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ABSTRACT

The Stanford Achievement Test (SAT), Test of Academic Skills Level I was administered to 10,186 tenth grade students in Hawaii during fall 1984. This two-section report presents findings from the SAT's mathematics subtest. This subtest measured students' competency in these nine areas: numbers, symbols, and sets; number properties and operations (whole numbers); number properties and operations (common and decimal fractions); number properties and operations (integers and exponents); mathematical sentences; geometry and measurement; ratio and percent; graphs, probability, and statistics; and mathematical reasoning. Section I, an overview, discusses the purpose of the test, the background of the test administration, and the approach for program analysis; a general summary of performance is included. Section II provides analysis of the mathematics subtest relative to the task requirement, student performance in Hawaii compared to national performance, implications, and recommendations. Supporting documentation (including SAT objectives correlated with learner objective or performance expectation) is included in appendices. The statewide summary of group stanine results indicates that tenth grade students in Hawaii performed slightly better than the national norm population with 78 percent scoring in the average and above average ranges. This is 1 percent higher than the national norm of 77 percent. (JN)

MATHEMATICS PROGRAM ANALYSIS OF GRADE 10 STANFORD ACHIEVEMENT TEST, TEST OF ACADEMIC SKILLS

Fall 1984 Administration

Office of Instructional Services/General Education Branch • Department of Education • State of Hawaii • RS 85-8017 • June 1985

The Honorable George R. Ariyoshi
Governor, State of Hawaii

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FOREWORD

As part of the Department's competency-based thrust, the analysis of test results is being conducted and reported. Performance data from tests and other sources are critical in the educational process and should be used to assist students, improve instruction, and upgrade programs. The efforts to date by teachers, principals and specialists are making significant impact on the achievement of students as indicated by the test results.

Although recent test results indicate overall improvement statewide, it is hoped that each level within the Department will continue to conduct review and analysis of formal data to determine student needs and related intervention activities. The momentum for positive change has begun and should be maintained, if not accelerated, as we work together to provide a solid foundation for all subsequent learning.

Francis M. Hatanaka

Francis M. Hatanaka, Superintendent

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I. OVERVIEW

OVERVIEW

A. Purpose

The purposes of this report are:

1. To provide information on the effectiveness of the mathematics program in the high school, including identification of deficiency areas which require attention and the implications and recommendations for improving instruction towards the goals and objectives of the Foundation Program and Mathematics Education.

2. To provide a model for subsequent district and school analyses.

It is expected that state, district and school level improvement efforts will be directed at the identified deficiency areas.

B. Background of the Test Administration

The Stanford Achievement Test (SAT) has been administered since the mid-1970's to students of grades 2, 4, 6, 8, and 10 as a means of assessing and analyzing student performance in planning program improvement. For the purpose of this report, the data analysis and recommendations for improvement will be restricted to grade 10. The SAT Test of Academic Skills (TASK) Level I was administered to 10,186 grade 10 students in the Fall of 1984.

C. Approach for Program Analysis

The following framework guided the program planner for mathematics in the analysis process. With minor modification or changes in focus, the framework may be used by schools or teachers in the assessment of test results for use in instructional planning and delivery.

1. How well does the test measure the program efforts? (Curriculum Validity)

   a. How well does the subtest content (items) reflect the major program emphases?

   b. Are there test items that measure what is <u>not</u> taught until later in the school experience?

   c. Are there major emphases for grade 10 that are <u>not</u> measured by this test?

2. How are the students performing? (Student Achievement)

   a. How well are the students doing statewide?

   b. Are there variations among subtest areas?

   c. Are variations what would have been expected? If so, why?

   d. Are variations consistent across all seven districts?

Each subtest was analyzed according to task description, student performance, implications for program/instruction, and recommendations for improvement.

D. General Summary of Performance

The statewide summary of group standardized test results indicates that tenth grade students in Hawaii performed slightly better than the national norm population with 78% scoring in the average and above average ranges. This is 1% higher than the national norm (77%).

	Below Average %	Average %	Above Average %
National	23	54	23
Hawaii 10th Graders	22	57	21

GRADE 10 ADMINISTRATION

A. Overall Analysis

The Stanford Achievement Test (SAT) Test of Academic Skills (TASK) Level I includes one mathematics subtest.

1. The curriculum validity of the test is determined by comparing the test items with the Grade 10 Foundation Program Performance Expectations and learner objectives of the Mathematics Program Guide. Although students are in the tenth grade, the test is administered early in the Fall and measures achievement up to the end of the ninth grade. Analysis of the SAT indicates that the test is moderately effective in assessing the attainment of some of the goals, objectives, and student performance expectations of the State Mathematics Program. There are eleven performance expectations of Foundation Program Objective I: Develop basic skills for learning and effective communication with others. The test does not measure eight performance expectations relating to geometry, statistics, graphs and tables. In addition, one performance expectation is measured by one item and another performance expectation is only partially measured.

   The problem-solving process is a major goal of the mathematics program as well as of the Foundation Program (Foundation Program Objective III: Develop decision-making and problem-solving skills). There are seven performance expectations of which the SAT addresses one.

   Approximately 91% of the SAT items measure expectations which may require performance at a level below Grade 9.

2. Student Performance

   The results displayed in Figure 1 on the next page indicate that although tenth grade students in Hawaii did not score as well as the national norm population on mean number right and corresponding scaled scores, the stanine distribution indicates slightly better performance by Hawaii's students. A comparison of the 1983 and 1984 results reveals the following:

   a. There is no change in the number right and slight increase in scaled scores. The scaled scores are based upon the raw scores. Scaled scores enable the interpreter to compare from grade to grade, battery to battery, and form to form, the scores within a single test area. Scaled scores are not comparable from one test area to another.

   b. There is a decrease in the percent of students scoring in the below average range, corresponding increase in the average range and no change in the above average range. The percent of students scoring in the average and above average ranges (78%) is slightly higher than the percent of students in the nation (77%) scoring in the same ranges.

	Mean Scores						Stanine Distribution								
	Number Right			Scaled Scores			Below 1 2 3			Average 4 5 6			Above 7 8 9		
	Norm	'83	'84	Norm	'83	'84	Norm	'83	'84	Norm	'83	'84	Norm	'83	'84
HAWAII TENTH GRADERS	37	34	34	196	193	194	23	24	22	54	55	57	23	21	21

Figure 1

3. Implications

Although the tenth grade performance is almost comparable to that of the norm population, there is a need to work towards improvement in all areas.

4. Recommendations

Analysis should be made of the subtest to identify those items students did not perform well on. Comparisons should be made of these items with the performance expectations and mathematics program objectives, reasons for student performance should be determined, and improvement strategies should be implemented where appropriate. Although the problem-solving process is not tested fully, a priority should be placed on the instructional delivery of the problem-solving process and development of logical thinking skills to improve overall mathematics performance.

B. Subtest Analysis

The following is an analysis of the mathematics subtest relative to the task requirement, student performance in Hawaii as compared to national performance, implications, and recommendations. The student performance comparison is made with respect to the mean p-values in each of the item-grouping areas. The subtest is divided into nine groups in which the test items are closely related. The p-value, which gives the percent of students answering the problem correctly is used to determine what students may need help with. A comparison of local p-values with those of the national norm is used in discussing the implications which are drawn from the relationship of performance expectations with the SAT objectives.

Further study within each of the item-group areas is made for those areas in which the local p-value is lower than the national p-value. Each item with a lower p-value is listed, but only those items considered significantly lower* are discussed in the section on implictions. Thus, the sections on implictions and recommendations will deal primarily with identifying areas for program improvement.

*Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

1. Description of Task

The subtest consists of 48 items which require the student to read each item and select an answer from five options. Item groupings are in nine areas: 1) numbers, symbols, and sets; 2) number properties and operations - common and decimal fractions; 4) number properties and operations - integers and exponents; 5) mathematical sentences; 6) geometry and measurement; 7) ratio and percent; 8) graphs, probability, and statistics; and 9) mathematical reasoning.

2. Student Performance

Figure 2 below compares the local and national mean p-values in each item-grouping area. The results show that students in the State of Hawaii scored slightly lower in the areas of numbers, symbols, and sets; graphs, probability and statistics; and mathematical reasoning. A comparison between the 1983 and 1984 results indicates slight increases in eight of the nine item-grouping areas as shown below.

ITEM GROUPING AREA	LOCAL % 1983	LOCAL % 1984	National %	Difference 1983	Difference 1984
Numbers, symbols, and sets	73	74	75	-2	-1
Number properties and operations - whole numbers	79	79	79	-0-	-0-
Number properties and operations - common and decimal fractions	68	69	69	-1	-0-
Number properties and operations - integers and exponents	72	73	72	-0-	+1
Mathematical sentences	73	74	72	+1	+2
Geometry and measurement	63	64	64	-1	-0-
Ratio and percent	62	63	60	+2	+3
Graphs, probability, and statistics	66	67	69	-3	-2
Mathematical reasoning	72	73	74	-2	-1

Figure 2

Item analysis indicates that the test objectives where students scored lower were as follows:

a. Numbers, Symbols, and Sets

1) Identifies definition of a prime number (item 22*).

2) Identifies a relationship between two sets (item 29*).

3) Determines value of a linear expression with two unknowns, given value of each (item 32).

b. Number Properties and Operations - Whole Numbers

1) Identifies a number, given its prime factors (item 4).

2) Recognizes one as the multiplicative identity (item 24*).

3) Solves for variable in an equation (item 37*).

c. Number Properties and Operations - Common and Decimal Fractions

1) Adds two common fractions having like denominators, with renaming (reduction) (item 10).

2) Identifies relative value of an improper fraction (item 15*).

3) Identifies relative value of a common fraction (item 23*).

4) Solves a one-step word problem by adding with mixed numbers and converting inches to feet (item 35*).

d. Number Properties and Operations - Integers and Exponents

1) Finds a product when one factor is given in exponential form (item 31).

e. Ratio and Percent

1) Solves a rate problem (item 16).

2) Finds a total when a part and its percent of total are given (item 41).

f. Graphs, Probability, and Statistics

1) Solves a word problem by identifying percents on a circle graph (item 19).

2) Solves a word problem by determining an amount represented by a percent given on a circle graph (item 20*).

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*Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

g. Mathematical Reasoning

1) States solution of a word problem as a mathematical expression (item 40).

2) Solves a word problem by deduction (item 43*).

Specific items in each of the above areas where students scored significantly lower were items 15, 20, 22-24, 29, 35, 37, and 43. The p-values for all of these items except item 16 were also significantly lower in 1983.

C. Implications

Tenth grade students in Hawaii did not do as well as the norm group on specific items that require:

1. identifying the relative value of an improper fraction,
2. solving a word problem by determining an amount represented by a percent given on a circle graph,
3. identifying the definition of a prime number,
4. identifying the relative value of a common fraction,
5. recognizing one as the multiplicative identity,
6. identifying a relationship between two sets,
7. solving a one-step word problem by adding with mixed numbers and converting inches to feet,
8. solving for a variable in an equation, and
9. solving a word problem by deduction.

Recognizing one as the multiplicative identity and solving a one-step word problem by adding with mixed numbers and converting inches to feet are objectives that will have been met by the end of the tenth grade. Identifying a relationship between two sets does not match any mathematics learner objective or performance expectation of the Foundation Program. Solving for a variable in an equation will be addressed in all Level A courses and solving a word problem by deduction is an objective of the Core Geometry course. However, the first four objectives are related to performance expectations or mathematics learner objectives that students should have met by the end of the eighth grade. Consequently, there is a need to improve student performance in all areas.

Items with local p-values at least 4 percentage points lower than the national norm are considered significantly low.

D. Recommendations

Continue to pursue the performance expectations with more emphasis placed on related learner objectives that address concepts where p-values were significantly lower than the national norm. Attention should be given to developing the concept of a fraction and computing with fractions which are problem areas of the sixth and eighth grades. Program improvement should also include a variety of problem-solving experiences and approaches which require students to apply the higher-level thinking, decision-making, and evaluative skills that are necessary for students to function as responsible citizens in society. The essential competencies and graduation requirements should also be a major consideration in program planning to ensure that students will have acquired all the necessary learnings by the time they graduate.

APPENDIX

Appendix A

Grade 10 SAT Item Matches

Item #	SAT Objective	Learner Objective (LO) Performance Expectation (PE)	Grade
1	Adds a broken column of three numbers.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
2	Subtracts a three-digit number from a four-digit number, with renaming.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
3	Renames a standard numeral in expanded notation.	Writes numerals in expanded and exponential notation.	7-8 LO
4	Identifies a number, given its prime factors.	Investigates how to determine prime and composite numbers in a variety of ways.	7-8 LO
		Investigates a variety of ways to determine least common multiples and common factors.	7-8 LO
5	Divides by a one-digit number, with an internal remainder.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
6	Multiplies common fractions.	Multiplies and divides mixed and common fractions.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
7	Identifies the decimal equivalent of a common fraction.	Expresses fractions as decimals to hundredths.	5 LO
8	Reduces a fraction to lowest terms.	Finds equivalent fractions in a variety of ways.	4 LO
9	Identifies a standard numeral from its word form.	Reads, writes (using words and symbols) and verbalizes mathematical ideas in order to communicate quantitative information.	7-8 LO
10	Adds two common fractions having like denominators, with renaming (reduction).	Adds and subtracts like-denominator fractions and commonly-used decimals.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
11	Names a geometric figure from a description.	Uses correct terminology in describing the properties of geometric figures.	10 PE
12	Subtracts with two common fractions having unlike denominators, no reduction.	Adds and subtracts commonly-used fractions (mixed and common) with unlike denominators.	6 PE
		Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
13	Identifies the place value represented by a digit.	Reads, writes, and orally names numerals to 100,000 and identifies the place value of each digit.	4 LO
14	Adds with negative integers.	Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
15	Identifies the relative value of an improper fraction.	Compares mixed numbers.	5 LO
16	Solves a rate problem.	Solves simple ratio, proportion, and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE
17	Solves a rate problem.	Solves simple ratio, proportion, and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE
18	Solves a word problem by computing a percent represented on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO
19	Solves a word problem by identifying percents on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
20	Solves a word problem by determining an amount represented by a percent given on a circle graph.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion and percent problems.	8 PE
		Extends ability to read, interpret, and make graphs and tables.	7-8 LO
21	Finds the average of three numbers.	Finds averages.	5 LO
22	Identifies the definition of a prime number.	Investigates characteristics of prime and composite numbers and classifies numbers less than 50 as prime or composite.	5 LO
23	Identifies the relative value of a common fraction.	Orders fractions from least to greatest using "< " and " > ".	5 LO
24	Recognizes one as the multiplicative identity.	Uses algebraic techniques and describes their relationship to the properties of real numbers.	8 PE 10 PE
25	Indicates the exponential notation for a number repeated as a factor.	Writes numerals in expanded or exponential notation.	7-8 LO
26	Solves a three-step, money word problem.	Uses operations of addition and subtraction involving money expressions.	4 LO
		Measures and computes measurements using the four basic operations.	6 PE
27	Finds the average of five numbers.	Finds averages.	5 LO
28	Solves for the variable in an equation.	Uses algebraic techniques and describes their relationship to the properties of real numbers.	8 PE 10 PE
29	Identifies a relationship between two sets.	No match.	
30	Locates the decimal point in the product of two decimals, no multiplication.	Adds, subtracts, multiplies and divides decimals.	8 PE
31	Finds a product when one factor is given in exponential form.	Performs the four basic operations with simple rational expressions.	Core Algebra
32	Determines the value of a linear expression with two unknowns, given the value of each.	Evaluates algebraic expressions, including the order of operations.	Algebra 1A

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
33	Solves a one-step, money word problem by subtracting.	Uses operations of addition and subtraction involving money expressions.	4 LO
		Measures and computes measurements using the four basic operations.	6 PE
34	Multiplies a three-digit number by a two-digit number, no renaming.	Adds and subtracts whole numbers; multiplies any whole number by a 2-digit number; and divides any whole number by a 1-digit number.	6 PE
35	Solves a one-step word problem by adding with mixed numbers and converting inches to feet.	Adds, subtracts, multiplies and divides fractions and integers.	8 PE 10 PE
		Computes measurements using the four basic operations and converts among units.	8 PE
36	Solves a one-step, money word problem by computing a percent of discount.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problems.	8 PE
37	Solves for the variable in an equation.	Solves simple equations in one unknown.	Level A
38	Finds a percent of a number.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problems.	8 PE
39	Determines the missing data needed so solve a word problem.	Asks appropriate questions to identify and clarify a problem and determines the information needed to solve the problem.	FPO III 6 PE
40	States the solution of a word problem as a mathematical expression.	Uses algebraic techniques and describes their relationship to the properties of real numbers.	8 PE 10 PE
41	Finds a total when a part and its percent of the total are given.	Solves simple ratio, proportion and percent problems.	6 PE
		Solves ratio, proportion, and percent problems.	8 PE

Item #	SAT Objective	Learner Objective (LO) or Performance Expectation (PE)	Grade
42	Determines the distance between two points on a number line.	Adds, subtracts, multiplies and divides integers.	8 PE 10 PE
43	Solves a word problem by deduction.	Is aware of how statements in mathematics can be organized into a deductive system, that is, a system consisting of undefined terms, axioms, theorems, and relationships.	Core Geometry
44	Finds the least common denominator of three common fractions.	Finds equivalent fractions in a variety of ways.	4 LO
45	Applies the associative property of multiplication.	Uses algebraic techniques and describes their relationship to the properties of real numbers.	8 PE 10 PE
46	Indicates the meaning of a metric prefix.	Computes measurements using the four basic operations and converts among units.	8 PE
47	Chooses the correct interpretation of a Venn diagram.	No match.	
48	Identifies a mathematical equation that represents a verbally stated relationship.	Uses algebraic techniques and describes their relationship to the properties of real numbers.	8 PE 10 PE

Appendix B

Items Not Matched to Grade 10 PEs

Item #	SAT Objective	Grade PE/LO
1	Adds a broken column of three numbers.	6 PE
2	Subtracts a three-digit number from a four-digit number, with renaming.	6 PE
3	Renames a standard numeral in expanded notation.	7-8 LO
4	Identifies a number, given its prime factors.	7-8 LO
5	Divides by a one-digit number, with an internal remainder.	6 PE
7	Identifies the decimal equivalent of a common fraction.	5 LO
8	Reduces a fraction to lowest terms.	4 LO
9	Identifies a standard numeral from its word form.	7-8 LO
13	Identifies the place value represented by a digit.	4 LO
15	Identifies the relative value of an improper fraction.	5 LO
16	Solves a rate problem.	6 PE 8 PE
17	Solves a rate problem.	6 PE 8 PE
18	Solves a word problem by computing a percent represented on a circle graph.	6 PE 8 PE 7-8 LO
19	Solves a word problem by identifying percents on a circle graph.	6 PE 8 PE 7-8 LO
20	Solves a word problem by determining an amount represented by a percent given on a circle graph.	6 PE 8 PE 7-8 LO
21	Finds the average of three numbers.	5 LO

Item #	SAT Objective	Grade PE/LO
22	Identifies the definition of a prime number.	5 LO
23	Identifies the relative value of a common fraction.	5 LO
25	Indicates the exponential notation for a number repeated as a factor.	7-8 LO
26	Solves a three-step, money word problem.	4 LO 6 PE
27	Finds the average of five numbers.	5 LO
29	Identifies a relationship between two sets.	--
30	Locates the decimal point in the product of two decimals, no multiplication.	8 PE
31	Finds a product when one factor is given in exponential form.	Core Algebra LO
32	Determines the value of a linear expression with two unknowns, given the value of each.	Algebra 1A LO
33	Solves a one-step, money word problem by subtracting.	4 LO 6 PE
34	Multiplies a three-digit number by a two-digit number, no renaming.	6 PE
36	Solves a one-step, money word problem by computing a percent of discount.	6 PE 8 PE
37	Solves for the variable in an equation.	Level A LO
38	Finds a percent of a number.	6 PE 8 PE
39	Determines the missing data needed to solve a word problem.	FPO III 6 PE
41	Finds a total when a part and its percent of the total are given.	6 PE 8 PE
43	Solves a word problem by deduction.	Core Geometry LO
44	Finds the least common denominator of three common fraction.	4 LO

Item #	SAT Objective	Grade PE/LO
46	Indicates the meaning of a metric prefix.	8 PE
47	Chooses the correct interpretation of a Venn diagram.	--

Appendix C

Grade 10 PEs Not Addressed

Performance Expectations	Comments
Adds, subtracts, multiplies and divides fractions and integers.	Partial.
Computes measurements of common plane and solid geometric figures.	No match.
Describes and explains uses and misuses of basic statistical measurements.	No match.
Calculates and interprets statistical measurements from a set of data.	No match.
Calculates measures of dispersion and correlation of data.	No match.
Uses correct terminology in describing the properties of geometric figures.	Match by one item.
Explains relationships of the parts of a geometric figure and among geometric figures.	No match.
Describes ways that geometric properties and relationships are organized in a deductive system.	No match.
Makes graphs and tables to display and compare measurement data.	No match.
Graphs and analyzes polynomial, rational, exponentials, and logarithmic functions, and solves corresponding equations and inequalities.	No match.