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ABSTRACT

Change efforts undertaken by schools and districts as a result of obtaining data from the October 1976 testing of 40 mathematics objectives for fourth graders in Delaware are briefly described. End-of-the-year results from 13 districts which gave posttests in May 1977 are also presented. Data are reported by total score, strand, and objective. A concise summary indicates that the 3,831 students tested performed best in grade 4 in the areas of numeration, operations and properties, and mathematical sentences. They were poorest in the areas of graphing and functions, and mathematical reasoning. Approximately 14% were unable to answer at least 50% of the items. (MS)

STATE OF DELAWARE

DEPARTMENT OF PUBLIC INSTRUCTION

DOVER, DELAWARE 19901

OBJECTIVE-REFERENCED MEASURE IN MATHEMATICS

SUMMARY REPORT

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INTRODUCTION AND PURPOSE OF REPORT

During the week of October 18-22, 1976, an assessment instrument measuring 40 statewide mathematics objectives was administered to 6,971 grade four public school students in Delaware. The 160 item test was designed for the purposes of (1) providing entry level diagnostic information in mathematics that was student and skill specific to be used for instructional planning and (2) furnishing schools and districts with data that could support curriculum analysis and improvement.

These assessment data, aggregated to the state level, were analyzed and presented in a report entitled, "The Objective-Referenced Measure in Mathematics for Delaware Grade Four Students - Final Report".(1) This document provided a baseline description of student status in mathematics at the beginning of grade four. The report also highlighted mathematics strengths and weaknesses by objective.

Results from the October testing were returned to districts early in the school year so that classroom teachers and administrators could focus on improvement efforts during the 1976-77 school year. In order to assist in these improvement efforts, 13 districts requested the use of the test materials for retesting students at the end of the school year. In response to the district requests, the Planning, Research, and Evaluation Division organized and operated a second testing effort during the week of May 2-6, 1977. Data analysis and report generation were performed by Project DELTA of the University of Delaware at minimal district cost.

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(1) The Objective-Referenced Measure in Mathematics for Delaware Grade Four Students, Final Report, By Delaware Educational Accountability System Committee of the Planning, Research, and Evaluation Division, Delaware State Department of Public Instruction, February 1977.

It is the purpose of this report to 1) briefly describe the change efforts undertaken by schools and districts as a result of obtaining the test results and 2) to describe the end of the year results obtained by the 13 districts that post-tested students in May of 1977.

SCHOOL AND DISTRICT CHANGE EFFORTS

Numerous educational changes occurred in local educational agencies as a result of receiving and utilizing the district, school and classroom level test data, interpretative material, and support products developed by the Department of Public Instruction. These district activities were funded to a large extent through the Delaware Educational Accountability System mini grant program but also were given significant financial support from local district funds. Specific district and school change efforts and activities included:

* a multitude of test result analysis and interpretation workshops led by both local and state staff training approximately 80% of Delaware grade four teachers and administrators.

* a regrouping of grade four students according to skill proficiency in order to provide them with more individualized and needs-based instructional programs.

* the adoption of a federally validated mathematics program in one district to help those children in need of remediation in the improvement of arithmetic skills.

* the development and implementation of a graduate level inservice course by the Department of Public Instruction and University of Delaware for teachers of one district focusing on the statewide mathematics objectives designed to improve teacher skills and competencies in mathematics instructional techniques.

* the analysis of the statewide mathematics objectives in relation to school instructional materials to supplement the textbook to objective correlation provided by the state.

* the formulation of instructional planning guides to aid in the articulation of mathematics instruction across grade levels within schools and districts.

* the focusing of classroom instruction on those statewide terminal grade four objectives used as the test framework.

END OF YEAR RESULTS OF THE DISTRICTS POST-TESTING WITH THE OBJECTIVE REFERENCED MEASURE IN MATHEMATICS

Description of the Sample

Students from 13 school districts participated in the post-testing effort at district request. A total of 3,831 regular grade four students comprise this sample. Special education students were also tested in most of the districts but their results were not included in this data analysis.

In order to determine how representative the 13 post-tested districts were of the state as a whole, the 1976 grade four mathematics survey test district means and socioeconomic status (SES) data of these districts were examined. The results of this investigation indicated that when taken as a group, these 13 districts tend to be slightly above average on both math achievement and SES factors. The range of scores on these factors, however, are widely distributed and include both very low and very high districts on each of these two characteristics. It may be concluded, therefore, that the results described in this report may not be considered representative of how the grade four students in the entire state would have performed had all students been post-tested.

DISTRICT POST-TESTING RESULTS

The items on the test assess 40 of the statewide mathematics objectives identified as terminal grade four objectives. That is, according to the stated purpose of the objectives, students should have received instruction on these objectives before the end of grade four and thus should be capable of performing well on those skills measured by this test.

The narrative and tables that follow describe students results by total score, by strand or category and by specific objective.

Results by Total Score

For the purpose of analyzing and summarizing the test results, the 160 item test was divided into four equal score groups. The lowest score group represents between zero and 25 percent of the items correct. Each of the next three score groups represent 25 percent more of the items correct through the highest score group representing 76 to 100 percent of the items answered correctly by students. Table 1 shows the division of the score groups, and the number and percentage of students in each score group for the 13 districts administering the test to students in May.

According to the results, approximately 45 percent of the students post-tested were able to correctly answer between 76 and 100 percent of the items correctly. An additional 40 percent correctly answered between 51 and 75 percent of the items. There may be cause for concern regarding the 14 percent of the students who could not correctly respond to at least 50 percent of the items.

Results by Strand

The 160 items used on the test were grouped into nine broad skill areas called strands. Six to 40 items are clustered within each of these nine categories. Eight of the nine strands had a sufficient number of items to subdivide the items into four score groupings based on percent of items correct. The percent of students within each score group for the 13 districts are presented for all eight strands in Table 2.

Strand A - Numbers and Numerals. The 17 test items in this category measure students' basic understanding of the number system including such specific skills as 1) relating fractions to parts of a geometric shape, 2) identifying the attributes of a given set of numbers and objects, 3) identifying even and odd whole numbers, and 4) arranging simple fractions in order.

TABLE 1

DISTRICT POST-TESTING RESULTS
GROUPED BY TOTAL SCORE

Total Score Range	Approximate Percent of Items Correct	Number of Students	Percent of Students	Score Range Subtotal in Percent Post-Test
160 - 151	100 - 94	102	2.66	
150 - 141	93 - 88	417	10.89	
140 - 131	87 - 82	596	15.56	
130 - 121	81 - 76	615	16.05	45.16
120 - 111	75 - 69	515	13.44	
110 - 101	68 - 63	427	11.15	
100 - 91	62 - 57	330	8.61	
90 - 81	56 - 51	283	7.39	40.59
80 - 71	50 - 44	212	5.53	
70 - 61	43 - 38	153	3.99	
60 - 51	37 - 32	97	2.53	
50 - 41	31 - 26	53	1.38	13.44
40 - 31	25 - 19	23	0.60	
30 - 21	18 - 13	4	0.10	
20 - 11	12 - 7	0	0.00	
10 - 0	6 - 0	4	0.10	0.81

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Over 36 percent of the students were able to correctly answer between 75 and 100 percent of the items in this mathematics strand. Just over 42 percent of those students tested obtained correct answers on 50 to 75 percent of the items. It should be noted that over 21 percent could not correctly answer at least 50 percent of the items in the Numbers and Numerals strand.

Strand B - Numeration. Test items in this skill group assess the students' ability to read, write, interpret, and change form within the number system. More specifically, this category relates to skills needed in determining place value and equating numerical and verbal forms of numbers. A total of 11 items were used to assess student achievement in this category.

Over 60 percent of the students tested in May obtained between 75 and 100 percent of the items correct while about 30 percent correctly answered 50 to 75 percent of the items. Only 12 percent of the students could not correctly answer at least 50 percent of the items.

Strand C - Operations and Properties. This mathematics strand contains items that measure the students' ability to add, subtract, multiply and divide. The items not only determine student computational abilities with whole numbers; but also with simple fractions and mathematical symbols. Forty items assessed student achievement in this area of mathematics.

Nearly 62 percent of the students tested obtained between 75 and 100 percent of the items correct. An additional 27 percent correctly answered between 50 and 75 percent of the items. Only 11 percent of the post-tested students could not answer at least 50 percent of the items.

Strand D - Mathematical Sentences. The items within this category measure the student's ability to translate a verbal idea or physical situation

into a mathematical expression in order to arrive at a solution. Fourteen items measure the achievement of students in this category.

More than half (55 percent) of the students could correctly answer between 75 and 100 percent of the items relating to mathematical sentences. Nearly a third more answered correctly between 50 and 75 percent of the items, while 12 percent did not obtain at least 50 percent of the items.

Strand E - Geometry. This strand contains 24 items that measure a student's ability to identify and classify one and two dimensional figures and to solve computational problems based on the measures of these figures. Specific skills include the identification of lines, points and angles; finding the distance around various polygons; approximating the area of polygons; and identifying types of triangles.

Only 30 percent of the post-tested students correctly answered 75 percent or more of the items while just over 50 percent of the students were able to obtain correctly between 50 and 75 percent of the geometry items. About 19 percent of the students did not correctly answer at least 50 percent of the items.

Strand F - Measurement. Test items in this skill group relate to the students' ability to recognize the need for a measure, choose the most appropriate measure, select the most appropriate tool of measurement, and measure an object to the nearest unit. Emphasis was placed on the metric system although items were not confined to this measurement system. Twenty-two items assessed this category.

Nearly 40 percent of the students in the post-tested districts were able to correctly answer between 75 and 100 percent of the items in the measurement category. Approximately 43 percent more of the students obtained between 50 and 75 percent of the items correct. Just over 17 percent received correct

answers on 50 percent or fewer of the items.

Strand G - Graphing and Functions. The items within this category measure the students' abilities to associate rational numbers with points in one and two dimensions. Nine items tested student skill ability in this area.

About 32 percent of the post-tested grade four students correctly answered between 75 and 100 percent of the graphing and functions items. An additional third of the students correctly obtained between 50 and 75 percent of the items. The remaining 34 percent could not answer at least 50 percent of the items in this category.

Strand I - Mathematical Reasoning. The items within this strand measure student achievement in rounding numbers; estimating solutions to mathematical problems; and reading, interpreting, and finding solutions to word and picture problems. A total of 17 items were used to assess student skills in this category.

Nearly 38 percent of the students assessed at the end of the fourth grade were able to correctly answer between 75 and 100 percent of the items in mathematical reasoning. Approximately the same amount of students correctly answered between 50 and 75 percent of the items. Nearly 26 percent of the students could not obtain correct answers on at least 50 percent of the items.

Summary of Strand Level Results

Students tested performed best at the end of grade four in the areas of 1) numeration, 2) operations and properties and 3) mathematical sentences with more than 50 percent of the students able to correctly answer 75 to 100 percent of the items within each strand. This same trend was noted in the test results at the beginning of the grade four program.

The weakest areas in mathematics appear to occur in 1) graphing and functions and 2) mathematical reasoning. More than 25 percent of the students tested were able to correctly answer fewer than 50 percent of the items in the two categories.

Results by Objectives

Forty statewide objectives were assessed with 3 to 6 items. An average percent correct was calculated for each objective based on those students participating in the post-testing effort. The average percent correct for each of the forty objectives is presented in Table 3 (pages 13-16).

Using an average percent correct of 70 as a criterion, 20 of the 40 objectives could be considered mathematics strengths for students taking the post-test. With this same criteria only eight objectives would have been considered strengths based on the results of the beginning of the year test. The following list represents those mathematics objectives on which post-tested students performed best.

1. Identifying one collection of coins as >, <, or = value of another collection of coins (limit $2)
2. Identifying lines of symmetry in geometrical figures
3. Stating and writing multiplication facts up to ten with whole numbers
4. Multiplying whole numbers up to a three digit factor by a one digit factor
5. Solving simple open sentences using whole numbers
6. Computing sums of given whole numbers up to five digits with and without regrouping
7. Determining length in the metric system
8. Identifying whole numbers in verbal form when presented with it in numerical form

9. Recognizing and using the commutative property of addition and multiplication with whole numbers

10. Determining the perimeter of polygons using whole numbers

11. Stating and writing division facts up to ten with whole numbers

12. Identifying whole numbers in numerical form from a verbal form

13. Identifying a fraction which expresses part of a standard geometric shape to tenths

14. Reading, interpreting, and finding solutions for word/picture problems

15. Relating positive and negative numbers to realistic situations

16. Interpreting the place value for whole numbers of up to five digits

17. Computing differences of given whole numbers up to five digits with and without regrouping

18. Constructing and interpreting bar and line graphs

19. Telling time to the nearest minute

20. Dividing whole numbers with a one digit divisor up to three digit dividends (with no remainder)

If an average percent correct of 50 percent or fewer on each objective, were used as the standard, three mathematics skills could be considered weaknesses for students tested in May of 1977. Applying this same standard to the October test results, a total of 14 objectives could have been considered weaknesses. The list that follows presents those skills that may be considered weak areas in mathematics.

1. Approximating the area of simple irregular shapes (using square grid)

2. When given the point in the plane, identify the ordered pair

3. Arranging a set in order of at least three unit fractions

CONCLUSIONS AND RECOMMENDATIONS

As a result of the data presented in this report the following conclusions may be drawn:

* Tested students performed best at the end of grade four in the areas of 1) numeration, 2) operations and properties, and 3) mathematical sentences.

* Post-tested students performed poorest in the areas of 1) graphing and functions and 2) mathematical reasoning.

* Approximately 14 percent of the students tested at the end of grade four were not able to answer at least 50 percent of the items on the total test. The total test represents attainment of objectives specified as necessary for students to have learned by the end of grade four.

* Fifteen and 28 percent of the students respectively, were not able to perform well in the areas of addition and subtraction.

* If the performance of all Delaware students would have been similar to the students post-tested then Delaware students performed better on more objectives and poorly on fewer objectives at the end of the grade four instructional program.

The following recommendations are made in concurrence with the State Supervisor of Mathematics, in order to assist in correcting the deficiencies or further improving the conditions noted in this report:

* Encouragement and further opportunities should be given to teachers for the purpose of analyzing the post-testing results of their specific students. Grade five remedial programs should then be developed and directed toward those students exhibiting deficiencies in the tested objectives.

* Those students identified as performing exceptionally well on the end of the year test should be provided with a mathematics program built upon their attained skills. The enrichment program should extend student knowledge and capabilities in mathematics.

* The teachers of students in grades four and five should jointly analyze the classroom level results to detect end of year mastery and non-mastery of objectives for each student. The mathematics instructional program at grade five should then be planned prior to the start of grade five in order to meet the unique needs of each child.

* Department of Public Instruction staff should increase their efforts in providing leadership and technical assistance to schools in the areas of curriculum improvement and instructional program planning.

TABLE 3

AVERAGE PERCENT CORRECT BY OBJECTIVE
DISTRICT POST-TEST RESULTS

OBJECTIVE CODING	OBJECTIVE	AVERAGE PERCENT CORRECT POST-TEST
A1	IDENTIFY A FRACTION WHICH EXPRESSES PART OF A STANDARD GEOMETRIC SHAPE TO TENTHS.	78
A2	IDENTIFY THE COMMON AND/OR DIFFERENT ATTRIBUTES OF A GIVEN SET.	69
A3	IDENTIFY EVEN AND ODD WHOLE NUMBERS.	68
A4	ARRANGE A SET IN ORDER OF AT LEAST THREE UNIT FRACTIONS.	33
B1	INTERPRET THE PLACE VALUE FOR WHOLE NUMBERS OF UP TO FIVE DIGITS.	73
B2-A	IDENTIFY WHOLE NUMBERS IN VERBAL FORM WHEN PRESENTED WITH IT IN NUMERICAL FORM.	83
B2-B	IDENTIFY WHOLE NUMBERS IN NUMERICAL FORM FROM A VERBAL FORM.	80
C1-A	COMPUTE SUMS OF GIVEN WHOLE NUMBERS UP TO FIVE DIGITS WITH AND WITHOUT REGROUPING.	85
C1-B	COMPUTE DIFFERENCES OF GIVEN WHOLE NUMBERS UP TO FIVE DIGITS WITH AND WITHOUT REGROUPING.	72
C2	MULTIPLY WHOLE NUMBERS UP TO A THREE DIGIT FACTOR BY A ONE DIGIT FACTOR.	85
C3	DIVIDE WHOLE NUMBERS WITH A ONE DIGIT DIVISOR UP TO THREE DIGIT DIVIDENDS. (WITH NO REMAINDER)	70

TABLE 3 (Continued)

OBJECTIVE CODING	OBJECTIVE	AVERAGE PERCENT CORRECT POST-TEST
C4	IDENTIFY ONE COLLECTION OF COINS AS >, <, OR = VALUE OF ANOTHER COLLECTION OF COINS (LIMIT $2).	88
C5	RECOGNIZE AND USE THE ASSOCIATIVE PROPERTY OF ADDITION AND MULTIPLICATION WITH WHOLE NUMBERS.	56
C6	RECOGNIZE AND USE THE COMMUTATIVE PROPERTY OF ADDITION AND MULTIPLICATION WITH WHOLE NUMBERS.	82
C9	ADD AND SUBTRACT A PAIR OF LIKE FRACTIONS.	56
C10-A	STATE AND WRITE MULTIPLICATION FACTS UP TO TEN WITH WHOLE NUMBERS.	86
C10-B	STATE AND WRITE DIVISION FACTS UP TO TEN WITH WHOLE NUMBERS.	82
D1	SOLVE SIMPLE OPEN SENTENCES USING WHOLE NUMBERS.	85
D2	CONSTRUCT OPEN SENTENCES TO USE IN SOLVING GIVEN STORY PROBLEMS.	66
D3	IDENTIFY THE CORRECT RELATIONS SYMBOL (>,<, =).	65
E1	IDENTIFY AND NAME BASIC GEOMETRIC FIGURES SUCH AS POINT, LINE, LINE SEGMENT, RAY, ANGLES, CONGRUENT FIGURES, ETC.	69
E2	DETERMINE THE PERIMETER OF POLYGONS USING WHOLE NUMBERS.	82
E3	DETERMINE THE AREA OF RECTANGLES USING WHOLE NUMBERS. (USING WHOLE NUMBERS AND SQUARE GRID).	55

TABLE 3 (Continued)

OBJECTIVE CODING	OBJECTIVE	AVERAGE PERCENT CORRECT POST-TEST
E5	IDENTIFY LINES OF SYMMETRY IN GEOMETRICAL FIGURES.	86
E6	IDENTIFY TYPES OF TRIANGLES AND QUADRILATERALS FROM MODELS OR ILLUSTRATIONS. (LIMITED TO RIGHT TRIANGLES, SQUARES, RECTANGLES FROM PICTURES).	66
E7	IDENTIFY PARALLEL AND INTERSECTING LINES IN A PLANE. (INFORMAL EXPERIMENT; REALISTIC SITUATION).	53
E8	APPROXIMATE THE AREA OF SIMPLE IRREGULAR SHAPES. (USING SQUARE GRID).	49
F1-A	IDENTIFY STANDARD METRIC MEASURES USED TO MEASURE LENGTH, MASS (WEIGHT), CAPACITY (VOLUME) AND TEMPERATURE.	58
F1-B	DETERMINE LENGTH IN THE METRIC SYSTEM.	85
F2	CONVERT A SIMPLE MEASURE IN ONE UNIT TO A MEASURE IN ANOTHER UNIT WITHIN THE SAME SYSTEM. (METRIC PLUS OTHER UNITS - LIKE 7 DAYS = 1 WEEK).	60
F3	IDENTIFY THE CHANGE IN COINS WHICH WOULD BE RECEIVED IN MAKING PURCHASES WITH VALUES UP TO $1.	69
F6	TELL TIME TO THE NEAREST MINUTE.	70
G1	RELATE POSITIVE AND NEGATIVE NUMBERS TO REALISTIC SITUATIONS.	78
G2	GIVEN THE ORDERED PAIR, IDENTIFY THE POINT IN THE PLANE.	56

TABLE 3 (Continued)

OBJECTIVE CODING	OBJECTIVE	AVERAGE PERCENT CORRECT POST-TEST
G3	GIVEN THE POINT IN THE PLANE, IDENTIFY THE ORDERED PAIR.	46
H1	CONSTRUCT AND INTERPRET BAR AND LINE GRAPHS.	71
I1	ESTIMATE SOLUTIONS IN PROBLEM SOLVING SITUATIONS.	60
I2	READ, INTERPRET, AND FIND SOLUTIONS FOR WORD/PICTURE PROBLEMS.	78
I3	ROUND OFF WHOLE NUMBERS TO NEAREST TEN'S, HUNDRED'S, OR THOUSAND'S.	53
I4	SOLVE A MATHEMATICAL SENTENCE OR SIMPLIFY A MATHEMATICAL EXPRESSION TO DETERMINE THE ORDER OF NUMBERS.	55