AN ANALYSIS OF THE EFFECT OF THE TIME FACTOR IN THE STUDENT PERFORMANCES ON THE SCHORLING, CLARK, AND POTTER, HUNDRED-PROBLEM ARITHMETIC TEST

A Thesis

Presented to

the Department of Mathematics

Indiana State Teachers College

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

---

by

Ernest A. Deagan

August 1951

The thesis of Ernest A. Deagan,
Contribution of the Graduate School, Indiana State Teachers College, Number 731, under the title--
An Analysis of the Effect of the Time Factor in the Student Performances on the Schorling, Clark, and Potter, Hundred-Problem Arithmetic Test
is hereby approved as counting toward the completion of the Master's degree in the amount of 8 hours' credit.

Committee on thesis:

Orvel E. Stacy

Walter O. Shriner

Vesper D. Moore, Chairman

Representative of English Department:

James L. Boyle

Date of Acceptance 8-20-'51

TABLE OF CONTENTS

LIST OF TABLES

TABLE PAGE

TABLE PAGE

CHAPTER I

THE PROBLEM

Statement of the problem. The major purpose of this investigation was to determine the effect of the time factor in the performances of a group of college freshmen at Indiana State Teachers College on the Hundred Problem Arithmetic Test,[1] by Schorling, Clark, and Potter.

INTRODUCTION

Tests of various kinds have been used for many centuries. For example, tests in the skill of hunting, courting, and war were--and still are--in use in some of the backward civilizations. To cite an example, the American Indians sent young warriors out to live in the wilds for several weeks as a test of their ability to survive.

"Tests and examinations of various kinds were in use hundreds and even thousands of years ago...."[2]

The beginning of the standardized test is of much later origin.

---

[1]Raleigh Schorling, John Clark, and Mary Potter, Hundred-Problem Arithmetic Test (New York: World Book Company, 1944)

[2]C. W. Odell, Educational Measurement in High School (New York: The Century Co., 1930) p. 30.

Writing in 1845, Horace Mann argued that the new examination or standardized test was superior to all other methods for the following reasons:[3]

1. It is impartial.

2. It is just to the pupils.

3. It is more thorough than older forms of examinations.

4. It prevents the "officious interference" of the teacher.

5. It "determines beyond appeal or gainsaying, whether the pupils have been faithfully and competently taught."

6. It takes away "all possibility of favoritism."

7. It makes the information obtained available to all.

8. It enables all to appraise the ease or difficulty of the questions.

Although Mann was emphasizing the superior points of the new examinations he has indicated the purposes of the standardized test. The need for the standardized test was beginning to be felt in England, France, and America at the close of the nineteenth century. This need can be demonstrated from the results of the following.[4]

A geometry paper which was submitted to 118 teachers received grades ranging from 29 to 92,

---

[3]G. M. Ruch, The Objective or New Type Examination (Chicago: Scott, Foresman and Company, 1929) p. 4

[4]G. W. Wilson and K. J. Hoke, How to Measure (New York: The Macmillan Co., 1931) p. 554.

the passing mark being 75. Sixty-eight of the teachers, or nearly 58% of them, marked the paper a failure. Fifty of the group marked it 75 or above, one giving it a grade of 92.

One can observe that this is not consistent grading. This is one of the reasons for the development of the tests.

Some other reasons follow.[5]

Dearborn, Johnson, Kelly, Starch, Elliot, and others have made studies which show that practically all ordinary school marks given pupils' work are rather highly subjective; that is, the marks depend to a considerable degree upon the person giving them and vary greatly if given by different individuals or by the same individuals at different times.

Wilson and Hoke[6] in their book list some other reasons.

1. There are constant complaints from teachers in upper grades against the poor quality of work done in the lower grades.

2. There is wide variation in the distribution of grades among the various departments of the same school. In one high school, for example, 80% of the English grades were 90 or above, while only 4% of the mathematics grades were 90 or above. In the same high school, the German teacher gave 70% of her pupils 90 or above, while the Latin teacher gave only 2½% of her pupils a grade of 90 or above.

---

[5]Odell, op. cit., p. 6

[6]Wilson and Hoke, op. cit., pp. 551-554.

3. There is a wide variation in the distribution of grades among teachers in the same department. Of two instructors in the same department one gave 43% of his students the grade of "excellent" and to none the grade of "failure," whereas the other gave to none of the students the grade of "excellent" and to 14% the grade of "failure." There must have been a few good and a few bad in each group.

4. The fact that pupils transferring from one school system to another are frequently demoted indicates that minor details rather than large fundamental considerations are the determining factors in classifying them.

It can be observed that there was a need for consistent and more nearly accurate measurement in school work. "It is pointed out that progress in any field is largely limited by the degree to which accurate measurement therein is possible."[7] When Mann, Rice, and many others expressed their views the educational test movement was underway. Progress in the development of standardized tests was slow and not readily accepted in the beginning. Ridicule of the pioneers in the testing field was not uncommon.

Certain principles have guided the entire standardization development. Russell[8] states these as six axioms:

The first of these axioms is that whatever exists at all exists in some amount.

---

[7]Odell, op. cit., p. 5.

[8]Charles Russell, Standard Tests. (Boston: Ginn and Company, 1930) pp. 53-54.

The second axiom is that whatever exists in amount can be measured.

The third axiom is that efficiency in teaching depends upon desirable changes in children.

The fourth axiom is that the evaluation of learning depends upon the ability to make changes, as well as upon the changes made.

The fifth axiom is that the value of a desirable objective in education is determined by its tangibility.

The final axiom is that the worth of the methods or materials of instruction is unknown until their effect is measured.

The new test or standardized test was, according to Ruch,[9] introduced to serve several purposes.

1. They represent an attempt to control or standardize the conditions of the examination period with respect to directions, time allowances, method of responding, etc.

2. They are objective or impartial; i.e., the personal equation of the examiner is minimized or eliminated--minimized in the administration, and eliminated almost or quite completely in the scoring of the examination.

3. They provide norms or standards by which the scores of individual pupils may be evaluated and interpreted in the light of facts. Such facts are the performances of large numbers of supposedly typical pupils on the same tasks.

As authors differ in their thinking, one other list of purposes is presented. The purposes of the standardized tests as set forth by Odell[10] follows.

---

[9]Ruch, op. cit., p. 22.

[10]Odell, op. cit., p. 4.

1. Determining pupil classification, including promotion and failure.

2. Stimulating pupils to study.

3. Diagnosing pupils so that they may receive more efficient instruction.

4. Reporting to pupils, parents, and others interested in the quantity and quality of work being done by pupils.

5. Serving as the basis for educational and vocational guidance.

One other purpose that is not mentioned in Odell's list but is of prime importance to the teacher is that the standardized test indicates for the teacher how well she is doing her job. It is important that the teacher teach what is accepted as the norms or standards of the pupils under her charge.

The non-standardized test is not sufficient to serve the purposes that have been mentioned. A few of their shortcomings are:

1. The grading is not consistent.

2. Many are not objective or impartial.

3. They do not classify the students tested with the accepted norms or standards.

4. The personal feelings of the examiner does enter into the grading.

5. The conditions of the examination period are not necessarily controlled.

The standardized test on the other hand does meet the following needs.

1. The grading is consistent.

2. The standard test is objective and impartial.

3. The standard tests classify students tested with the accepted norms.

4. The personal feelings of the examiner are minimized or eliminated.

5. The conditions of the examination are controlled as much as possible, with respect to direction, time allowed, method of responding, and grading.

Since the standardized test meets many requirements, it is now commonly used. One can now find a standardized test for practically every subject at the elementary and secondary level.

No definite date can be assigned to the beginning of the standardized test, but the movement took place in the late nineteenth or early twentieth century. The first complete book that dealt with standardized tests was by Thorndike in 1896. Many men had written about such tests before this time.

Odell[11] cites some of the early work.

---

[11]Odell, op. cit., pp. 30-31.

In 1864 an English schoolmaster, Reverend George Fisher constructed a "scale book" which contained sample questions and various degrees of proficiency in answering the questions in several school subjects.

About this time Galton in England and a few years later J. McKeen Cattell in America, began work along the lines of measuring individual differences and mental abilities....

The first event which appears to have any direct connection with the modern measurement movement was Dr. J. M. Rice's work which began in 1894 and continued through several years. His best known test had to do with uniform spelling. In addition he constructed and administered tests in arithmetic and language...Fifteen years later, after the movement had got well under way, Rice was accorded considerable honor for his pioneer work.

Pressey[12] also mentioned the beginning of the movement, but his dates are much more recent.

No longer ago than 1908 appeared the first systematically organized form of the Binet Scale. In 1910 was published the first of the modern scales for the measurement of classroom products--Thorndike's Scale for Measuring the Quality of Handwriting. In 1915 Otis devised the first group scale for measuring general intelligence, embodying the principles later used in the army group tests.

The measurement movement, therefore, is comparatively new; in fact, the most important developments have come during the past few years. Particularly did the extensive psychological work done in the army during 1917 and 1918 give new impetus to the movement and establish new methods in testing.

---

[12]S. L. Pressey and L. Cole Pressey, Introduction to the Use of Standard Tests. (New York: World Book Co., 1931) pp. 1-2.

A REVIEW OF CERTAIN STUDIES IN WHICH THE TIME FACTOR WAS ANALYZED

A study was made by W. K. Kinkaid[13] to determine whether the time element used in administering objective tests affected scores made by children of adolescent age and to determine which sex and which level of intelligence was most affected. His survey was made during the latter part of the first semester of the school year, 1938-39. Five tests were given to each 125 6B pupils and 125 8B pupils at intervals not to exceed one calendar week. The tests used by Mr. Kinkaid were Arithmetic Computation, Grades 3 to 8, Forms 3 and 4, by T. L. Torgerson, published by the Public School Publishing Company, Bloomington, Illinois.

Some of the findings from his research were,

> 1. The mean for [eighth grade] the timed group was 53.55 and the mean for the untimed group was 53.95. The standard deviation for the timed group was 10.005 and for the untimed group the standard deviation was 9.77.
>
> 2. The mean for [sixth grade] the timed group was 39.45, while the mean for the untimed group was 40.225. The standard deviation for the timed group was 10.835 and the standard deviation for the untimed group was 11.56.

---

[13]W. K. Kinkaid, "A Comparison of Scores Made by Sixth and Eighth Grade Pupils in Four Schools of North Central Indiana on Timed and Untimed Tests in Reading and Arithmetic," (unpublished Master's thesis, Indiana State Teachers College, Terre Haute, 1939) pp. 3-39

3. Although ordinarily one would expect any group to do more work in double time, all the comparisons found between the different types of tests.... the amount gained was considered statistically insignificant.

A study conducted by O. E. Strong[14] to determine the amount of algebra remembered by freshmen upon entering college was made at Indiana State Teachers College in 1931. The findings here presented show just what the college freshman taking his first college course in mathematics can be expected to perform.

Findings: According to the norms on Hotz tests, college freshmen performed roughly half their training. One-half of the problems of the informal test were solved by 50 percent of the students having had one year of algebra; whereas three fourths of the problems were done by 50 per cent of the students who had studied one and one-half years of algebra. Manipulation powers have diminished, but maturity has tended to improve ability to solve verbal problems.

A study conducted by F. V. Higgins[15] at Indiana State Teachers College to determine how much mathematics was retained by college freshmen, reveals the following:

The Iowa Placement Test on Mathematics Training, Revised Form A, had been given to students at Indiana

---

[14] O. E. Strong, "Some Recent Investigations in the Teaching of Mathematics," (unpublished Master's Thesis, Indiana State Teachers College, Terre Haute, 1931), p. 83

[15] F. V. Higgins, "An Analysis of Errors as Revealed by the Iowa Placement Examinations in Mathematics," (unpublished Master's thesis, Indiana State Teachers College, Terre Haute, 1936,) pp. 105-6

State Teachers College between the years 1929-1934 when they entered their first course in mathematics. From the results of these tests, the responses of 256 students are studied.

In general the findings of this study seem to indicate that many things learned in high school mathematics are not retained on entering college; or they may indicate that a number of items on this test involve knowledge of skills and terms in which high school students do not receive adequate training. The recent trend has been to lower the mathematical requirements for graduation from high school. For this reason, students enter college with training in only the more basic mathematical skills.

At Miami University, Walter S. Guiler conducted a survey in the fall semesters of the three successive college years (1938-39, 1939-40, 1940-41). Freshmen entering the school of Education during this period were given the Christofferson-Rush-Guiler Analytical Survey test in Computational Arithmetic. This test was divided into three sections. Mr. Guiler sums up the results of the students' performances on each section of the tests as follows:

Fractions[16]

1. Lack of comprehension of the process involved constituted the outstanding source of difficulties encountered by the college freshmen in their work with fractions.

2. The second largest group of errors was due to faulty computation.

3. Changing fractions to a common denominator constituted a third major source of difficulty.

---

[16]W. S. Guiler, "Difficulties Encountered by College Freshmen in Fractions, Decimals, and Per cents," Journal of Educational Research, 39: 1-13, October, 1945.

4. Reducing fractions to lowest terms was a source of error for a considerable number of students.

5. Borrowing constituted a major source of difficulty in the subtraction of fractions.

6. Many students experienced difficulty in changing mixed numbers to improper fractions and vice-versa.

Decimals[17]

A large proportion of the college freshmen manifested weakness in certain phases of work with decimals. Approximately one-fifth of the students encountered difficulty in subtracting decimal numbers; more than one-fourth in adding decimal numbers; more than two-fifths, in changing fractions to decimals; and more than three-fifths, in changing mixed numbers to decimals.

Per cents[18]

Slightly more than one-half of the students exhibited weakness in finding a per cent of a number; more than one-half, in finding what per cent one number is of another number; approximately seven-eights, in finding a number when a per cent of it is known; nearly one-half, in finding the result of a per cent of increase or decrease on a given number; and approximately three-fourths, in finding a percent of increase or of decrease of one number or another number.

Another study which should be mentioned here was conducted by Ben A. Sueltz.[19]

---

[17]Ibid., 40; 1-13, September, 1946

[18]Ibid., 40: 81-95, October, 1946.

[19]Ben A. Sueltz, "Mathematical Understandings and Judgments Retained by College Freshmen," The Mathematics Teacher, 44: pp. 13-19, January, 1941.

Approximately two thousand junior high school pupils and one thousand college students have taken tests designed to measure the Mathematical Understanding, Mathematical Judgment, and Mathematical Computations in functional situations. These tests have the limitations of the "paper and pencil" technique....The conclusions here stated are derived not only from the sample items that have been presented but also upon the broader experience in evaluation.

1. Pupils and students at all levels tend to learn those things that the teacher expects of them and to learn in a pattern set by the teacher...

2. Weaknesses tend to persist from one level to another. This is particularly true of arithmetic learnings...

3. Certain types of exercises in which the mathematical element is not complicated and is found in situations in which older students have had experience prove a good deal easier for the older group. This may be an argument for basing learning upon real experience...

4. The extension of learning in arithmetic is neglected in the typical secondary school program. This is most lamentable if, as most citizens believe, arithmetic is the most functionally useful part of mathematics for most people.

5. Schools tend to place too much dependence upon "paper and pencil" work. Many high school and college students set down figures and compute without doing any critical thinking. Furthermore they tend to use pencil and paper for simple things that ought to be done mentally...

6. Students tend to do comparatively well in abstract algebra such as computing with negative numbers and in solving comparatively simple equations, but they tend also to be little concerned with the understanding and significance of what they are doing. In general "algebraic tricks" rather than algebraic thinking is most characteristic of students who have studied only one year of algebra.

How well the student of today is prepared in mathematics before he enters college or takes advanced training of any sort is shown in a study by J. A. Nyberg and S. Casner.[20] Nyberg and Casner based the following conclusions on two sets of tests, one given to high school pupils in December, 1938, to 111 seniors, and in April, 1939, the same test was given to 101 seniors. The other test was given ten years later in December, 1948, and April, 1949. The total number of students completing the test was 234; each tenth paper was discarded making the number 212 for easier comparisons.

> The graduate of 1949 has studied mathematics approximately half a semester more than the graduate of 1939.
>
> Assuming that the students who have the fewest semesters of mathematics have a lower I.Q., and that the students who have the most semesters of mathematics have a higher I.Q., then the dull students are taking about the amount of mathematics that they did ten years ago, and the bright students are taking more mathematics.
>
> Comparing the average number of solutions per students, [on an eight problem test] there is an improvement of 21 per cent. Further study of the figures show that the group with 4 or fewer semesters of mathematics improved 18 per cent while those who had more than 4 semesters improved only 4 per cent.

---

[20] J. A. Nyberg and S. Casner, "Arithmetic Now and Ten Years Ago," Journal of Business Education, 25: 15-16, January, 1950.

In seeking an explanation for the improvement, it can be noted that in 1932 classes in General Mathematics were first introduced in the schools. These classes are for the students who are not likely to succeed in algebra. In 1935 when the first group entered high school there was one class in General Mathematics for each of ten classes in algebra; between 1945 and 1949, the number of the classes was in a ratio of 1 to 2.

CHAPTER II

AN ANALYSIS OF THE STUDENTS PERFORMANCES ON THE SCHORLING, CLARK, AND POTTER HUNDRED-PROBLEM ARITHMETIC TEST UNDER TIMED AND UNTIMED CONDITIONS

The purpose of this phase of the investigation was to secure and analyze data on a group of college freshmen performances on the Hundred-Problem Arithmetic Test. These performances were influenced by changing the time factor.

TECHNIQUES EMPLOYED

Data were secured by administering two forms of the Schorling, Clark, and Potter Hundred-Problem Arithmetic Test, namely Form V and Form W, to 240 college freshmen enrolled at Indiana State Teachers College during the fall and winter quarters of the school year, 1950-51. These students were not planning to major in mathematics or in the related fields of physical science. To eliminate the experience factor, in taking the tests, the original group was divided into two equal sections. One of these sections was given the test under standard timed conditions and then they were administered another form of the test with unlimited time. The remaining half of the total group was first given the test with unlimited time and then another form of the test administered under standard timed conditions.

An analysis of the data was made and is presented in the following categories: (1) performances of the college freshmen on the total Hundred-Problem Arithmetic Test, under standard timed conditions, (2) performances of the college freshmen on the various parts of the Hundred-Problem Arithmetic Test, under standard timed conditions, (3) performances of the college freshmen on the total Hundred-Problem Arithmetic Test, with unlimited time, (4) performances of the college freshmen on the various parts of the Hundred-Problem Arithmetic Test, with unlimited time, (5) a comparison of the performances of the college freshmen on the Hundred-Problem Arithmetic Test, under standard timed conditions with the performances of the college freshmen on the Hundred-Problem Arithmetic Test with unlimited time, and (6) a comparison of the performances of the college freshmen on the various parts of the Hundred-Problem Arithmetic Test, under standard timed conditions with their performances on the various parts of the test, when time was unlimited.

Performances of the College Freshmen on the Total Hundred-Problem Arithmetic Test, Under Standard Timed Conditions

The students to whom the tests were administered were enrolled at Indiana State Teachers College in the course, General Mathematics, required for all students not

majoring in mathematics or the related fields of physical science.

The test was administered in accord with the directions presented in the Manual of Directions[1] which accompanies the test. This manual is cited as the authority for answers to the following questions: (1) How much time was allotted to complete the test? and (2) How should the test be scored?

How much time was allotted to complete the test?

> When every pencil is up say: "Begin." Make a note of the time (both minutes and seconds) as soon as you give the signal to start.
>
> At the end of 6 minutes say: "Now begin Subtraction, Example 11."
>
> At the end of 6 minutes (making 12 minutes from the start) say: "Now begin Multiplication, Example 21."
>
> At the end of 7 more minutes (making 19 minutes from the start) say: "Now begin Division, Example 36."
>
> At the end of 7 more minutes (making 26 minutes from the start) say: "Now begin Fractions, Decimals, and Per Cents, Example 51."
>
> At the end of 14 more minutes (exactly 40 minutes from the beginning of the test) say: "Stop!"

---

[1]Raleigh Schorling, John Clark, and Mary Potter, "Hundred-Problem Arithmetic Test," Manual of Directions, (New York: World Book Company, 1949) p. 3

How should the test be scored?

The test consists of 100 items. The pupil's final score is the total number right. (Careful studies have shown that for the purpose of this test it is not necessary to weigh the items; merely count the number right.)

TABLE I

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE PROBLEMS IN THE HUNDRED-PROBLEM ARITHMETIC TEST, UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*95-99	39
90-94	46
85-89	42
80-84	27
75-79	32
70-74	6
65-69	10
60-64	7
55-59	8
50-54	9
45-49	5
40-44	5
35-39	2
30-34	2
	240

*Table I is read thus: of the 240 college freshmen who were administered the Hundred Problem Arithmetic Test, under standard timed conditions, 39 students made correct solutions ranging from 95 to 99 inclusive on the problems in the Hundred-Problem Arithmetic Test.

The Manual of Directions for the Hundred-Problem Arithmetic Test provided the data with which the relative competence of the group of college freshmen could be determined. It is stated in this manual that:

The standing of a group in relation to the performance of the national standardization population may

be determined by finding the percentile rank corresponding to the median score for the group. The final grade percentile norms are given in Table 3 for Form V...The percentile rank corresponding to the median may be found in these tables by locating the median in the column headed, "Total Number Right," for the test form used, and reading off the percentile rank for the grade tested.

The 50-percentile, or median, represents average performance for each grade of the national standardization population....For a class of 25 or more, a deviation of more than 3 raw-score points from the national median for either test form may be considered a significant deviation, so that we may say that the performance of this class is the national average for this grade.

A portion of the tables, from the Manual of Directions, that indicated final grade percentile norms, follows:

TABLE 3, FORM V

Total Number Right	Percentile Rank in Grade 7	8	9	10	11	12
70	-	-	-	-	-	50
71	-	-	-	-	-	52
72	-	-	-	-	-	54
73	-	-	-	-	-	56
74	-	-	-	-	-	58
75	-	-	-	-	-	59
76	-	-	-	-	-	61
77	-	-	-	-	-	63
78	-	-	-	-	-	65
79	-	-	-	-	-	67
80	-	-	-	-	-	69
81	-	-	-	-	-	71
82	-	-	-	-	-	74
83	-	-	-	-	-	76
84	-	-	-	-	-	78
85	-	-	-	-	-	80
86	-	-	-	-	-	82
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

From the preceding table it can be observed that the median score for the twelfth grade population was 70 problems solved correctly. The median score for the college freshmen group was 85.33 problems solved correctly. This corresponds with the eightieth percentile of the performances of the twelfth grade population. The median score of correctly solved problems for the college group exceeded the median score of the correctly solved problems of the twelfth grade standardization population by approximately 15 raw-score points. Hence, by the technique of comparison of group performances presented in the Manual of Directions, it is obvious that the group performance of these college freshmen was significantly better than the performances of the standardization population.

It should be recalled that one half of the group of college freshmen had experienced the solutions of another form of this test prior to their taking Form V under standard timed conditions.

Findings

1. The range of the scores of correctly solved problems was from 31 to 99, or 68 made by the total group of college freshmen.

2. The mean number of correct solutions was 80.87.

3. The median number of correct solutions was 85.33

4. The standard deviation was 15.28.

5. The performances of the college freshmen were significantly better on the total test than that of the twelfth grade standardization population.

Performances of the College Freshmen on the Various Parts of the Hundred-Problem Arithmetic Test under Standard Timed Conditions

The Hundred-Problem Arithmetic Test, Form V, is divided into five separate sections, namely: (1) addition, (2) subtraction, (3) multiplication, (4) division, and (5) fractions, decimals and per cents performances on each section are presented.

ADDITION

The students had six minutes[2] to complete the Addition section of the Hundred-Problem Arithmetic Test. The problems that appeared in the Addition section were:

(1)
8
7
3
6
9
5
8

(2)
463
877
539
198

(3)
$386.85
96.66
6.57
.98
100.00
5.94
60.00

(4)
7/10
3/5

(5) 7/8 + 3/16 =

(6)
17 5/8
5 1/3

(7) 3/5 + 1/2 + 7/10 =

(8)
9 3/4
27 7/8
8 9/16

(9) .07 + 5.23 + 8.29 + 1.40 =

(10) $2.25 + $14.70 =

[2] Ibid.

TABLE II

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE TEN PROBLEMS IN THE ADDITION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*10	83
9	80
8	46
7	14
6	4
5	6
4	4
3	2
2	1
1	0
	240

*Table II is read thus; of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, under standard timed conditions 83 students made 10 correct solutions, on the addition section of the test.

Findings

1. The range of the scores of correctly solved problems was from 10 to 2, or 8 made by the total group of college freshmen.

2. The mean number of correct solutions was 8.73.

3. The median number of correct solutions was 9.04.

4. The standard deviation was 1.47.

5. The percentages of correct solution were 87.3.

SUBTRACTION

The students had six minutes[3] to complete the Subtraction section. The problems were:

---

[3]Ibid.

(11) $\begin{array}{r} 1124 \\ -742 \\ \hline \end{array}$ (12) $\begin{array}{r} 880.75 \\ -785.78 \\ \hline \end{array}$ (13) 11/12 - 1/6 =

(14) $\begin{array}{r} 8\ 3/8 \\ -5\ 3/4 \\ \hline \end{array}$ (15) 2 3/4 - 2/3 = (16) \$5.04 - 18¢ =

(17) 9.752 - 6.007 = (18) \$32 - \$6.58 =

(19) 9.25 - 2.20 = (20) $\begin{array}{r} 9006 \\ -4039 \\ \hline \end{array}$

TABLE III

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE TEN PROBLEMS IN THE SUBTRACTION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*10	124
9	64
8	28
7	16
6	4
5	1
4	0
3	3
2	0
1	0
	240

*Table III is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, under standard timed conditions 124 students made 10 correct solutions, on the subtraction section of the test.

Findings

1. The range of the scores of correctly solved problems was from 10 to 3, or 7 made by the total group of college freshmen.

2. The mean number of correct solutions was 9.13.

3. The median number of correct solutions was 9.53.

4. The standard deviation was 0.76.

5. The percentages of correct solutions were 91.3.

MULTIPLICATION

The students had seven minutes[4] to complete the section entitled "Multiplication."

The problems in this section were as follows:

(21) $\begin{array}{r} 95 \\ \times 82 \\ \hline \end{array}$ (22) $\begin{array}{r} 609 \\ \times 40 \\ \hline \end{array}$ (23) $\begin{array}{r} 769 \\ \times 708 \\ \hline \end{array}$ (24) $3/4 \times 60 =$

(25) $5/4 \times 3/2 =$ (26) $5/8 \times 12/10 =$

(27) $45 \times 2/5 =$ (28) $20\ 3/5 \times 12 =$

(29) $1\frac{1}{2} \times 2\frac{1}{4} \times 3/4 =$ (30) $\begin{array}{r} 4.928 \\ \times 3.2 \\ \hline \end{array}$

"Put the decimal point in each answer where it belongs."

(31) $20 \times .20 = 400$ (32) $1.6 \times 0.3 = 48$

(33) $0.5 \times 5 = 25$ (34) $0.245 \times 2 = 490$

(35) Does 1.2×0.5 equal 6.0 or .60 or .060 or 60?

---

[4] Ibid.

TABLE IV

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE FIFTEEN PROBLEMS IN THE MULTIPLICATION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*15	77
14	82
13	30
12	15
11	9
10	3
9	5
8	6
7	5
6	2
5	2
4	3
3	0
2	1
1	0
	240

*Table IV is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, under standard timed conditions 77 students made 15 correct solutions, on the multiplication section of the test.

Findings

1. The range of the scores of correctly solved problems was from 15 to 2, or 13 made by the total group of college freshmen.

2. The mean number of correct solutions was 13.19.

3. The median number of correct solutions was 14.02

4. The standard deviation was 2.47.

5. The percentages of correct solutions were 87.9.

DIVISION

The students had seven minutes[5] to complete the division section. The problems in this section were:

(36) 36 ÷ 3 = (37) 636 ÷ 6 = (38) 948 ÷ 9 =

(39) .004/.0284 (40) .34/105.4

"Place the decimal point in each answer where it belongs, adding zeros when necessary."

(41) .123/560.88 (42) 1.23/.56088 (43) 12.3/56.088

(44) Does 4786 ÷ 10 equal 4.786 or 47.86 or 478.6 or 4786?

(45) $2\frac{1}{2} \div 4\frac{1}{2}$ = (46) 3 3/4 ÷ 3/4 = (47) 3/8 ÷ 4 =

(48) $4\frac{1}{2} \div 8$ = (49) 21/882 (50) 83/11371

---

[5] Ibid.

TABLE V

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE FIFTEEN PROBLEMS IN THE DIVISION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*15	75
14	73
13	40
12	18
11	5
10	3
9	1
8	7
7	3
6	6
5	4
4	2
3	1
2	1
1	1
	240

*Table V is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, under standard timed conditions 75 students made 15 correct solutions, on the division section.

Findings

1. The range of the scores of correctly solved problems was from 15 to 1, or 14 made by the total group of college freshmen.

2. The mean number of correct s olutions was 13.02.

3. The median number of correct solutions was 13.88.

4. The standard deviation was 2.75.

5. The percentages of correct solutions were 86.8.

FRACTIONS, DECIMALS, AND PER CENTS

The students had 14 minutes[6] to complete the fractions, decimals, and per cents section. The problems included in this section were as follows:

"Write each of the following as per cent:"

(51) 3/100 = (52) 3/5 = (53) 5/8 = (54) .75 =

(55) .075 = (56) 4/5 = (57) 1/3 = (58) 3/8 =

(50) .2 = (60) 0.875 =

"Write each of the following as a decimal fraction:"

(61) 3/10 = (62) $\frac{1}{4}$ = (63) 2/5 = (64) 60% = (65) $7\frac{1}{2}\%$ =

(66) 7/100 = (67) 3/5 = (68) 1/8 = (69) $12\frac{1}{2}\%$ = (70) $37\frac{1}{2}\%$ =

"Write each of the following as a common fraction:"

(71) 20% = (72) 9% = (73) 25% = (74) $12\frac{1}{2}\%$ = (75) 33 1/3%=

"Complete the following:"

(76) 25% of 120 = (77) 2.3% of 40 = (78) 120% of 20 =

(79) 2/3% of 3000 = (80) ___% of 24 = 8 (81) ___% of 60= 6

(82) __% of 20 = 25 (83) 4 = __% of 20 (84) 9 = __% of 18

(85) 8 = __% of 80

---

[6]Ibid.

"Write the decimals as per cents:"

(86) .355 (87) .123 (88) .1825

"Rewrite the following decimals, arranging them in the order of their size, the largest first and the smallest last:"

(89) .93 .15 .94

(90) .40 2.5 .875

"Write these as decimal fractions; carry the answer to three places and round off to two places:"

(91) 7/16 = (92) 5/16 =

(93) Mary bought an $8 dress at a 15% discount. What did she pay for the dress?

(94) What is the interest for a year on $175 at 6%?

(95) Mr. Brown found that 22½% of his peaches were not good enough to sell. Out of 80 bushels he could sell _____ bushels.

(96) Carl earned $32 during his summer vacation. He spent 14½% of this money for schoolbooks. How much did his books cost?

(97) What do you pay for goods marked $13.50 with a discount of 2%?

(98) What per cent of your investment do you make if you invest $125 and gain $5?

(99) What is the interest for a year on $300 at 4½%?

(100) There are 2150 pupils in one junior high school of this city. The principal of this school expects an increase of 6% in the number of pupils next semester. How many pupils does he plan to have next semester?

TABLE VI

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE FIFTY PROBLEMS IN THE SECTION ENTITLED FRACTION, DECIMALS, AND PER CENTS OF THE HUNDRED-PROBLEM ARITHMETIC TEST UNDER STANDARD TIMED CONDITIONS

Scores	Frequency
*50-46	65
45-41	43
40-36	42
35-31	25
30-26	18
25-21	19
20-16	16
15-11	8
10-6	4
5-1	0
	240

*Table VI is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, under standard timed conditions 65 students made correct solutions ranging from 46 to 50 inclusive on the problems in the section entitled Fractions, Decimals, and Per Cents.

Findings

1. The range of the scores of correctly solved problems was from 50 to 6, or 44 made by the total group of college freshmen.

2. The mean number of correct solutions was 36.48.

3. The median number of correct solutions was 34.05.

4. The standard deviation was 10.94.

5. The percentages of correct solutions were 73.0.

Performances of the College Freshmen on the Total Hundred-Problem Arithmetic Test, Form W, with Unlimited Time

The students who were administered this test were enrolled in the required course, General Mathematics. These students were not majoring in Mathematics or the related field of physical science.

The Hundred-Problem Arithmetic Test, Form W, is designed to be given under the same timed conditions as Form V; however, the students were given all the time necessary to complete the test. The scores were calculated in the same manner as they were for Form V; that is, the number of correct solutions determine the score.

TABLE VII

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE PROBLEMS IN THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*95-99	75
90-94	65
85-89	32
80-84	24
75-79	14
70-74	12
65-69	5
60-64	5
55-59	0
50-54	2
45-49	1
40-44	1
35-39	0
30-34	0
	240

*Table VII is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, with unlimited time, 75 students made correct solutions ranging from 95 to 99 inclusive on the problems in the Hundred-Problem Arithmetic Test.

Findings

1. The range of the scores of correctly solved problems was from 43 to 99, or 56 made by the total group of college freshmen.

2. The mean number of correct solutions was 88.13.

3. The median number of correct solutions was 91.04.

4. The standard deviation was 10.18.

Performances of the College Freshmen on the Various Parts of the Hundred-Problem Arithmetic Test, Form W, with Unlimited Time

The Hundred-Problem Arithmetic Test, Form W, is divided into five separate sections, namely: (1) addition, (2) subtraction, (3) multiplication, (4) division, and (5) fractions, decimals, and per cents.

The students' performances on each section are presented.

ADDITION

The students had all the time they needed to complete this section of the Hundred-Problem Arithmetic Test. The problems that appeared in the addition section follow:

(1) 7 9 8 5 6 8 4

(2) 389 766 498 252

(3) $ 86.78 700.00 3.59 5.00 265.74 .98 50.85

(4) 9/16 5/8

(5) 4/5 + 3/10 =

(6) 14 7/8 8 3/4 3/4 + 5/16 =

(8) 9 1/3 8 5/6 35 11/12

(9) .09 + 4.38 + 6.20 + 1.57 =

(10) $1.25 + $12.60 =

TABLE VIII

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE TEN PROBLEMS IN THE ADDITION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*10	135
9	66
8	23
7	12
6	2
5	1
4	1
3	0
2	0
1	0
	240

*Table VIII is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, with unlimited time, 135 students made 10 correct solutions on the addition section.

Findings

1. The range of the scores of correctly solved problems was 4 to 10 or 6 made by the total group of college freshmen.

2. The mean number of correct solutions was 9.30.

3. The median number of correct solutions was 9.61.

4. The standard deviation was 0.98.

5. The percentages of correct solutions were 93.0.

SUBTRACTION

The students had all the time they needed to complete this section of the Hundred-Problem Arithmetic Test, Form W. The problems which were included in this section appear below:

(11) $\begin{array}{r} 1527 \\ -853 \\ \hline \end{array}$ (12) $\begin{array}{r} 946.38 \\ -857.39 \\ \hline \end{array}$ (13) $7/8 - 1/4 =$

(14) $\begin{array}{r} 9\ 1/4 \\ -3\ 2/3 \\ \hline \end{array}$ (15) $4\ 11/12 - 5/6 =$ (16) $\$3.15 - 29¢ =$

(17) $9.574 - 4.003 =$ (18) $\$52 - \$8.76 =$

(19) $6.80 - 3.03 =$ (20) $\begin{array}{r} 8005 \\ -3029 \\ \hline \end{array}$

TABLE IX

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE TEN PROBLEMS IN THE SUBTRACTION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*10	136
9	77
8	19
7	5
6	3
5	0
4	0
3	0
2	0
1	0
	240

*Table IX is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, with unlimited time 135 students made 10 correct solutions on the subtraction section.

Findings

1. The range of the scores of correctly solved problems was 6 to 10 or 4 made by the total group of college freshmen.

2. The mean number of correct solutions was 9.41.

3. The median number of correct solutions was 9.62.

4. The standard deviation was 0.82.

5. The percentages of correct solutions were 94.1.

MULTIPLICATION

The students were allowed all the time needed to complete the section entitled "Multiplication" of the Hundred-Problem Arithmetic Test, Form W. The problems included in this section follow:

(21) $\begin{array}{r} 38 \\ \times 76 \\ \hline \end{array}$ (22) $\begin{array}{r} 504 \\ \times 90 \\ \hline \end{array}$ (23) $\begin{array}{r} 976 \\ \times 805 \\ \hline \end{array}$ (24) $\frac{3}{8} \times 48 =$

(25) $\frac{3}{5} \times \frac{9}{2} =$ (26) $\frac{4}{3} \times \frac{9}{10} =$ (27) $36 \times \frac{3}{4} =$

(28) $30\frac{1}{4} \times 15 =$ (29) $2\ 1/2 \times 2\ 3/4 \times 1/3 =$ (30) $\begin{array}{r} 537.8 \\ \times \quad .24 \\ \hline \end{array}$

"Put the decimal point in each answer where it belongs."

(31) $30 \times .30 = 900$ (32) $1.8 \times 0.2 = 36$

(33) $0.4 \times 4.0 = 160$ (34) $0.125 \times 3 = 375$

(35) Does 1.5×0.2 equal 3.0 or 30. or .30 or .030?

TABLE X

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE NUMBER OF CORRECT SOLUTIONS TO THE FIFTEEN PROBLEMS IN THE MULTIPLICATION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*15	105
14	78
13	32
12	17
11	3
10	2
9	2
8	0
7	1
6	0
5	0
4	0
3	0
2	0
1	0
	240

*Table X is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test, with unlimited time 105 students made 15 correct solutions on the multiplication section.

Findings

1. The range of scores of correctly solved problems was from 7 to 15, or 8 made by the total group of college freshmen.

2. The mean number of correct solutions was 14.02.

3. The median number of correct solutions was 14.31.

4. The standard deviation was 1.23.

5. The percentages of correct solutions were 93.5.

DIVISION

The students were given all the time necessary to complete the division section of the Hundred-Problem Arithmetic Test. The problems which appeared in that section are as follows:

(36) 48 ÷ 4 = (37) 525 ÷ 5 = (38) 843 ÷ 8 =

(39) $.003\overline{).0276}$ (40) $.36\overline{)147.6}$

"Place the decimal point in each answer where it belongs, adding zeros when necessary."

(41) $1.46\overline{)3693.8}$ (42) $.146\overline{)3.6938}$ (43) $14.6\overline{)36938}$

(44) Does 3854 ÷ 10 equal 3854 or 385.4 or 38.54 or 3.854?

(45) $1\frac{1}{2} \div 3\frac{1}{2}$ = (46) 5 1/4 ÷ 3/4 = (47) 3/4 ÷ 8 =

(48) $3\frac{1}{2} \div 4$ = (49) $32\overline{)992}$ (50) $87\overline{)12093}$

TABLE XI

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE FIFTEEN PROBLEMS IN THE DIVISION SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*15	94
14	66
13	38
12	17
11	7
10	5
9	3
8	0
7	3
6	5
5	1
4	1
3	0
2	0
1	0
	240

*Table XI is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test with unlimited time; 94 students made 15 correct solutions on the division section.

Findings

1. The range of the scores of correctly solved problems was from 4 to 15, or 11 made by the total group of college freshmen.

2. The mean number of correct solutions was 13.53.

3. The median number of correct solutions was 14.11.

4. The standard deviation was 2.05.

5. The percentages of correct solutions were 90.2.

FRACTIONS, DECIMALS, AND PER CENTS

The students were allowed all the time they needed to complete the section entitled, "Fractions, Decimals, and Per cents" of the Hundred-Problem Arithmetic Test. The problems that appear in this section follow:

"Write each of the following as per cent:"

(51) 7/100 = (52) 2/5 = (53) 3/8 = (54) .25 = (55) .025 = (56) 3/5 = (57) 2/3 = (58) 5/8 = (59) .3 = (60) 0.625 =

"Write each of the following as a decimal fraction:"

(61) 7/10 = (62) 3/4 = (63) 3/5 = (64) 40% = (65) $8\frac{1}{2}\%$ = (66) 9/100 = (67) 1/5 = (68) 3/8 = (69) $87\frac{1}{2}\%$ = (70) $12\frac{1}{2}\%$ =

"Write each of the following as a common fraction:"

(71) 30% = (72) 7% = (73) 75% = (74) $37\frac{1}{2}\%$ = (75) 66 2/3% =

"Complete the following:"

(76) 75% of 160 = (77) 3.2% of 60 = (78) 75% of 160 =

(79) 2/3% of 6000 = (80) __% of 30 = 6 (81) __% of 36 = 12

(82) __% of 40 = 50 (83) 8 = __% of 20 (84) 8 = __% of 16

(85) 6 = __% of 60.

Write these decimals as per cents:"

(86) .455 = (87) .237 = (88) .1525 =

"Rewrite the following decimals, arranging them in the order of their size, the largest first and the smallest last:"

(89) .83 .35 .84

(90) .60 3.5 .675

"Write these as decimal fractions; carry the answer to three places and round off to two places:

(91) 9/16 = (92) 11/16 =

(93) Ruth bought a $12 coat at a 15% discount. What did she pay for the coat?

(94) What is the interest for a year on $275 at 6%?

(95) Mr. Davis found that 22½% of his apples were not good enough to sell. Out of 160 bushels he could sell ____ bushels.

(96) Sam earned $36 during his summer vacation. He spent 14½% of this money for school books. How much did his books cost?

(97) What do you pay for goods marked $13.50 with a discount of 4%?

(98) What per cent of your investment do you make if you invest $250 and gain $10?

(99) What is the interest for a year on $600 at 4½%?

(100) There are 1625 pupils in one junior high school of this city. The principal of this school expects an increase of 4% in the number of pupils next year. How many pupils does he plan to have next year?

TABLE XII

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM FIFTY PROBLEMS IN THE FRACTIONS, DECIMALS, AND PER CENTS SECTION OF THE HUNDRED-PROBLEM ARITHMETIC TEST WITH UNLIMITED TIME

Scores	Frequency
*50-46	101
45-41	64
40-36	31
35-31	19
20-26	11
25-21	4
20-16	7
15-11	3
10-6	0
5-1	0
	240

*Table XII is read thus: of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Test with unlimited time, 101 students made correct solutions ranging from 50 to 46 inclusive on the problems in the section entitled "Fractions, Decimals, and per cents."

Findings

1. The range of the scores of correctly solved problems was from 13 to 50, or 37 made by the total group of college freshmen.

2. The mean number of correct solutions was 41.54.

3. The median number of correct solutions was 42.00.

4. The standard deviation was 8.12.

5. The percentages of correct solutions were 83.1.

A Comparison of the Performances of the College Freshmen on the Hundred-Problem Arithmetic Test under Standard Timed Conditions with the Performances of the College Freshmen on the Hundred-Problem Arithmetic Test with Unlimited Time

The Hundred-Problem Arithmetic Test, Form V, was first given to half of the group of college freshmen under standard timed conditions. Then this same half of the students were administered the Hundred-Problem Arithmetic Test, Form W, with unlimited time. The remaining half of the group of college freshmen were first administered the Hundred-Problem Arithmetic Test, Form W, with unlimited time; then this same half of the students were administered the Hundred-Problem Arithmetic Test, Form V, under standard timed conditions.

An analysis of the group performances of the college freshmen, on the Arithmetic tests for timed and untimed conditions were summarized and are presented in Table XIII.

TABLE XIII

THE NUMBERS OF COLLEGE FRESHMEN WHO MADE THE INDICATED SCORES DETERMINED FROM THE PROBLEMS IN THE HUNDRED-PROBLEM ARITHMETIC TEST, UNDER TIMED AND UNTIMED CONDITIONS

Scores	Frequency	
	Timed	Untimed
*95-99	39	75
90-94	46	65
85-89	42	32
80-84	27	28
75-79	32	14
70-74	6	12
65-69	10	5
60-64	7	5
55-59	8	0
50-54	9	2
45-49	5	1
40-44	5	1
35-39	2	0
30-34	2	0
	240	240

*Table XIII is read thus; of the 240 college freshmen who were administered the Hundred-Problem Arithmetic Tests, 39 students made a score from 95 to 99 inclusive under standard timed conditions, while 75 students made a score from 95 to 99 inclusive with unlimited time.

Findings

1. The mean number of correct solutions for the 240 students under standard timed conditions was 80.87. The mean number of correct solutions for the same 240 students with unlimited time was 88.13.

2. The median number of correct solutions for the 240 students under standard timed conditions was 85.33. The median number of correct solutions for the same 240 students with unlimited time was 91.04.

3. Pearson's Product Moment Correlation Formula was used to find the correlation between the students' scores on the total test for timed and untimed conditions.

Pearson's Product Moment Correlation "r" follows:

$$r = \frac{n\Sigma xy - \Sigma x \Sigma y}{\sqrt{[n\Sigma x^2 - (\Sigma x)^2][n\Sigma y^2 - (\Sigma x)^2]}}$$

In this formula,
n equals the number of cases,
x equals a single score on the timed test,
y equals a single score on the untimed test,
Σx equals the summation of the scores on the timed test,
Σy equals the summation of the scores on the untimed test,
Σxy equals the summation of the products of each individual score from the timed and untimed tests,
$\Sigma x \Sigma y$ equals the product of the sum of the timed scores and untimed scores,
Σx^2 equals the summation of the squares of the scores on the timed test,
Σy^2 equals the summation of the squares of the scores on the untimed test,
$(\Sigma x)^2$ equals the square of the summation of the scores on the timed test,
$(\Sigma y)^2$ equals the square of the summation of the scores on the untimed test.

The calculations which are required to find "r" are partly reproduced as follows:

Student	Score when Timed x	Score when Untimed y	xy	x^2	y^2
(1)	94	97	9118	8836	9409
(2)	82	92	7544	6724	8464
(3)	92	95	8740	8464	9025
-	-	-	-	-	-
-	-	-	-	-	-
-	-	-	-	-	-
n= 240	Σx=	Σy=	Σxy=	Σx^2=	Σy^2=

Substitution in the preceding formula yielded r = 0.74. By authority of H. O. Rugg[7] this is a significant correlation. Rugg states that, "With the present limitations on educational testing few correlations in testing will run above 0.70, and it is safe to regard this as a very high coefficient of correlation." Cooke[8] verifies this point when he states that, "When 'r' is between 0.50 and 0.75 the correlation is fairly high." This correlation should be interpreted thus: it is highly indicated that the scores will be distributed approximately the same for the group whether the tests are given under timed conditions or are given under unlimited timed conditions.

4. A further comparison was made to determine if these college freshmen did significantly better when time was unlimited.

The following data was determined from Tables I and VII: (1) the mean for timed (Mx) and untimed (My) tests, (2) the number of cases (n), (3) the standard deviation

---

[7]Harold O. Rugg, Statistical Methods Applied to Education, (Boston: Houghton Mifflin Company, 1917), p. 256.

[8]Dennis H. Cooke, Minimum Essentials of Statistics, (New York: The Macmillan Company, 1936) p. 120.

of the scores under timed (σx) and untimed (σy) conditions, and (4) the standard error in the timed mean ($S.E._{Mx}$) and the untimed mean ($S.E._{My}$).

The standard error of the mean is given by the formula $S.E._{Mx} = \frac{\sigma x}{\sqrt{n}}$ where σx is the standard deviation for the test under standard timed conditions and n is the number of cases. "The reasonableness of the formula is apparent from the fact that a small dispersion and a large number of cases decrease the size of $S.E._{Mx}$." [9]

The difference between the means of the performances of the group under timed conditions and untimed conditions was evaluated and the significant level for this difference was determined. The formula

$$S.E._{(Mx-My)} = \sqrt{(S.E.)^2_{Mx} + (S.E.)^2_{My}}$$

was employed to determine the standard error of the difference between the two means.

---

[9]Karl J. Holzinger, Statistical Methods for Students in Education, (Boston: Ginn and Company, 1928) p. 232.

TABLE XIV

COMPARATIVE DATA BASED ON THE SCORES MADE BY THE COLLEGE FRESHMEN ON THE SCHORLING, CLARK, AND POTTER HUNDRED-PROBLEM ARITHMETIC TEST UNDER TIMED AND UNTIMED CONDITION

Data	College Freshmen	
	Untimed	Timed
Number of cases	240	240
Mean Score	88.13	80.87
Difference between means	7.26	
Standard deviation	10.18	15.28
Standard Error of the mean	0.66	0.99
The standard error of the difference between the two means	1.19	

It may be observed that the difference between the mean scores was 7.26 in favor of the untimed test, and that the standard error of the difference was 1.19. Seven and twenty-six hundredths divided by 1.19 is approximately 6.10; therefore, the difference between the two means was approximately 6.10 times as great as the standard error of this difference.

A difference of 3 times the standard error is commonly assumed to be significant. The difference between themean scores of the group on the untimed test and the group on the timed test, of 6.10 times the standard error of this difference indicates a practical certainty that the group performances on the untimed test was significantly better than that of the group performances on the timed test.

A Comparison of the Performances of the College Freshmen on the Various Parts of the Hundred-Problem Arithmetic Test under Standard Timed Conditions with Their Performances on the Various Parts of the Hundred-Problem Arithmetic Test, When Time Was Unlimited

The percentage of correct solutions on the timed and untimed tests were summarized and are presented in Table XV.

TABLE XV

PERCENTAGES OF THE CORRECT SOLUTIONS TO THE PROBLEMS IN THE VARIOUS PARTS OF THE SCHORLING, CLARK, AND POTTER HUNDRED-PROBLEM ARITHMETIC TEST UNDER TIMED AND UNLIMITED TIME CONDITIONS

The various parts and problem numbers	Mean No. Correct Solutions		Per cent correct		Percentage gained or lost
	Timed	Untimed	Timed	Untimed	
Addition, 1-10	8.73	9.30	87.3	93.0	5.7
Subtraction, 11-20	9.13	9.41	91.3	94.1	2.8
Multiplication, 21-35	13.19	14.02	87.9	93.5	5.6
Division, 36-50	13.02	13.53	86.8	90.2	3.4
Fractions, Decimals, and Per Cents, 51-100	36.48	41.54	73.0	83.1	10.1
Total Test	80.87	88.13	80.87	88.13	7.26

*Table XV is read thus: the 240 college freshmen solved correctly 87.3% of the problems in the addition section under timed conditions and 93.0% when time was unlimited; this was a gain of 5.7% over the timed test.

Findings

1. It can be observed from Table XV that the greatest per cent of increase was in the section entitled "Fractions,

Decimals and Per cents." This increase was 10.1%, or approximately 2 times as much as in any other section of the test.

2. There was a gain of 2.8% in the subtraction section when the students had unlimited time. This was the least gain on any of the five sections.

3. In each section the percentage of correct solutions were increased with unlimited time.

SUMMARY

1. The 240 college freshmen who were administered the Hundred-Problem Arithmetic Test under timed conditions did significantly better than the twelfth grade standardization population.

2. The correlation between the students' scores for the timed and untimed tests was 0.74. This correlation is significant.

3. The 240 college freshmen did significantly better on the untimed test than they did on the timed test.

4. The greatest increase in the performances on any one section was 10.1% in the untimed test over the timed test. This increase was made in the section entitled "Fractions, Decimals, and Per Cents."

CHAPTER III

CONCLUSIONS AND RECOMMENDATIONS

The purpose of this investigation was to determine the effect of the time factor in the performances of a group of college freshmen at Indiana State Teachers College on the Schorling, Clark, and Potter Hundred-Problem Arithmetic Test.

TECHNIQUES EMPLOYED

Data were secured by administering two forms of the Schorling, Clark, and Potter Hundred-Problem Arithmetic Test to 240 college freshmen enrolled at Indiana State Teachers College during the fall and winter quarters of the school year, 1950-51. These students were not planning to major in mathematics or in the related fields of physical science. To eliminate the experience factor in taking the tests, the original group was divided into two equal sections. One of these sections was given the test under standard timed conditions and then they were administered another form of the test with unlimited time. The remaining half of the total group was first given the test with unlimited time and then another form of the test was administered under standard timed conditions.

Summary of the Findings

1. It was determined from the performances of the college students that the median number of correct solutions was 85.33 while the median number of correct solutions by the twelfth grade standardization population was 70.00. On the timed test the college freshmen who were administered the Hundred-Problem Arithmetic Test under timed conditions did significantly better than the twelfth grade standardization population.

2. The correlation between the students' scores on the total tests for timed and untimed conditions was evaluated by Pearson's Product Moment Formula and was found to be 0.74. This was a significantly high coefficient of correlation.

3. By determining the difference between the means and the standard error differences of the means, it was determined that the college freshmen did significantly better on the untimed test than on the timed test.

4. The greatest increase on any one section of the test when time was unlimited was made on the section, "Fractions, Decimals, and Per Cents." The increase on this section was 10.1% or approximately 2 times as much as in any other section of the test.

In each section the percentage of correct solutions was increased with unlimited time.

RECOMMENDATIONS

Topics that seem worthy of investigation that have developed from this study are:

1. Results of the time factor for college freshmen on another commonly used standardized mathematics test.

2. Results of the time factor in standardized mathematics tests for students at the elementary level.

3. Results of the time factor in standardized mathematics tests for students at the secondary level.

4. Results of the time factor in areas of study other than mathematics.

BIBLIOGRAPHY

Cooke, Dennis H., Minimum Essentials of Statistics. New York: The MacMillan Company, 1936. 271pp.

Guiler, W. S., "Difficulties Encountered by College Freshmen in Fractions, Decimals, and Per cents," Journal of Educational Research, 39: 1-13, October, 1945.

Higgins, F. V., "An Analysis of Errors as Revealed by the Iowa Placement Examinations in Mathematics." Unpublished Master's Thesis, Indiana State Teachers College, Terre Haute, 1936. 106 pp.

Kinkaid, W. K., "A Comparison of Scores Made by Sixth and Eighth Grade Pupils in Four Schools of North Central Indiana on Timed and Untimed Tests in Reading and Arithmetic." Unpublished Master's Thesis, Indiana State Teachers College, Terre Haute, 1939. 48pp.

Nyberg, J. A. and S. Casner, "Arithmetic Now and Ten Years Ago," Journal of Business Education, 25: 15-16, January, 1950.

Odell, C. W. Educational Measurement in High School. New York: The Century Company, 1930. 641pp.

Pressey, Sidney L. and Luella Cole Pressey, Introduction to the Use of Standard Tests. New York: World Book Company, 1931. 266pp.

Ruch, G. M., The Objective or New-Type Examination. Chicago: Scott, Foresman and Company, 1929. 478pp.

Rugg, Harold O., Statistical Methods Applied to Education. Boston: Houghton Mifflin Company, 1917. 410pp.

Russell, Charles, Standard Tests. New York: Ginn and Company, 1930. 516pp.

Strong, O. E., "Some Recent Investigations in the Teaching of Mathematics." Unpublished Master's Thesis, Indiana State Teachers College, Terre Haute, 1931. 126pp.

Sueltz, Ben A.,"Mathematical Understandings and Judgments Retained by College Freshmen." The Mathematics Teacher, 44: 13-19, January, 1941.

Wilson, Guy W. and Kremer J. Hoke, How to Measure. New York: The MacMillan Company, 1931. 285 pp.