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ABSTRACT

Four high school special education teachers in the Vocational Education Program in the South Bend Community School Corporation participated in a mathematics program. They then conducted classroom research related to their inservice activities with their mildly handicapped students. Teachers used manipulative materials in their inservice sessions and indicated positive attitudes toward their use with low achievers. Each teacher selected a minimum of 10 students for participation in the study; the entire class participated in the activities. Focus of the study was student achievement on computation with whole numbers. Each teacher determined the format for use of manipulatives, such as Try-A-Tile Cards, math match card games, pathway activities, calculators, and dice games. Increases in achievement on computations were obtained on all subtests and composites with one exception. Results lent support to the notion that use of mathematics manipulatives with slow learners can improve computation skills. In addition, classroom activities created a high level of interest in mathematics among many students. (YLB)

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MATHEMATICS MANIPULATIVES IN A PRE-VOCATIONAL PROGRAM: TEACHER INSERVICE AND CLASSROOM RESEARCH

The achievement of slow learners in mathematics is influenced greatly by cultural differences and deficient cognitive functioning. Yet research has provided limited information on how to effectively produce mathematics programs and instruction for environmentally and/or academically disadvantaged students. Schulz (1972) points out that education has been "notoriously unimaginative and unsuccessful" in providing mathematics programs for the slow learner. He further states that in our current educational situation, "the teacher is the cultural agent of change who can adapt the strategies and tactics of instruction to meet the needs of the slow learner."

Over the last twenty years, many mathematics educators have urged greater use of manipulative materials in teaching mathematics at all levels. The NACOME report (1975) recommended that "concrete experiences be an integral part of the acquisiton of abstract ideas." More recently, the National Council of Teachers of Mathematics, in its "Agenda for Action," recommended that "teachers use diverse instructional strategies, materials, and resources in their teaching." Although research efforts are limited as noted earlier, they have generally shown that manipulatives are especially effective with slow learners, producing achievement and attitudinal gains (Howard, 1970; Schippert, 1965).

This articles discusses an inservice program for teachers of mildly mentally handicapped high school students and results

of classroom research conducted by them on the use of mathematics manipulatives.

In-Service Program

The South Bend Community School Corporation provides a Pre-Vocational Education (PVE) Program for its handicapped youth. The PVE curricula offer a variety of academic courses and practical work experiences designed to prepare high school students to enter the working force after graduation.

Through a grant from the Indiana Department of Public Instruction, Division of Equal Educational Opportunity, to the Desegregation/Integration Department of the South Bend Community School Corporation, high school special education teachers were given an opportunity to receive 20 hours of inservice training in mathematics or reading over a two month period. Four teachers from three high schools volunteered to participate in the mathematics inservice program, with the stipulation that they would conduct classroom research related to their inservice activities. A ranking by the teachers of areas of concern in mathematics provided the framework for the inservice sessions. The session topics are listed below:

1. What mathematics should we teach to the low achiever?
2. Principles for teaching computational skills, classroom starter activities, Try-A-Tiles, tangrams.
3. Calculator activities, polyhedra dice games for computational skills.
4. Card games for computational skills and informal geometry.

5. Fraction Dominoes, fraction pieces, Fraction Bars, magic squares.

6. Fraction activities via cards and dice games.

7. Money concepts, Pathway activities for computational skills.

8. Data Analysis, discussion of results of experiments.

Participants were actively involved using manipulative materials in each session, with most materials being new to the teachers. Comments by the teachers at the end of the program indicated positive attitudes toward the use of manipulatives with low achievers.

The Studies

Under guidelines of the grant, each teacher randomly selected a minimum of ten students for participation in the study; the entire class, however, participated in the activities. The high school students enrolled in this special education program have been classified as mildly mentally handicapped.

All teachers agreed that student achievement on computation with whole numbers was their major concern. Pre- and post-tests for subtraction, multiplication, and division, taken from the commercially available "Electric Drill" program for remedial work in mathematics, were used by three teachers. Each subtraction test contained 19 problems; multiplication tests, 25 problems; and division tests, 25 problems. One teacher used different forms of the Test of Adult Basic Education, Level M, for pre- and post-tests. The mathematics sections of the tests contained 12 problems for each of the four operations.

Each participating teacher determined the particular format for use of manipulatives in the classroom. Classroom quantities of the materials were available from the inservice instructor.

Study 1

For a period of ten weeks, students in a PVE mathematics class (grades 9-10) spent the last 10 to 15 minutes of each class using manipulatives to reinforce place value concepts and basic computational skills. The following activities were used during the experiments: Try-A-Tile cards for addition, subtraction, multiplication, and division, Math Match card games for addition, subtraction, multiplication, and division, Tangle Tables for addition and multiplication, Pathways Activities for addition and subtraction, and Random Digit activities for addition, subtraction, multiplication, and division.

Results of the pre- and post-tests, using parallel forms of the Test of Adult Basic Education, Level M, are presented in Table 1.

Table 1: Study 1

(N=10)

		Pretest	Post-test	t
Addition	M	9.7	9.7	0
	SD	0.82	1.25	
Subtraction	M	8.8	9.0	.22
	SD	1.48	1.63	
Multiplication	M	6.9	8.9	2.02*
	SD	2.69	2.08	
Division	M	4.2	6.4	2.37*
	SD	2.9	2.67	
Total	M	29.6	34.0	2.60*
	SD	5.97	3.16	

*$p < .05$

Increases in achievement were obtained on three operations, and on the total score. Using a t test for related-sample means, multiplication, division, and total gains were significant ($p<.05$).

Study 2

The PVE mathematics class consisted of grade 12 students who had not been in a structured mathematics program for two years. Each student was required to spend "free time" of approximately twenty minutes per day using manipulatives and games. Each student was provided with a hand-held calculator which could be taken home to practice on computational skills. Try-A-Tile Cards for subtraction, multiplication, and division, and Pathways Activities for addition and subtraction were used during class "free time."

Results of the pre- and post-tests, using the "Electric Drill" program tests, are presented in Table 2.

Table 2: Study 2

(N=10)

		Pre-test	Post-test	t
Subtraction	M	12.4	12.7	.28
	SD	4.38	2.63	
Multiplication	M	12.7	15.4	1.52
	SD	4.14	4.30	
Division	M	5.1	18.3	5.56*
	SD	5.57	6.57	
Total	M	30.2	47.4	5.54*
	SD	10.59	4.53	

*$p<.05$

Gains were achieved on the three individual operations and on the composite score; however, only the division and total increases were significant ($p < .05$).

Study 3

The twelve students participating in Study 3 were in grades 9 through 12. They spent approximately 10 minutes per day for ten weeks using hand-held calculators, Tangle Tables for addition and multiplication, Try-A-Tile cards for all operations, and tangrams for perceptual skills.

Results of the pre- and post-tests, using the "Electric Drill" program tests, are presented in Table 3.

Table 3: Study 3
(N=12)

		Pre-test	Post-test	t
Subtraction	M	11.8	13.0	1.01
	SD	5.27	5.05	
Multiplication	M	9.92	10.92	.76
	SD	8.31	9.20	
Division	M	7.58	8.17	.97
	SD	9.15	8.93	
Total	M	29.33	32.08	1.16
	SD	20.34	21.60	

Although there were increases for each operation and the total, no increase was significant.

Study 4

The PVE mathematics class consisted of students in grades 9 and 10. Tangrams were used for 15 minutes by all students on Tuesdays and Thursdays. Math match card games were played for approximately 30 minutes on Mondays, Wednesdays, and Fridays.

Try-A-Tile Cards for all operations were used daily for approximately 30 minutes by different students. Polyhedra dice games were played or calculators were used daily for 15 to 20 minutes. Results of Study 4 are presented in Table 4. Again, "Electric Drill" tests were used.

Table 4: Study 4
(N=10)

		Pre-test	Post-test	t
Subtraction	M	11.8	14.7	.90
	SD	5.27	4.42	
Multiplication	M	15.5	17.1	1.60
	SD	8.48	6.72	
Division	M	9.7	12.8	2.53*
	SD	7.82	8.99	
Total	M	39.1	44.9	2.88*
	SD	19.26	17.2	

*$p < .05$

Increases in achievement were obtained on all three tests and on the composite; division gains and total gains were significant ($p < .05$).

Discussion

Increases in achievement on computations with whole numbers were obtained on all subtests and composites, with the exception of the addition test in Study 1 in which no gain or loss was found. This particular result might be expected in as much as addition is the first operation studied, and is usually regarded as the easiest to learn and to remember.

Although strict controls on the use of the various manipulatives and on the time format were not possible, the results of the classroom studies do lend support to the notion that the use

of mathematics manipulatives with slow learners can improve computational skills. In addition, classroom activities created a high level of interest in mathematics among many studies, motivating them to complete assignments in order to use the manipulatives, and making them eager to participate in class discussion.

A regulated mathematics program for slow learners, including short units of study, and provisions for reinforcement of computational skills through the use of many manipulative devices and game-like activities, is an apparent viable alternative to the traditional "drill" programs for these students. Additional research needs to be conducted on the use of various mathematics manipulatives with slow learners and on the long term effectiveness of such use.

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