattern blocks, chip trading boards, counters, algebra tiles, attribute pieces, fraction bars, and Cuisenaire rods, have been employed to teach children and adolescents a variety of math concepts. These manipulative materials have been used to teach students counting, place value, word problem solving, basic computation, numeration, and equation solving skills. Mastropieri, Scruggs, and Shiah (1991) found that the use of manipulatives facilitated the acquisition of basic mathematical concepts. Mercer and Miller (1992, 1993) stated that a variety of examples and manipulative objects led to a strong conceptual knowledge base in mathematics for students with learning disabilities in math. Marsh and Cooke (1996) discovered that using manipulatives when solving math story problems greatly enhanced students' ability to identify the correct operation to solve word problems. Daniels, Hyde, and Zemelman (1993) indicated that manipulative use enables students to become knowledgeable and confident in the math ability area.

While a perusal of literature revealed that there are a vast number of articles offering excellent suggestions as to how to employ manipulative materials, empirical investigations on the affects of manipulatives on learning math concepts are limited. Most studies, even those using math manipulatives, have not included participants who have learning disabilities. In Sowell's (1989) meta analysis of manipulative math instruction evaluating the findings from 60 studies, the conclusion was reached that long term use of concrete materials as opposed to abstract instruction resulted in significantly greater gains in mathematical learning. Evaluation of the use of manipulative materials with persons classified as having learning disabilities revealed that manipulative instruction was effective in teaching place value skills (Peterson, Mercer, & O'Shea, 1988), word problem skills (Marsh & Cooke, 1996), computation skills (Mercer & Miller, 1992; Miller, Mercer, & Dillon, 1992) and problem solving skills (Maccini & Hughes, 2000). A search of the literature failed to find any studies evaluating the impact of manipulative instruction on students with learning disabilities in the area of geometry, specifically dealing with area and perimeter concepts. Adults routinely employ the knowledge of area and perimeter to solve problems in their daily lives in such areas as buying rugs, curtains, tiles, blinds, fencing, and lumber. These types of problems easily are solved. Students are exposed to the principles of area and perimeter on a daily basis, however, when these principles are introduced in a secondary school classroom, the student's disability coupled with a fear of failure produces a stumbling block in learning resulting in confusion and frustration. Therefore, effective means must be developed to teach students with learning disabilities in math to solve area and perimeter problems for success in school and life.

The purpose of this study was to evaluate the affect of manipulative instruction on the acquisition and maintenance of perimeter and area problem solving skills by students with learning disabilities in math. Specifically, the following study questions were addressed: (a) How long would the students with learning disabilities in math take to acquire skills in perimeter and area?; (b) Once the skills in area and perimeter were mastered, would the skills be maintained over time?; and (c) Would the students be able to transfer the area and perimeter skills learned through manipulatives into paper-pencil calculations?

Methodology

Participants

Three students classified as learning disabled in mathematics and attending a school in a rural area of the Central United States participated in the study: (a) Bill, a 9th grader, enrolled in Algebra, (b) Amber, a 7th grader, enrolled in pre Algebra, and (c) Bob, a 10th grader, received Geometry instruction in the resource room. Assessment via the Woodcock-Johnson Psycho-Educational Battery-Revised, Tests of Achievement (1989) revealed that the students broad math scores and math reasoning scores were in the following percentiles respectively: (a) Bill, 11th and 27th, (b) Amber, 30th and 64th, and (c) Bob, 8th and 32nd.

Materials

Materials used in the study included three geoboards and rubber bands. Problems randomly were selected from *Geometry for Primary Grades* (Fitzgibbon, 1999), *Intermediate Geometry* (Fetty, 1999), and *Middle Grade Math: Tools for Success* (Chapin, Illingworth, Landau, Masingila, & McCracken, (1997).

Design

The design employed for this study was a multiple baseline design across people and two behaviors, perimeter and area problem solving ability (Tawney & Gast, 1984). First, Bill began instruction while Amber and Bob remained on baseline. Amber and Bob's perimeter or area behavior was probed every other day while on baseline. Second, when Bill's data indicated a trend toward acquiring the perimeter or area solving skill, then Amber began treatment. Third, Bob was exposed to treatment once Amber began acquiring the perimeter or area solving skill.

Area and perimeter problem solving skills were deemed acquired when each student correctly solved 80% or greater or the problems attempted on each of three consecutive days. Students initially were trained in solving perimeter problems and then in area problems. When students met the 80% or greater criterion for solving area and perimeter problems, training ceased and maintenance checks were performed. These checks were performed in the resource room by the students' teacher two times per week over the course of 3 weeks. The teacher individually asked each child with the aid of the geoboard to calculate the answer to five perimeter and five area problems. In addition after a 2 week Christmas break students were asked to use paper and pencil to calculate the answers to four area and four perimeter problems.

Procedure

All training in solving area and perimeter problems was conducted on a one-on-one basis in a resource room for students with learning disabilities. Training was conducted on a daily basis for 15 to 20 minutes by a teacher certified in special education. The teacher recorded the number of problems the student correctly solved, the type of errors made by the student, the length of time the student required to solve the problems, and the length of time required in the training session.

The following procedure was used to teach perimeter problem solving. In the first session only, the teacher told the student perimeter meant how far it is around your (gave examples, such as this room, your yard, etc.) and demonstrated perimeter to the student via walking all the way around the room. Then the teacher demonstrated how to make shapes on the geoboard and allowed the student to create various shapes on the board. In subsequent sessions, other activities were incorporated. First, the teacher demonstrated on the geoboard that the perimeter of shapes could be determined by counting from nail to nail (the distance from one nail to another nail is one unit). Second, a square was constructed on the board and the student placed a rubber band at the corner of the square and moved a finger around the square from nail to nail until returning to the rubber band. The student then stated how many units found in the perimeter. Second, the teacher created five random shapes on the geoboard one at a time and encouraged the student, with prompting as needed, to determine the perimeter. Third, the teacher selected two perimeter problems from one of the math books and demonstrated to the student how to solve the problems using a geoboard. The student then solved the problems with prompting as necessary. Fourth, the teacher selected two more perimeter problems from the math books and allowed the student to solve them on the geoboard with prompting as necessary. Fifth, the teacher selected three to five perimeter problems from the math books and allowed the student to solve these problems on the geoboard with no prompting. This activity served as the daily test.

The following procedure was used to teach area problem solving. In the first session only, the teacher told the student that area means how much room you have to (gave examples, such as this room, your yard, etc.) and demonstrated area to the student via counting room tiles. Second, the teacher constructed a four-by-four nail square on the geoboard and asked the student to divide the square in as many one-by-one nail squares as possible. Then the student was asked to count the squares and determine the number of square unit. Third, the teacher created five random shapes on the geoboard one at a time and encouraged the student, with prompting, to determine the area of each shape. Fourth, the teacher selected two area problems from one of the math books and demonstrated to the student how to solve the problems using a geoboard. The student then solved the problems with prompting as necessary. Fifth, the teacher selected two more area problems from the math books and allowed the student to solve them on the geoboard with prompting as necessary. Sixth, the teacher selected three to five area problems from the math books and allowed the student to solve these problems on the geoboard with no prompting. This activity served as the daily test.

Treatment fidelity was evaluated during 25% of the sessions. A classroom aide was given a list of the steps the teacher was to follow when administering treatment and was asked note whether each step was followed in the same manner for each student. Inspection of this data revealed 100% adherence to prescribed method of treatment.

Reliability of scoring student responses was evaluated by having an aide observe and score students solutions to problems during 25% of the treatment sessions. There was a 100% agreement between the teacher's and aide's scoring of students' solutions to problems.

Results and Discussion

None of the students were able to correctly solve any of the area or perimeter problems presented to them during the baseline conditions. Each term intervention was introduced for area as well perimeter problem solving there was a marked increase in problem solving ability. Bill reached performance criterion (80% or greater problems solved correctly on 3 or more consecutive days) in perimeter problem solving after 6 days and in area problem solving after 5 days. Amber required 7 days to reach criterion in perimeter problem solving, and 5 days to attain criterion in area problem solving. Bob became proficient in perimeter problem solving in 5 days and in area problem solving in 5 days.

Maintenance checks performed twice per week in each of 3 consecutive weeks following treatment revealed that all students solved all area and perimeter problems given correctly when using the geoboard. Immediately following Christmas vacation, Bill, Amber, and Bob were given four area and four perimeter problems and asked to solve them using only paper and pencil. Their scores were 100%, 90%, and 90% respectively.

Clearly, the treatment resulted in a fairly rapid acquisition and maintenance of basic perimeter and area problem solving skills. Also, the training appears to have resulted in transfer of skills learned to paper and pencil problem solving solutions. These results are in accord with previous findings in the field that indicate that concrete manipulatives facilitate acquisition of various math skills (Marsh & Cooke, 1996; Mercer, & Miller, 1992; Sowell, 1989). They extend previous findings by revealing that use of concrete manipulatives promotes the maintenance of skills.

The success the students demonstrated could be attributed to any of a number of factors. These include their teacher's level of enthusiasm and skill in delivering instruction, the use of fairly simple area and perimeter problems that involved no angles and/or irregular shapes, or the concrete depiction of the concepts of area and perimeter.

One limitation of this study is that a test of generalization was not employed. Would the students be able to perform area and perimeter problem solving skills in their general education classrooms in group settings with limited teacher supervision? Another limitation involves the type of problems given, none contained angles because geoboard instruction does not allow for such representations. However, in real life, angles must be taken into consideration when solving area and perimeter problems. Therefore, future researchers need to examine means to effectively promote generalization of area and perimeter problem solving skills and ways to incorporate angles into manipulative instruction. Manipulative instruction as employed in this study does appear to be an effective strategy for learning and both the students and teacher enjoyed using the materials.

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