R E P O R T R E S U M E S

ED 013 705 RE 000 149

UNIFORMITY OF GROWTH IN THE BASIC SKILLS THROUGHOUT THE SCHOOL YEAR AND DURING THE SUMMER.

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PUB DATE FEB 67

EDRS PRICE MF-$0.25 HC-$0.44 11P.

DESCRIPTORS- *TEST INTERPRETATION, *ACHIEVEMENT TESTS, GROUP TESTS, INTERNAL SCALING, *STANDARDIZED TESTS, *GRADE EQUIVALENT SCALES,

THE ASSUMPTION THAT ONE-TENTH OF THE YEARLY GROWTH IN ALL ACHIEVEMENT AREAS TAKES PLACE EACH MONTH OF THE SCHOOL YEAR AND THAT ONE-TENTH OF THE YEARLY GROWTH OCCURS DURING THE SUMMER MONTHS WAS INVESTIGATED. THE STUDY WAS CONDUCTED IN CONNECTION WITH THE ANNUAL IOWA BASIC SKILLS TESTING PROGRAM IN THE STATE OF IOWA. MEDIANS FOR THE 11 SUBTESTS WERE ESTABLISHED AS OF JANUARY 15. ADDITIONAL ADMINISTRATIONS OF THE TESTS WERE CONDUCTED AROUND APRIL 15 AND OCTOBER 15. DATA BEARING ON SUMMER GROWTH WERE OBTAINED LATE IN MAY AND EARLY IN SEPTEMBER. THE SCHOOL-YEAR PHASE WAS CONDUCTED IN GRADES 3-4, 4-5, AND 5-6. THE SUMMER PHASE WAS CONDUCTED IN GRADES 5-6. THE EXPECTED DISTRIBUTIONS WERE OBTAINED BY INTERPOLATING BETWEEN THE DISTRIBUTIONS OBTAINED FOR THE SAMPLES IN THE JANUARY PROGRAMS. THE MEDIANS OF THE EXPECTED DISTRIBUTIONS WERE SIGNIFICANTLY DIFFERENT FROM THE MEDIANS OF THE OBTAINED DISTRIBUTIONS OF OCTOBER AND APRIL. FINDINGS INDICATED THAT THE ASSUMPTION OF UNIFORM GROWTH THROUGHOUT THE SCHOOL YEAR WAS QUESTIONABLE. NO ONE ALTERNATIVE ASSUMPTION APPEARED TO BE MORE APPROPRIATE. THE MAJOR RESULTS ARE SUMMARIZED IN TABULAR FORM. (RH)

UNIFORMITY OF GROWTH IN THE BASIC SKILLS THROUGHOUT THE SCHOOL YEAR AND DURING THE SUMMER

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Two types of score scales are employed with elementary school achievement test batteries. The first type is derived from data obtained on a single reference group and includes such scores as percentile ranks, z-scores, stanines, etc. This type of score scale is used to describe a given pupil's status or relative standing in the reference group. The second type is derived from data from several reference groups and includes K-scores, grade-equivalents, and age equivalents. This type of score places a given performance in relation to the reference groups and is particularly useful for measuring progress.

This study was designed to investigate certain assumptions which underlie the derivation of grade-equivalent scales and the estimation of percentile norms by interpolation. In deriving grade-equivalent scales, it is customary to establish raw score medians for successive grades for a particular time of year and to divide the interval between medians into ten equal parts before assigning grade-equivalents to integral raw score values. In interpreting grade-equivalent scores, it is usually recommended that the second digit of the grade-equivalent score be interpreted as the median performance for pupils at the end of the month corresponding to this value. Thus, for example, a grade-equivalent of 54 is interpreted as the median performance of pupils finishing the fourth month in the fifth grade (December). The usual assumption is that growth in all achievement areas takes place at the same uniform rate throughout the nine months of the school year. Nine tenths of the distance between grade medians is usually assigned to reflect nine "months" growth during the school year, and one tenth of the distance is used to represent one "month" of growth during the three summer months

Standardization data for all major elementary school test batteries are obtained during one restricted time period during the school year. The percentile norms for grade equivalent scores which are generally provided for other time periods are estimated by interpolation. This is generally done by assuming a uniform rate of growth and interpolating distributions of scores at pre-established proportions of the interval between the standardization distributions.

The assumption of a uniform rate of growth in all achievement areas is certainly questionable. For example, one might reasonably hypothesize that growth in vocabulary would be relatively uniform, not only throughout the school year but over the summer months as well. On the other hand, one might expect growth in a skills area closely tied to specific instruction, such as punctuation or arithmetic, to be somewhat sporadic, and for performance possibly even to regress somewhat during the summer.

The general hypotheses investigated for the eleven subtests of the Iowa Tests of Basic Skills are:

1) that distributions actually obtained at certain times of the school year do not differ from "expected" distributions established on the basis of an assumption of a uniform rate of growth during the school year, in which one month of growth is equal to .1 of the difference between successive grade medians established at time of standardization, and
2) that growth during the three summer months is .1 of the difference between successive grade medians.

Procedures

This study was conducted in connection with the annual Iowa Basic Skills Testing Program in the state of Iowa. In this program, medians for the eleven subtests are established

as of January 15. The medians are assigned grade-equivalents ending in 4.5 to correspond to the fact that the scores are obtained at a point which is 4.5 months into the school year.

To obtain data for investigating the first general hypothesis, additional administrations of the tests were conducted in the time periods around April 15 and October 15. Data bearing on the nature of summer growth were obtained late in May and early in September.

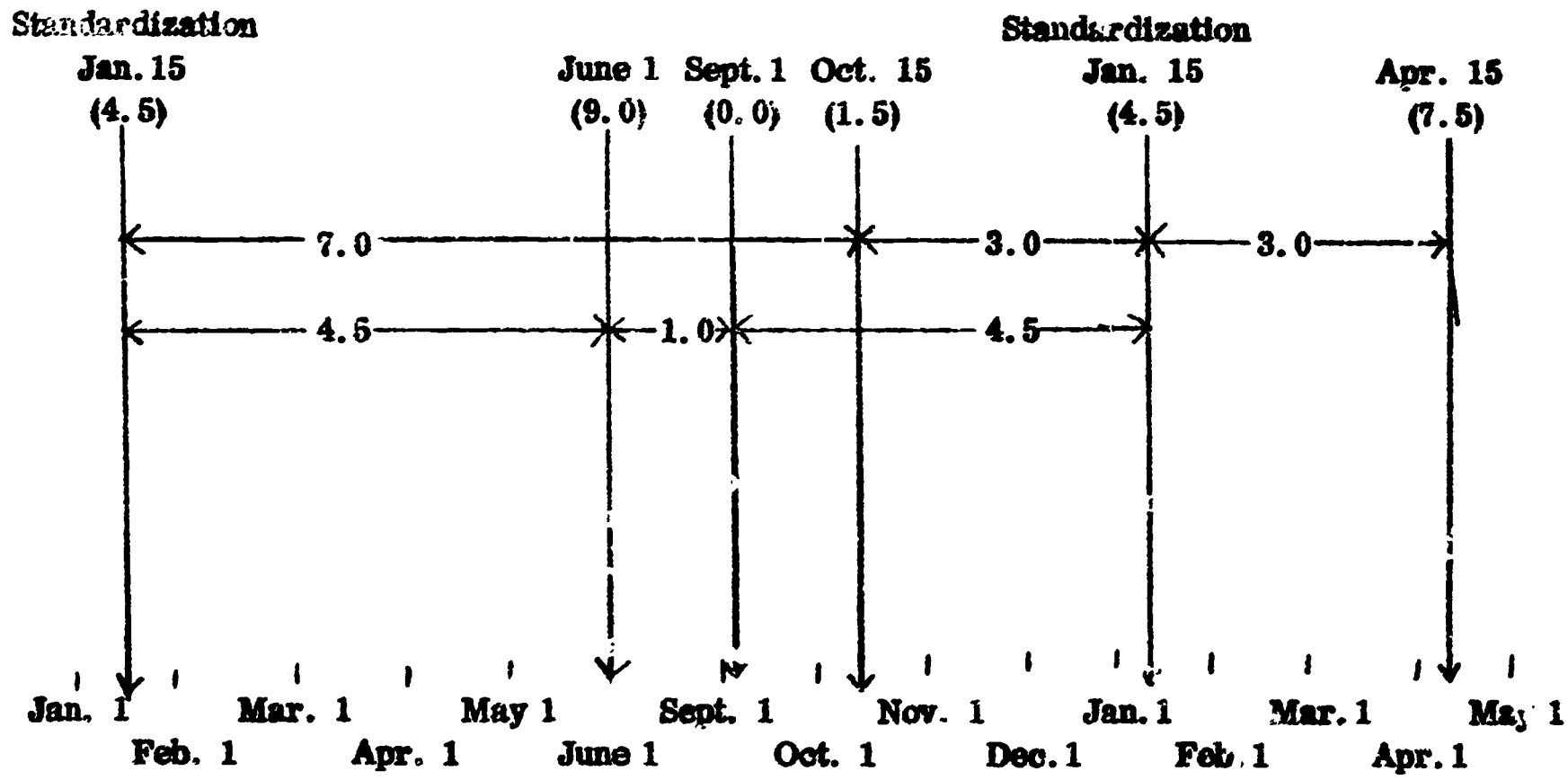
The study was conducted in two phases, with two independent sets of samples used for investigating the school-year and summer problems. Four independent samples were used in each phase, one for each of the four main test areas. The school-year phase was conducted in Grades 3-4, 4-5, and 5-6. The summer phase was conducted in Grades 5-6.

The samples of school systems were selected from those which had participated in the 1965 Iowa Basic Skills Testing Program. They were selected to be reasonably comparable with respect to level of performance and school size. Forms 3 and 4 were administered in January 1965, and in January 1966, in counterbalanced order. Forms 1 and 2 (in counterbalanced order) were administered in the special testing.

A summary of the characteristics of the sample is shown in Table 1.

INSERT TABLE I ABOUT HERE

The "expected" distributions were obtained by interpolating between the distributions obtained for the samples in the January programs. The nature of the interpolations is diagrammed below:



Each set of distributions was compared at the nearest integral GE value to the fiftieth percentile. The exact grade-equivalent for comparison was determined from the distributions obtained for the total program population for the January, 1964 Iowa Basic Skills Testing Program. After the grade-equivalent for comparison was determined, the percentile rank of the grade-equivalent was determined for both the expected and observed distributions. An approximate z-test (Blommers and Lindquist pp. 319-320) was then made to determine whether the difference in the two proportions was larger than could reasonably be attributed to random sampling. A ten percent level of significance was adopted for rejection of the null hypothesis in each of the comparisons.

INSERT TABLE II ABOUT HERE

Results

The major results are summarized in Table II. For each subtest, the top line presents the medians of the "expected" distributions established by the interpolation procedures described above, rounded to the nearest integral grade-equivalent value. The bottom line in each of the comparisons shows the medians of the obtained distributions which were significantly different from the expected medians ($\alpha = .10$).

It will be observed that 12 of the 33 October medians and 17 of the 33 April medians are significantly different from expectation. Some of the differences are relatively large, some as large as 7 "months." For the October comparisons, 7 of the obtained values were identical to expectation, 14 were below expectation, and 12 were above expectation. For April, 5 were the same as expectation, 3 were below, and 25 were above expectation. The latter differences reflect the fact that growth between January and April was greater than predicted through the use of the usual assumptions.

The differences for vocabulary and reading were relatively minor and non-significant. The significant differences were fairly evenly distributed throughout the other subtests: 13 of the 24 differences in the language median were significant, as were 8 of 18 of the work-study differences and 8 of the 12 differences in arithmetic.

Only 5 of the 22 differences in the subtest medians for the summer phase of the study were significantly different from expectation. In general, the data obtained for May for the summer sample, and the data obtained for April for the Grades 5-6 school-year sample are not in close agreement. This is also true of the September summer sample data and the Grades 5-6 October data.

INSERT TABLE III ABOUT HERE

In Table III the summer changes in terms of grade-equivalents are reportedly for each of the eleven subtests. In the arithmetic skills, there was a loss at each selected percentile. The loss in the Arithmetic Problem Solving subtest was in general larger than the loss in the Arithmetic Concepts subtest. The largest loss during the summer occurred below the sixtieth percentile in the Punctuation subtest. In general in the work-study skills there were observed gains at the selected percentile points. In the reading comprehension and language skills subtests, there were generally losses at the selected percentile points. In the upper nine-tenths of the vocabulary scores there was a gain during the summer months, but in the lower ten per cent of the distribution there was a loss.

Concluding Statement

On the whole, the results of the study suggest that the assumptions that one-tenth of the yearly growth takes place each month of the school year and that one-tenth of the yearly growth occurs during the summer months are almost certainly not strictly correct.

The evidence of a substantial loss during the summer months in the language and arithmetic tests is consistent and convincing. The "patterns" obtained for growth during the school year were quite inconsistent from test to test and from grade to grade. In implementing an assumption of something other than uniform growth in interpolating between grade medians established at time of standardization, it would almost certainly be necessary to obtain data for the particular tests in question and possibly, for different grade levels. The one trend in the data which seems to be reasonably consistent is that growth between January 15 and April 15 is, on the average, something more than three-tenths of a year, at least in the language, work-study, and arithmetic areas. But even this generalization is subject to reservation.

While the assumption of uniform growth throughout the year is seriously open to question, no alternative "theory" of the nature of growth is proposed. To the contrary, it seems unlikely that any one alternative assumption would be more appropriate.

TABLE I

CHARACTERISTICS OF THE SAMPLES IN THE SCHOOL-YEAR PHASE AND THE SUMMER PHASE

	School-year Phase						Summer Phase			
Testing Periods	Jan. 1965		Oct. 1965		Jan. 1966	Apr. 1966	Jan. 1965	May 1965	Oct. 1965	Jan. 1966
Grades	3 - 4		4 - 5		5 - 6		5 - 6			
	S*	P**	S	P	S	P	S	P		
Voc-Mig.	11	542	11	493	11	504	8	603		
Language	11	553	11	615	11	571	8	563		
W-S	12	677	12	649	12	681	7	442		
Arith.	12	645	12	585	12	599	9	552		

*School Systems
**Pupils

TABLE 11

SUMMARY OF THE OBSERVED AND EXPECTED MEDIAN GRADE-EQUIVALENTS FOR THE INTERPOLATED TIME PERIODS

Subtest	Sample	School-Year					Summer	
	Grades	3 - 4		4 - 5		5 - 6	5 - 6	
	Dates	Oct.	Apr.	Oct.	Apr.	Oct.	Apr.	May	Sept.
Vocabulary	Exp.	40	46	52	58	60	66	59	60
	Obs.	41	47	51	59	60	67	59	60
Reading Comprehension	Exp.	41	47	52	58	60	66	59	60
	Obs.	39	47	52	57	61	67	58	58
Spelling	Exp.	44	50	54	60	65	73	61	62
	Obs.	42*	53*	55	64*	66	74	62	60
Capitalization	Exp.	46	55	56	64	66	77	64	65
	Obs.	47	59*	57	70*	64*	79*	66*	64
Punctuation	Exp.	45	51	56	63	68	78	63	65
	Obs.	45	58*	58	67*	66*	78	67*	62*
Usage	Exp.	43	49	53	62	65	75	58	59
	Obs.	43	52*	53	61	60*	71*	59	57
Map Reading	Exp.	44	52	55	60	64	71	64	65
	Obs.	44	52	53	61	67*	75*	62	64
Reading Graphs and Tables	Exp.	43	49	53	59	62	70	63	64
	Obs.	42	51*	54	62*	64	70	61	63
Knowledge and Use of Reference Materials	Exp.	43	49	53	60	63	69	64	66
	Obs.	42	51*	55*	62	66*	74*	64	64
Arithmetic Concepts	Exp.	44	52	55	62	63	70	61	62
	Obs.	41*	52	51*	64*	62	74*	65*	63
Arithmetic Problem Solving	Exp.	43	49	53	59	63	70	61	62
	Obs.	40*	51*	50*	60	61*	69	63	59*

*Significantly different at .10 level.

TABLE 3

Changes in Grade-Equivalents at Selected
Percentile Points During the Summer Vacation

Subtest \ PR	05	10	20	30	40	50	60	70	80	90	9
Vocabulary	-1.8	-0.2	0.1	0.4	0.8	0.7	0.6	0.4	0.8	0.0	1
Reading Comprehension	-1.7	-1.3	-2.1	-1.3	0.8	0.0	0.0	0.0	0.1	-1.0	-1
Spelling	-1.0	-2.0	-2.6	-3.0	-2.5	-2.0	-1.0	-0.7	-0.7	-1.0	-0
Capitalization	-1.0	-2.0	-1.6	-1.5	-1.6	-1.7	-2.1	-2.0	-1.3	-1.0	-1
Punctuation	-3.9	-5.0	-5.8	-5.6	-4.8	-3.0	-3.0	-3.6	-3.8	-0.7	-0
Usage	-2.0	-3.3	-4.4	-3.5	-2.4	1.8	-0.8	-2.7	0.0	0.0	0
Map Reading	0.6	0.7	1.0	1.7	1.8	2.0	2.0	1.8	1.9	2.0	1
Reading Graphs and Tables	2.0	3.4	1.9	2.9	2.1	2.2	2.0	1.8	1.5	1.4	1
Knowledge and Use of Reference Materials	-0.5	-1.0	-0.5	0.0	0.0	0.0	1.0	0.0	0.1	0.0	0
Arithmetic Concepts	-1.6	-2.3	-1.8	-2.0	-2.0	-2.0	-2.3	-2.3	-2.7	-1.8	-2
Arithmetic Problem Solving	-2.0	-2.0	-3.0	-3.6	-3.8	-4.0	-3.5	-3.7	-3.0	-2.9	-2