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BULLETIN

OF THE

UNIVERSITY OF TEXAS

1915: No. 37

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A SCORE CARD FOR THE MEASUREMENT OF HANDWRITING

BY

C. TRUMAN GRAY

Instructor Department Education

Published by the University six times a month and entered as second class matter at the postoffice at Austin, Texas

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A. C. Baldwin & Sons, Austin, Texas

B108-715-1m-8402

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The benefits of education and of useful knowledge, generally diffused through a community, are essential to the preservation of a free government.

Sam Houston.

Cultivated mind is the guardian genius of democracy. . . . It is the only dictator that freemen acknowledge and the only security that freemen desire.

Mirabeau B. Lamar.

AUTHOR'S PREFACE

An investigation such as is set forth in the following pages can result only from the cooperation of a considerable number of persons. My appreciation of the work of all those who have helped is keenly felt. The greatest assistance has been received from Dr. J. Carleton Bell, Dr. Truman L. Kelly, and Dr. L. W. Sackett. The criticisms and suggestions of these men have been given freely at all times. Special mention should also be made of the work of my wife, Bessie Stretcher Gray, who has so ably assisted in the many statistical calculations.

C. T. G.

Austin, June, 1915.

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INTRODUCTION

One of the most interesting and important movements in modern education is that which has for its purpose the measurement of the immediate results attained by the teaching process. Less than a decade ago, it was assumed that the grading systems used by the present day schools gave such measurements, but the work of Starch and Elliott (12), Kelly (10), Gray (6), and others shows clearly enough that this method is unsatisfactory.

At present, other methods for securing such measurements are being proposed. An extended review of these various studies would be in place here, but space and time permits only the mentioning of the various plans.

First: Courtis (5) has used quite extensively a set of tests for measuring ability in arithmetic.

A second method is to be found in a series of scales introduced by Thorndike (16), and by Ayres (1) for the measurement of handwriting; by Thorndike (17) for drawing; by Buckingham (4) for spelling; by Hillegas (9) and by Ballou (2) for composition. In addition to this, there has been a tentative scale developed by Gray (8) for the measurement of reading.

The third type of work to be mentioned in this connection is that known as Minimum Essentials. The last yearbook of the National Society for the Study of Education is devoted entirely to this topic. In addition to this volume there are pamphlets published by Thompson (15) which contain the essentials for memory work in arithmetic and geography.

Attention may now be called to another method of measurement which seems to lend itself to the problems mentioned above, but which has received very little attention from educators. The method referred to is measurement by means of the score card. This plan for measuring has been developed and brought to a high degree of perfection by agriculturists, and the results obtained by them are recognized as accurate and scientific.

Such score cards consist of two essential parts: first, a list of the elements of the thing to be measured; and second, an evaluation of these points in such a manner that the sum of the values equals one hundred. A typical score card, that for wheat, is shown below. It will be noticed that it contains five main points with three minor points, and an evaluation of each of the points.

SCORE CARD FOR WHEAT

Texas A. and M. College.

SCALE OF POINTS	Perfect Score	Student's Score	Corrected Score
1. Weight per bushel	20		
2. Soundness	20		
3. Purity	15		
4. Size and plumpness of kernels	15		
5. Uniformity in—			
(a) Hardness	15		
(b) Color	10		
(c) Size of kernels	5		
Total	100		

Many different phases of educational activities, such as drawing, compositions, writing, school buildings, etc., seem to lend themselves to just such measurement as is provided in the score card; and yet as far as the author is aware, no such attempts have been made. It is true, however, that attempts have been made to use this method in the measurement of the efficiency of teachers. In the year 1908 the State Department of Education in Indiana published a score card for determining the "success grade" of any teacher who had had experience in teaching. The different points seemed to have been selected in an entirely arbitrary manner, and the values used were doubtless based upon one man's judgment as to their relative importance. The plan was considered too complicated by superintendents, and as a result, it was never put into general use.

In the year 1910 Professor E. C. Elliot presented to the state convention of city superintendents of Wisconsin "A

Tentative Scheme for the Measurement of Teaching Efficiency." Again it can only be inferred that the points entering into the scheme and their values have both been determined in an arbitrary way. The following is the schedule of points and their relative weights:

I. Physical Efficiency—12 points ..... (12)"
- 1. Impression—general 2
- 2. Health—general 2
- 3. Voice 2
- 4. Habits—personal 2
- 5. Energy 2
- 6. Endurance 2

II. Moral—Native Efficiency—14 points ..... (14)"
- 1. Self-control 2
- 2. Optimism—enthusiasm 2
- 3. Sympathy—tact 2
- 4. Industry—earnestness 2
- 5. Adaptability 2
- 6. Sense of humor 2
- 7. Judicial mindedness 2

III. Administrative Efficiency—10 points ..... (10)"
- 1. Initiative 2
- 2. Promptness and accuracy 2
- 3. Executive capacity 2
- 4. Economy (time, property) 2
- 5. Cooperation (associates and supervisors) 2

IV. Dynamic Efficiency—24 points ..... (24)"
- 1. Preparation 4
  Including:
  - (a) Intellectual capacity
  - (b) Academic education
  - (c) Professional training
- 2. Professional attitudes and interest 2
- 3. Human nature, attitudes, and interest (Appreciation of values—intellectual, social, and moral in child life) 2
- 4. Instructional skill 12
  Including:
  - (a) Attention and interest of pupils
  - (b) Formality v. vitality of instruction
  - (c) Motor v. verbal methods
  - (d) Application of the technique of teaching; organization and presentation of subject matter; the recitation as artistic product.
  - (e) Application of the technique of living; participation and contribution of pupils; the recitation as a democratic activity.
  - (f) The tools and machinery of instruction; effective adaptation.
  - (g) Assignment of work
- 5. Government and directive skill (discipline) ... 4

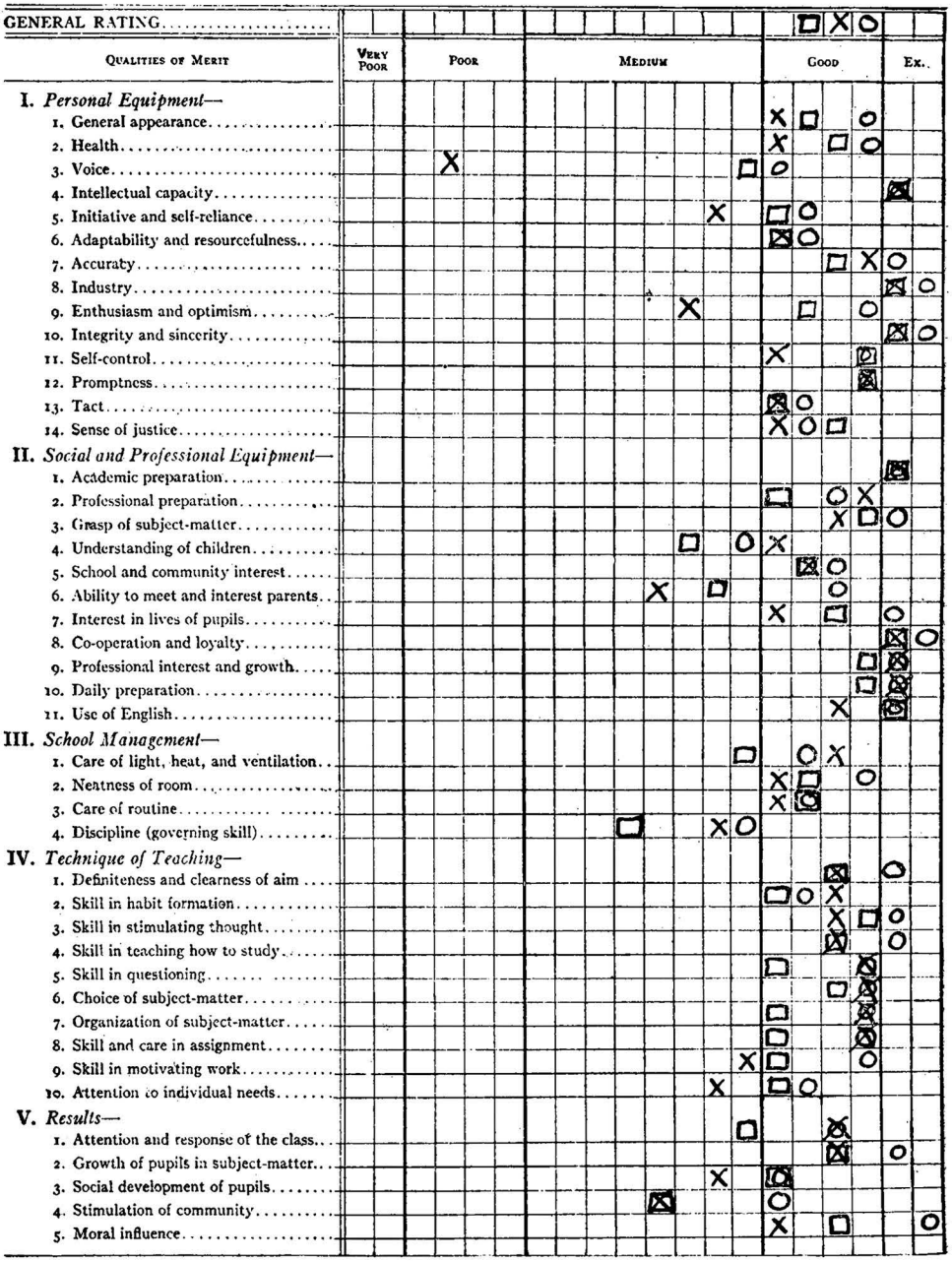
V. Projected Efficiency—6 points ..... (6)"
  1. Continuing preparation 2
     (a) daily
     (b) weekly
     (c) annual
  2. The school program 2
  3. Increase of professional equipment 2
     (professional reading and study; travel)

VI. Achieved Efficiency—24 points ..... (24)"
  1. Achievement
     (a) Illustrative results 8
     (b) Examinations; success and attainments of pupils 12
  2. Stimulation of individuals and community 4

VII. Social Efficiency—10 points ..... (10)
  1. Intramural interests 2
  2. Extramural interests
     (a) Cultural and ethical 2
     (b) Civics 2
     (c) School patrons 4

Another plan which has been worked out with much care has been published by Boyce (3). The points which enter into the record are chosen arbitrarily but with much care and thought, and no definite values are assigned. The author seems to think it better to use such terms as "Very Poor," "Poor," etc. Some work on the relative importance of the various points has been done by using correlation coefficients. A copy of the record with the estimates of three different judges upon the same teacher follows:

Efficiency Record



GRAPH II.—Efficiency of a teacher recorded by three different judges

Superintendent: □ ; Principal: × ; Supervisor: ○

Other plans of the same nature have been published by Witham (18), Stowe (14), Ruediger and Strayer (12).

This brief survey of the work done in this field seems to indicate that while the general plan of measuring the efficiency of a teacher by the score card is considered good, still the perfecting of such a plan will require much patience and effort. If these different score cards for grading the efficiency of teachers be examined, very few if any suggestions upon method will be found. In other words, no plan other than that of arbitrary selection is given for the determination of the points which should enter into the score card. Moreover, there is no provision made for the evaluation of the different rubrics except by means of the correlation coefficient; and there is no plan suggested for transferring these coefficients into such values as are used in the Indiana plan.

However, the fact that the score card is being brought to bear upon one of the most important problems in education,—the measurement of the efficiency of teachers, and the fact that it has been used so successfully in other fields, lead the author to believe that this method has a much larger place in education than has been accorded it. The purpose of the following pages is to present a score card for measuring one product of the teaching process and to present the methods by which the score card has been derived.

THE PROBLEM

More specifically our problem is the formation of a score card for the measurement of handwriting. As has been suggested this requires that the essential elements of writing be selected and that these various elements be weighted.

One of the chief advantages of this method of measurement when applied to writing lies in the fact that it requires an analysis of writing. To say to a child that his writing is very poor and deserves only fifty out of a possible one hundred points means little to either the child or the teacher and certainly it gives the child little if any basis upon which his efforts for improvement may be founded. The fact is that usually writing is not entirely bad, and if the teacher is competent she can analyze it so as to point out the good and the poor

points. If her analysis reveals that slant, spacing or size are to be criticized she at once gives both herself and the pupil a basis for future work.

The strongest argument which has been urged against both of the present writing scales is that they are each made upon a basis which in no sense attempts any analysis of writing. In one case the basis is general merit and in the other the basis of legibility is used. Grades in terms of such points may have many uses, but certainly from the standpoint of the teacher, of the pupil, and of the superintendent it would be valuable to have at least a part of the grades given in terms of the elements of writing.

If two systems of schools, or two systems of teaching writing, or two teachers of writing are to be compared as to the results shown in writing, the results would mean much more if certain elements of writing were agreed upon and the comparison made in terms of these.

The weighting of the different elements of writing is also an important problem. There are many teachers who emphasize movement above everything else, others emphasize slant, while not infrequently there are those who think that neatness is the prime thing in all writing teaching.

In view of such divergence of opinion it is certainly of value to know how a representative body of writing teachers or elementary school teachers rank and evaluate these various elements. Such knowledge could be used by teachers, supervisors, and superintendents in dealing with the problems of writing.

To summarize: The problem is a two-fold one, involving the determination of the elements of writing and the relative values of the elements chosen.

THE DETERMINATION OF THE POINTS WHICH ENTER INTO THE SCORE CARD

A study of the different score cards in agriculture reveals no definite plan of procedure for this phase of the problem at hand. Sometimes such cards are made entirely by a department in an agricultural college, or they may be authorized by

some association, or in still other instances they have been produced by a single individual. As has already been shown, the score cards which have been used in the measurement of the efficiency of teachers give little if any suggestion upon the determination of the points which enter into them.

The plan followed in the present investigation was first to get as large a list as possible of the elements of writing and then to select a limited number from this list. After considerable time had been spent in going through books on writing and corresponding with teachers and supervisors of writing and others who have much to do with writing either directly or indirectly the following list of the elements of writing was compiled:

Beauty
Shading
Legibility
Speed
Formation of letters
Execution
Position
Slant
Neatness
Endurance
Uniformity in turns
Uniformity in retraces
Uniformity in slant
Uniformity in spacing
Uniformity in endings
Ease
Individuality
Shape of letters
Lightness
Parts omitted
Conformity to an ideal
Spacing of letters
Spacing of words
Spacing of lines
Alignment
Movement
Form
Size
Uniformity
Accuracy
Smoothness
Uniformity in angles
Uniformity in loops
Uniformity in size
Uniformity in beginnings
Uniformity in height
Touch
Effort
Proportion
Strength of line
Parts added

An examination of this list reveals the many diverse ideas and opinions which are held in regard to writing. Evidently all of these points can not be used and our problem becomes one of selection. A closer examination of the list seems to show two rather distinct points of view. There are certain rubrics which are evidently intended to emphasize the manner in which the writing has been produced, while others are intended to emphasize writing as a product. To illustrate, the teacher who says that position and movement are the most important things in writing is thinking of writing as a process, while the teacher who says that "formation of letters" or

spacing is the most important is evidently thinking in terms of results.

To get a basis for a selection of the elements of writing it seems necessary to make a choice between these two points of view. Such a choice was determined by a consideration of certain problems which may be attacked by means of the score card in the future.

In other words there are certain important investigations in writing which are of such a nature that the amount of work required to get results by means of a score card constructed upon the basis that writing is a process would be almost prohibitive, while such work would proceed much more rapidly if the score card is constructed upon the basis that writing is a product. Many illustrations for this point might be given.

First, it seems that the teaching of writing is suffering from an over abundance of methods and systems. The elimination of poor methods can only be brought about by scientific and accurate investigations which compare these different methods. There is a basis for such a comparison if each system uses its best technique and then has its results compared with the results of other systems. Such comparisons are made many times in terms of technique and so do not give satisfactory results because the principles underlying the teaching of writing are not well-defined.

Second, the writing of a large number of children should be scored so that norms can be established and a basis given for the comparison of different school systems and of the different elementary and high school grades as to their writing. If such items as movement are to be included in the scoring, the work becomes almost impossible, because it means that each pupil must be scored separately while he is writing and to make this scoring valid it should be done by one person. The time and labor which this process would require make it almost impossible to score any considerable number of records, but under the conditions here proposed a superintendent could have each child in his school system write a sample with the technique used in that system, and the samples could be graded later by experts.

In addition to these two reasons for considering writing as

a product a third may be added. If the teacher of writing grades her pupils upon the basis that writing is a product, she establishes a relation between the process and the result. One reason that the child does not make progress in the matter of position is that no relation between position and results is seen. If the child were graded low on slant, say, and he were told that better slant could be had with proper position, certainly his interest in position would increase.

It is not the intention of the author to minimize the value of writing as a process nor does he wish to give the impression that such should not be kept in mind by the teacher, but there are many good reasons both from the standpoint of scientific investigations and of good teaching why writing may be considered as a result.

Certain principles which should be followed in the selection of the rubrics may now be discussed. The most obvious of these is that if the card is to be usable, the number of elements selected must be small. A serious objection to the score cards for the grading of teachers is that they contain such a large number of rubrics that the time required almost prohibits the general use of such a plan of grading. However, the number must be sufficiently large to cover the most essential if not all the different phases of writing. Later discussion will set forth the nine main points with five points subsidiary to one of the nine which number seems to meet both of the foregoing requirements.

Another principle which must be considered requires that the terms be mutually exclusive or as nearly so as possible. If we consider "beauty" for a moment it can be seen that it is a function of many other elements, and would not be selected because it includes too much. Other elements of which the same thing is true are legibility and neatness. On the other hand if such a thing as "spacing of letters" is considered, it is seen immediately that this refers to just one thing and all others are excluded.

In addition to these principles certain methods for selecting the elements suggest themselves. It would be possible to determine the correlation between general merit in writing and each of the points in the list given above, and also between

each two of the points in the list. Two objections may be urged against this method. First, if such results were obtained it would require a choice among those points for which the correlation is high, and then among those which did not correlate so highly, etc. After all, this resolves itself into an arbitrary choice which is just the thing to be avoided. The second objection would be the very large amount of work which would be required in collecting and compiling sufficient data for the solution of such a problem.

Another general plan which might be used would be to submit such a list to a representative body of teachers and have them mark what they considered to be the ten or twelve which are of most importance. The objection to be raised here is that it is not known in advance how many elements must be chosen and it is very doubtful if mutually exclusive points could be procured in this way.

A third plan which suggests itself is to have the points agreed upon by some one or two representative bodies of teachers. This method is approved in certain phases of agricultural work. However, until the score card establishes itself in education as an efficient method of measurement, very little can be expected from this source.

The last plan to be suggested is a selection which grows out of experience with the card itself. This plan coupled with arbitrary choice is the one used by the author. A number of students began the use of the card when it was in a very crude state with only tentative values, with the idea of determining what points should be used in order to give a complete account of writing. The general plan followed was to have these students grade separately a number of samples of writing each week and to follow the grading by a conference with the author. They were cautioned to watch for points in the writing which were not covered by the card that they were using. In light of the experience gained in the above experiment, and by keeping in mind the foregoing principles the following list of points was selected:

1. Spacing of letters.

This includes the uniformity and the length of the space,

i. e., the space may be too short, which leads to crowding, or it may be too long, or it may lack uniformity.

2. Spacing of lines.

The standard here is that the lines should be a uniform distance apart and that this distance should be neither too great or too small. If the paper is ruled this is made much easier for the writer, but even then, many persons do not succeed in properly spacing their lines.

3. Spacing of words.

This includes points similar to those under "1" above.

4. Slant.

Here is included such points as uniformity and degree of slant, i. e., the writing should not be extreme in either direction. This element of writing is closely related to position.

5. Size.

Writing should be uniform in size and neither too large nor too small. This is well expressed by the term proportion.

6. Alignment.

This suggests that the writing should follow a line and that this line should be perpendicular to the edge of the paper. If the paper is ruled this is made much easier for the writer, but even then many children have difficulty in meeting this requirement.

7. Neatness.

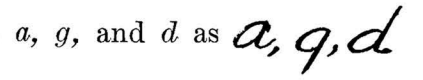
This was one of the last points to be added because it was first thought that it was a function of many other elements, and so need not be included. It was finally included so as to take account of such points as blotches, carelessness, and retracing. In this sense it is closely related to effort.

8. Heaviness. 

As the illustration indicates, this term is intended to include its opposite lightness. It suggests the width or quality of the line. It depends largely upon the movement used and in a less degree upon speed.

9. Formation of letters.

This is intended to emphasize the degree in which the letters conform to the correct form. It is rather a comprehensive term and five subsidiary points are included under it.

(a) Parts omitted.
Often seen in the letters *a*, *g*, and *d* as 
(b) Letters not closed.
Often seen in the letters mentioned above as

(c) Parts added.
Flourshes and dashes.
(d) Smoothness.
Indicates the execution. The letters should neither be cramped nor jerky.
(e) General form.
The following illustration would not be good form

THE EVALUATION OF THE POINTS WHICH ENTER INTO THE SCORE CARD

Two methods for obtaining such values suggested themselves, and in this initial attempt at such work, it was thought best to determine such values by each of the methods.

The first method to be mentioned is a modification of the Thorndike method used in deriving scales for drawing and writing. It was used also by Hillegas in his scale for composition and a modification of the same method was used by Buckingham in his scale for spelling.

The second method is known as the regression equation. The theory of this method is discussed in detail by Yule (19) and is used extensively in connection with an educational problem by Kelley (11).

In order to get data for the Thorndike method it was determined to get the judgments of a considerable number of persons upon the relative importance of the points listed on page 18. These judgments were rendered by three distinct groups of judges: first, teachers and supervisors of writing; second, elementary school teachers; and third, teachers and students of education.

RESULTS FROM TEACHERS AND SUPERVISORS OF WRITING

A list[1] of the members of The National Association of Penmanship Supervisors was obtained and to one hundred twenty-five of its members the following letter was sent:

My dear Sir or Madam:

Some of the teachers of writing in Texas have asked me to cooperate with them in arranging some plan to enable them and those under their supervision to grade writing in a more exact manner. Will you not cooperate in this matter by giving us the benefit of your expert opinion upon the points mentioned in the inclosed sheet. Any criticisms or suggestions will be appreciated.

Accompanying each letter was a sheet like the following, in which it will be noted that the points upon which the judgments are to be rendered are listed:

If a sample of handwriting is considered as a product or a result, the points listed below may be taken into consideration when such a sample is graded. Will you please rank the points in the list as to their importance in grading by placing the digit "1" before the one which you consider the most important of the nine points, the digit "2" before the one which you consider to be second in importance, and so on until you have ranked the entire list. If you think two or more should have the same rank, put the same digit before each.

Spacing of letters.
Spacing of words.
Spacing of lines.
Slant.
Size.
Alignment.
Neatness (blotches or carelessness).
Formation of letters.
Heaviness (a a)

[1]This list was very kindly furnished to me by Mr. G. G. Gudmundson of Bonne, Iowa, who is secretary of the above-mentioned association.

Under formation of letters the five points listed below may be considered as subsidiary points. Will you please rank these five points as you did the one above by placing the digit "1" before the one which you consider the most important, etc.

Parts omitted.
Letters not closed.
General form.
Parts added.
Smoothness.

From these letters seventy-five replies were received. The letters which accompanied many of the return sheets were very interesting and contained many valuable suggestions.

One of the most striking things revealed by this part of the investigations is the many diverse opinions held with reference to writing. A few expressed ideas very similar to those held by the graphologist, while others in direct contrast expressed views in harmony with the best psychological theories concerning the subject.

Still others expressed the opinion in no uncertain terms that the investigation was not scientific and refused to pass the judgments called for in the letter.

Some few expressed the belief that the one thing which is needed by writing teachers above everything else is an adequate system of measurement. They pointed out that this is demanded by both superintendents and boards of education, and that as yet writing teachers have made no contribution to this most important problem.

On the whole, the interest expressed in not only this line of work but any other which has for its purpose the betterment of handwriting was wholesome and augurs well for the future of writing,

Table 1 gives the distribution of the judgments upon the importance of the fourteen points. It will be recalled that the directions were such that two or more of the points could be given the same rank, and most of the judges saw fit to rank some of them in this way. This makes it necessary to designate certain ranks by such digits as 1.5, 2.5, etc. This comes from the artificial device of statistics which gives each of two points having the rank of 2, for example, a rank of 2.5. In

this table the different points are listed at the left and the digits at the top indicate the different ranks.

TABLE 1

Showing the distribution of judgments upon the relative importance of the various points listed below. The results for "spacing of letters" can be read as follows: No judges rank it as 1, three rank it as 1.5, etc.

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Spacing of letters	0	3	3	2	10	6	10	2	7	1	13	1	11	2	3	0	1
Spacing of words	0	1	0	1	4	6	9	3	9	2	9	1	11	5	12	1	1
Spacing of lines	0	0	1	0	3	4	4	2	6	0	4	3	11	3	15	3	16
Slant	9	1	8	3	12	8	9	2	7	0	4	4	2	0	4	0	2
Size	1	3	9	2	10	6	11	1	7	1	7	3	4	2	4	0	4
Alignment	1	1	1	0	4	1	4	3	3	0	8	3	11	2	7	6	20
Neatness	8	11	10	3	6	4	1	0	7	1	4	3	3	0	10	0	4
Formation of letters	29	5	7	2	9	5	0	2	4	0	2	0	4	0	3	1	2
Heaviness	4	7	6	5	3	4	5	1	5	1	7	2	8	2	6	1	8
Parts omitted	2	0	5	5	16	5	27	12	3								
Letters not closed	4	2	7	7	31	1	15	2	6								
General form	20	12	29	3	4	0	3	0	4								
Parts added	0	0	2	0	5	4	13	11	40								
Smoothness	36	13	12	1	5	0	4	1	3								

Some things about this table should be noted. The distribution of "formation of letters," "slant" and "size" are skewed to the left, which indicates that the final ranking of these will be high. In contrast with these the curves for "alignment" and "spacing of lines" are very much skewed to the right, indicating that the final ranking of these points will be low. The most symmetrical curves are for "spacing of letters" and "spacing of words," while that of "neatness" is peculiar in that it has three rather distinct modes, one at 1.5, another at 5, and a third at 8. Probably the most interesting distribution is that of "heaviness." It is almost rectangular with no central tendency. The close relation of this rubric to movement has been pointed out by many teachers and it was supposed in the beginning that this would show a very decided skew toward the left.

The next step in the procedure is to determine the sequence of the various rubrics, beginning with the one which is most important and so on down to the one which is least important. Such a sequence can be determined in a tentative way by an inspection of the distributions, shown in Table 1. This is to be followed by a count of the number of judges who place the first point above the second, the second above the third, etc. These results are shown in Tables 2 and 3.

TABLE 2

"E" stands for "equal." "M. I." stands for "more important." The table should be read 9 persons judge "formation of letters" equal in importance to "neatness," and 44 persons judge "formation" of letters more important than "neatness," etc. The digit "2" at the bottom of this column means that 2 persons judged "formation of letters" least important.

	Formation of letters		Neatness		Slant		Size		Heaviness		Spacing of letters		Spacing of words		Spacing of lines	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E	M.I.
Neatness	9	44														
Slant	3	2	6	38												
Size	4	3	5	5	12	39										
Heaviness	2	6	8	9	6	3	6	37								
Spacing of letters	1	7	5	1	8	6	2	5	3	39						
Spacing of words	0	5	4	2	4	3	1	6	6	1	30	40				
Spacing of lines	0	4	4	5	3	4	3	5	4	9	1	2	22	47		
Alignment	2	2	2	8	3	7	2	6	3	6	18	1	2	0	9	36
Least important		2		4		3		4		9		1		1		16

TABLE 3

E stands for "equal." M. I. stands for "more important." The table should be read: Fifteen persons judge "smoothness" as equal in importance to "general form" and thirty-seven persons judge "smoothness" as more important than "general form," etc. The digit 3 at the bottom of this column means that three persons judge smoothness as least important, etc.

	Smoothness		General form		Letters not closed		Parts omitted		Parts added	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.
General form	15	37								
Letters not closed	3	6	7	55						
Parts omitted	2	9	1	1	10	43				
Parts added	0	6	1	4	2	11	19	49		
Least important		3		4		6		5		40

By taking one-half of the "equal" judgments and adding them to the "more important" judgments in each case it is possible to reduce these results to a percentage basis. By referring to Table 2 it is seen that 44 judges rank "formation of letters" as more important than "neatness," and 9 rank the same points as equal. Adding 4.5 to 44 it is found that 64.6% of

the 75 judges have placed formation of letters above neatness in importance. In this same manner Tables 4 and 5 are derived.

TABLE 4

Spacing of lines is judged more important than alignment by.....54% of the judges
Spacing of words is judged more important than spacing of lines by..77% of the judges
Spacing of letters is judged more important than spacing of words by 73% of the judges
Heaviness is judged more important than spacing of letters by.....54% of the judges
Size is judged more important than heaviness by.....54% of the judges
Slant is judged more important than size by.....60% of the judges
Neatness is judged more important than slant by.....54% of the judges
Formation of letters is judged more important than neatness by.....65% of the judges

TABLE 5

Parts omitted is judged more important than parts added by.....77% of the judges
Letters not closed is judged more important than parts omitted by....64% of the judges
General form is judged more important than letters not closed by.....78% of the judges
Smoothness is judged more important than general form by.....59% of the judges

Referring now to Thorndike's table[2] it is possible to get a statement of the difference between each pair of items in Tables 4 and 5 in terms of the probable error (D) of the distribution of the judgments. By the use of this table, Tables 6 and 7 are derived.

TABLE 6

Difference between values for spacing of lines (b) and alignment (a).....= .149D.
Difference between values for spacing of words (c) and spacing of lines (b).....=1.094D.
Difference between values for spacing of letters (d) and spacing of words (c).....= .909D.
Difference between values for heaviness (e) and spacing of letters (d).....= .149D.
Difference between values for size (f) and heaviness (e)= .149D.
Difference between values for slant (g) and size (f).....= .376D.
Difference between values for neatness (h) and slant (g)..= .149D.
Difference of between values for formation of letters (i) and neatness (h).....= .571D.

TABLE 7

Difference between values for parts omitted (y) and parts added (z).....=1.094D.
Difference between values for letters not closed (x) and parts omitted (y).....= .532D.
Difference between values for general form (w) and letters not closed (x).....=1.143D.
Difference between values for smoothness (v) and general form (w).....= .337D.

Stating this more simply by using the letters in parenthesis. Tables 8 and 9 are derived.

2. Teachers College Record, Vol. 14, No. 5, page 25.

TABLE 8

b − a = .149 D
c − b = 1.094 D
d − c = .909 D
e − d = .149 D
f − e = .149 D
g − f = .376 D
h − g = .149 D
d − h = .576 D

TABLE 9

y − z = 1.094 D
x − y = .532 D
w − x = 1.143 D
v − w = .337 D

From Table 8 the following set of equations is derived:

(1) b − a = .149 D (1)
(2) c − a = 1.243 D (2)
(3) d − a = 2.152 D (3)
(4) e − a = 2.301 D (4)
(5) f − a = 2.450 D (5)
(6) g − a = 2.826 D (6)
(7) h − a = 2.975 D (7)
(8) i − a = 3.551 D (8)

Then, b+c+d+e+f+g+h+i−8a = 17.642 D

Adding to this a − a = 0

Then a+b+c+d+e+f+g+h+i−9a = 17.642 D

In the earlier part of the discussion is was suggested that the sum of the points must equal 100. Substituting this value, the equation becomes

9a = 100 − 17.642 D (9)

Now D is defined as that difference in importance upon which 75% of the judges agree and may have one of many numerical values, so it becomes necessary to determine a definite value for it. Since it is defined as a difference it must have a value greater than zero, for in judgments as here rendered a negative difference or a zero difference could not be considered, and if the values of the different elements are to be positive, the value of D cannot be greater than approximately 5.6.

It seemed impossible to determine the value any more accurately than this unless "a" in equation (9) was known, and so a value for "a" was next determined. In order to get data for this, the following sheet with the ranks which they had given at an earlier time were given to a number of persons. Returns were received from thirty judges.

Dear Sir or Madam:

The digits placed before each of the points listed below indicate the ranking which you gave the same points some time ago. Will you at this time please give the points numerical values in accordance with these ranking, so that the sum of the nine values will equal 100.

Spacing of letters
Spacing of words
Spacing of lines
Slant
Size
Alignment
Neatness (blotches or carelessness)
Formation of letters
Heaviness

Will you also distribute the number of points which you give to "formation of letters" among the following subsidiary points:

Parts omitted
Letters not closed
General form
Parts added
Smoothness

It will be remembered that "a" stands for the element which has the ninth rank, and so only values for the ninth rank are here concerned. The thirty values ranged from 1 to 7 with an average of 3.3 and mean variation of 1.4. The mode of the distribution is at three.

If "a" is given the value 3.3 in equation (9), the value of D becomes 3.9. Using the above values for "a" and "D" in equations (1) to (8), the following values are obtained:

		Expressed in whole numbers
Alignment (a)	= 3.33	3
Spacing of lines (b)	= 3.92	4
Spacing of words (c)	= 8.26	8
Spacing of letters (d)	= 11.87	12
Heaviness (e)	= 12.46	12
Size (f)	= 13.05	13
Slant (g)	= 14.54	15
Neatness (h)	= 15.13	15
Formation of letters (i)	= 17.42	18
Sum	= 99.98	100

Referring now to Table 9, the following set of equations is procured:

$y - z = 1.094\ D$ (a)
$x - z = 1.626\ D$ (b)
$w - z = 2.769\ D$ (c)
$v - z = 3.106\ D$ (d)

Adding these equations we get $v+w+x+y-4z = 8.595\ D$
Adding $z - z = 0$,
The equation becomes $v+w+x+y+z-5z = 8.595\ D$
Since the sum of $v+w+x+y+z = 18$, then,
$5z = 18 - 8.595\ D$ (e)

The distributions concerned here are entirely different from those just considered and so both "z" and "D" must be determined. To determine "z" the data obtained for the rubrics at the bottom of the sheet on page 26 is used. The average value for the lowest rank in this case is 1.44, with an average variation of .54. The range was from 1 to 3. Substituting this value for "z" in equation (e), "D" becomes 1.27. Using this value of "D" in equations (a) to (b), the following values are derived:

		Expressed in whole numbers
Parts added (z)	1.44	1
Parts omitted (y)	2.81	3
Letters not closed (x)	3.48	3
General form (w)	4.92	5
Smoothness (v)	5.35	6
	18.00	18

RESULTS FROM ELEMENTARY SCHOOL TEACHERS

Blanks like those sent to the writing teachers (see page 20) were given to all the elementary-school principals in Austin, Texas. Time was taken to explain carefully just what was wanted, and then in turn the matter was presented by the principal to the teachers. Seventy-five blanks were returned. Table 10 gives the distribution of the judgment upon the importance of the various points. This table has the same plan as Table 1, and so needs no explanation.

TABLE 10

Showing distribution of judgments by elementary school teachers upon the relative importance of the various points listed below. For key see Table 1.

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Spacing of letters	0	2	12	8	11	6	13	5	4	2	7	0	1	1	1	1	1
Spacing of words	4	0	3	6	12	6	11	4	11	2	9	1	1	1	3	1	0
Spacing of lines	0	0	1	0	9	2	6	1	10	5	13	4	15	0	5	0	4
Slant	0	0	2	1	7	2	4	1	5	1	11	3	16	3	8	1	10
Size	1	0	3	0	6	4	11	2	12	1	7	2	9	3	8	4	4
Alignment	1	0	4	0	3	1	8	2	4	4	4	5	10	0	13	2	14
Neatness	14	6	12	4	9	2	7	2	5	1	2	0	3	1	4	0	3
Formation of letters	39	8	11	1	7	1	3	1	1	0	0	1	0	0	2	0	0
Heaviness	0	0	2	2	3	2	1	0	1	1	3	0	7	1	18	5	29
Parts omitted	2	0	7	2	20	11	18	8	7								
Letters not closed	2	2	22	1	25	1	14	2	6								
General form	50	10	7	0	5	0	2	0	1								
Parts added	0	0	0	3	5	10	20	9	28								
Smoothness	7	8	28	2	7	0	7	1	15								

It should be noted that none of these distributions presents any such peculiarities as that of "neatness" or "heaviness" in Table 1. Those indicating high rank are skewed to the left, while those indicating the low rank are skewed to the right, and those for the middle rank approach the normal curve of distribution. The next step in the procedure is to determine the sequence of the various rubrics, beginning with the one which is most important and so on down to the one which is the least important. Such a sequence can be determined in a tentative way by an inspection of the distribution shown in Table 10. This is to be followed by a count of the number of judges who place the first point above the second, the second above the third, etc. These results are shown in Tables 11 and 12.

TABLE 11

Showing distribution of "equal to" and "more important" judgments by elementary school teachers upon the various points listed below. For key see Table 2.

	Formation of letters		Neatness		Spacing of letters		Spacing of words		Size		Spacing of lines		Slant		Alignment		Heaviness	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I
Neatness	14	44																
Spacing of letters	8	5	8	41														
Spacing of words	7	3	7	1	28	32												
Size	2	4	3	2	3	3	2	52										
Spacing of lines	7	3	5	2	11	6	11	10	2	41								
Slant	2	3	4	7	3	1	4	5	3	5	3	49						
Alignment	2	5	2	2	4	1	5	2	7	6	8	8	3	43				
Heaviness	1	3	3	7	2	2	2	3	7	13	3	2	1	10	8	44		
Least important		0		3		1		1		2		4		9		14		29

TABLE 12

Showing distribution of "equal to" and "more important" judgment upon the various points listed below. For key see Table 3.

	General form		Smoothness		Letters not closed		Parts omitted		Parts added	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.
Smoothness	13	56								
Letters not closed	4	3	6	41						
Parts omitted	2	3	4	3	7	43				
Parts added	2	2	5	9	7	13	28	39		
Least important		1		15		6		7		28

It is interesting to note the different ranks accorded the rubrics in Table 11 as compared with those in Table 2. "Formation of letters" and "neatness" retain the same place, while "heaviness" becomes last and "slant" is only seventh as compared with third place in Table 2. It would be exceedingly interesting to know what there is in the experiences of the elementary school teacher with writing that leads to this rather marked difference of opinion, but any discussion would be largely speculative and so probably not very profitable.

Again, by taking one-half of the "equal" judgments in each case and adding them to the "more important" judgments the results may be reduced to percentages. Tables 13 and 14 give these results.

TABLE 13

Alignment is judged more important than heaviness by	64% of judges
Slant is judged more important than alignment by	50% of judges
Spacing of lines is judged more important than slant by	67% of judges
Size is judged more important than spacing of lines by	56% of judges
Spacing of words is judged more important than size by	71% of judges
Spacing of letters is judged more important than spacing of words by	61% of judges
Neatness is judged more important than spacing of letters by	61% of judges
Formation of letters is judged more important than neatness by	68% of judges

TABLE 14

Parts omitted is judged more important than parts added by	72% of judges
Letters not closed is judged more important than parts omitted by	62% of judges
Smoothness is judged more important than letters not closed by	59% of judges
General form is judged more important than smoothness by	83% of judges

Referring now to Thorndike's table (see foot note page 24) we get Tables 15 and 16.

TABLE 15

The difference between the values for alignment (b) and heaviness (a)	= .532 D
The difference between the values for slant (c) and alignment (b)	= .337 D
The difference between the values for spacing of lines (d) and slant (c)	= .653 D
The difference between the values for size (e) and spacing of lines (d)	= .224 D
The difference between the values for spacing of words (f) and size (e)	= .821 D
The difference between the values for spacing of letters (g) and spacing of words (f)	= .414 D
The difference between the values for neatness (h) and spacing of letters (g)	= .414 D
The difference between the values for formation of letters (i) and neatness (h)	= .694 D

TABLE 16

The difference between the values for parts omitted (y) and parts added (z)	= .865 D
The difference between the values for letters not closed (x) and parts omitted (y)	= .453 D
The difference between the values for smoothness (w) and letters not closed (x)	= .337 D
The difference between the values for general form (v) and smoothness (w)	=1.412 D

Using the same value of "a" (3.33) as before and remembering that a+b+c+d+e +f+g+h+i=100, the following values are obtained:

		Expressed in whole numbers
Heaviness (a)	= 3.33	3
Alignment (b)	= 5.42	5
Slant (c)	= 6.75	7
Spacing of lines (d)	= 9.32	9
Size (e)	= 10.20	10
Spacing of words (f)	= 13.44	14
Spacing of letters (g)	= 15.07	15
Neatness (h)	= 16.74	17
Formation of letters (i)	= 19.48	20
Sum	99.95	100

Using the same values of "z" and putting v+w+x+y+z=20, the following values are obtained:

		Expressed in whole numbers
Parts added (z)	= 1.44	1
Parts omitted (y)	= 3.04	3
Letters not closed (x)	= 3.87	4
Smoothness (w)	= 4.50	5
General form (v)	= 7.11	7
Sum	19.96	20

RESULTS FROM TEACHERS AND STUDENTS OF EDUCATION.

The data next procured was from teachers and students of education. Eighty-two persons are included in this group. Outside of those who give instruction in the above mentioned subject they were all either seniors or juniors in the University of Texas. The matter was presented to each class either by the author or by one who was familiar with all the details of the investigation.

Table 17 gives the distribution of the different judgments from this group.

TABLE 17

Showing distribution of judgments by students upon the various points listed below. For key see Table 1.

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Spacing of letters	6	4	18	7	18	3	11	1	7	0	2	1	3	1	0	0	0
Spacing of words	0	3	8	9	10	5	18	2	9	2	5	1	7	1	1	0	1
Spacing of lines	0	0	1	3	5	3	9	2	10	6	17	2	10	0	8	0	6
Slant	1	1	2	1	3	1	6	1	6	0	9	1	14	0	23	1	12
Size	3	0	12	0	2	0	9	2	9	0	10	2	13	1	13	1	5
Alignment	2	3	7	2	6	0	7	0	6	2	13	3	15	0	15	0	1
Neatness	11	4	6	1	11	0	6	1	14	1	7	1	5	1	6	1	5
Formation of letters	44	9	8	1	4	0	5	3	2	1	1	2	1	0	1	5	0
Heaviness	0	0	1	0	1	0	3	0	2	0	5	3	7	2	9	1	48
Parts omitted	10	7	12	1	8	0	6	4	3								
Letters not closed	6	3	12	2	14	1	7	1	5								
General form	19	0	7	0	12	2	3	3	5								
Parts added	1	4	4	1	7	0	17	4	13								
Smoothness	9	0	11	0	5	3	6	3	14								

After determining as before which point is most important, which second in importance, etc., the next step is to find the number of judges who rank each rubric above the next lower in order. Tables 18 and 19 give such results.

TABLE 18

Showing distribution of "equal to" and "more important" judgments of students upon the various points listed below. For key see Table 2.

	Formation of letters		Spacing of letters		Spacing of words		Neatness		Spacing of lines		Size		Alignment		Slant		Heaviness	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.
Spacing of letters	6	60																
Spacing of words	1	3	16	49														
Neatness	3	3	0	1	2	43												
Spacing of lines	1	4	1	4	7	19	3	52										
Size	3	2	1	3	1	3	0	2	0	43								
Alignment	2	1	1	2	2	5	1	5	1	10	1	40						
Slant	3	2	1	5	1	1	0	7	0	8	1	9	2	54				
Heaviness	2	1	1	0	1	3	1	6	0	9	1	12	1	10	1	60		
Least important		0		0		1		5		5		5		2		12		48

TABLE 19

Showing the distribution of "equal to" and "more important" judgments of students upon the various points listed below. For key see Table 3. One section did not render judgments on these points which accounts for the numbers being smaller in this table than in the others.

	General form		Parts omitted		Letters not closed		Smoothness		Parts added	
	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.	E.	M.I.
Parts omitted	0	27								
Letters not closed	0	2	5	27						
Smoothness	2	5	0	1	3	29				
Parts added	1	9	4	8	0	5	0	29		
Least important		5		3		6		19		

Reducing the "more important" and "equal judgments" to percentages Tables 20 and 21 are derived.

TABLE 20

Slant is judged more important than heaviness by 74% of judges
Alignment is judged more important than slant by 67% of judges
Size is judged more important than alignment by 50% of judges
Spacing of lines is judged more important than size by 52% of judges
Neatness is judged more important than spacing of lines by 65% of judges
Spacing of words is judged more important than neatness by 54% of judges
Spacing of letters is judged more important than spacing of words by 70% of judges
Formation of letters is judged more important than spacing of letters by 76% of judges

TABLE 21

Smoothness is judged more important than parts added by 57% of judges
Letters not closed is judged more important than smoothness by 60% of judges
Parts omitted is judged more important than letters not closed by 58% of judges
General form is judged more important than parts omitted by 54% of judges

Referring again to Thorndike's table (see footnote, page 24) these differences may be stated in terms of probable error D

TABLE 22

Difference in values of slant (b) and heaviness (a) = .954 D
Difference in values of alignment (c) and slant = .653 D
Difference in values of size (d) and alignment = 0
Difference in values of spacing of lines (e) and size = .074 D
Difference in values of neatness (f) and spacing of lines = .571 D
Difference in values of spacing of words (g) and neatness = .149 D
Difference in values of spacing of letters (h) and spacing of words = .778 D
Difference in values of formation of letters (i) and spacing of letters = 1.046 D

TABLE 23

Difference in values of smoothness (y) and parts added (z)= .262 D
Difference in values of letters not closed (x) and smoothness= .367 D
Difference in values of parts omitted (w) and letters not closed .....= .299 D
Difference in values of general form (v) and parts omitted= .149 D

Manipulating these results as has been done before and putting a=3.33 and z=1.44, the following values are derived.

		Expressed in whole numbers
Heaviness ..... (a) =	3.33	3
Slant ..... (b) =	7.06	7
Alignment ..... (c) =	9.61	10
Size ..... (d) =	9.61	10
Spacing of lines ..... (e) =	9.90	10
Neatness ..... (f) =	12.15	12
Spacing of words ..... (g) =	12.72	12
Spacing of letters ..... (h) =	15.76	16
Formation of letters ..... (i) =	19.85	20
Sum	99.99	100

		Expressed in whole numbers
Parts added ..... (z) =	1.44	1
Smoothness ..... (y) =	2.58	3
Letters not closed ..... (x) =	4.23	4
Parts omitted ..... (w) =	5.55	6
General form ..... (v) =	6.19	6
Sum	19.99	20

The last step in the procedure is to get results by means of combining the judgments of the three groups. The distribution of the judgments by such combination is given in Table 28.

TABLE 24

Showing distribution of judgments by all judges upon the relative importance of the various points listed below. For key see Table 1.

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9
Spacing of letters	6	9	33	17	39	15	34	8	18	3	22	2	15	4	4	1	2
Spacing of words	4	4	11	16	26	17	38	9	29	6	23	3	19	7	16	2	2
Spacing of lines	0	0	3	3	17	9	19	5	26	11	34	9	36	3	28	3	26
Slant	10	2	12	5	22	11	19	4	18	1	24	8	32	3	35	2	24
Size	5	3	24	2	18	10	31	5	28	2	24	7	26	6	25	5	11
Alignment	4	4	12	2	13	2	19	5	13	6	25	11	36	2	35	8	35
Neatness	33	21	28	8	26	6	14	3	26	3	13	5	11	2	20	1	12
Formation of letters	112	22	26	4	20	6	8	6	7	1	3	3	5	0	6	1	2
Heaviness	4	7	9	7	7	6	9	1	8	2	15	5	22	5	33	7	85
Parts omitted	14	7	24	8	44	16	51	24	15								
Letters not closed	12	7	41	10	70	3	36	5	17								
General form	89	22	43	3	21	2	8	3	10								
Parts added	1	4	6	4	17	14	50	24	81								
Smoothness	52	21	51	3	17	3	17	5	32								

The calculation of the "equal to" and "more important" judgments gives Tables 25 and 26.

TABLE 25

Alignment (b) is judged more important than heaviness (a) by	55% of judges
Slant (c) is judged more important than alignment by	59% of judges
Spacing of lines (d) is judged more important than slant by	52% of judges
Size (e) is judged more important than spacing of lines by	59% of judges
Spacing of words (f) is judged more important than size by	58% of judges
Spacing of letters (g) is judged more important than spacing of words by	68% of judges
Neatness (h) is judged more important than spacing of letters by	51% of judges
Formation of letters (i) is judged more important than neatness by	70% of judges

TABLE 26

Parts omitted (y) is judged more important than parts added by	75% of judges
Letters not closed (x) is judged more important than parts omitted by	55% of judges
Smoothness (w) is judged more important than letters not closed by	62% of judges
General form (v) is judged more important than smoothness by	63% of judges

Manipulating these results as before the following values are found:

			Expressed in whole numbers
Heaviness	(a) =	3.33	3
Alignment	(b) =	4.65	5
Slant	(c) =	7.05	7
Spacing of lines	(d) =	7.58	8
Size	(e) =	9.98	10
Spacing of words	(f) =	11.61	12
Spacing of letters	(g) =	16.55	16
Neatness	(h) =	16.81	17
Formation of letters	(i) =	22.35	22
Sum		99.91	100

			Expressed in whole numbers
Parts added	(z) =	1.44	1
Parts omitted	(y) =	3.92	4
Letters not closed	(x) =	4.38	4
Smoothness	(w) =	5.50	6
General form	(v) =	6.74	7
Sum		21.98	22

RESULTS BY MEANS OF THE REGRESSION EQUATION

The first step in this procedure is to determine the correlation between "general merit" in handwriting and each of the nine points in the preceding list as well as the correlation of each point with each of the remaining eight. In order to get data for this part of the work, sixteen samples of writing were selected from the Thorndike scole. The reason for taking

these samples from the scale is that they have been carefully graded on the basis of general merit. One sample was taken from each division of the scale except in the case of division 15, from which two samples were selected. The samples were then ranked on the basis of each of the nine points in the preceding list. The ranking was done by fifty persons, all of whom were university students. Many of them were mature persons with experience in teaching. The following directions were given each one:

Dear Sir or Madam:

Will you please rank the accompanying samples of handwriting on the basis of the nine points at the top of the sheet attached to this. The numbers at the top of the sheet upon which the samples appear correspond to the numbers at the left of the attached sheet.

To rank the samples on the basis of slant, decide which sample has the best "slant" and put the digit "1" in the slant column in the square opposite the number which corresponds to the number at the top of the sample. Then decide upon the second best sample as to "slant" and place the digit "2" in its appropriate rectangle as before. Proceed in this way until each of the samples have been ranked. When all have been ranked on the basis of "slant," proceed in the same manner with "alignment," etc., until the samples have been ranked with reference to each of the nine points. If two or more of the samples should have the same rank, put down the digit representing this rank for each of them.

The following table will give the points to be taken into consideration when considering the different rubrics:

Slant
  Uniformity
  Mixed

Alignment

To determine this a straight edge may be used as a line or the judge may turn the sample edgewise, close one eye, and look down the different lines. Consider also that lines should be perpendicular to the edge of the paper.

Spacing of words
  Uniformity
  Length of space
Formation of letters
  Smoothness
  General form
  Parts omitted or added
Spacing of lines
  Uniformity
  Too close
  Too far apart
Heaviness 
Spacing of letters
  Uniformity
  Too close
  Too far apart
Neatness
  Blotches or careless
Size
  Uniformity
  Too large
  Too small

In addition to the written directions the problem was explained to each judge by the writer. The work was all done in the laboratory, and the time required was credited upon the regular work of the course which the student was taking, so that there was no occasion to rush. The time taken was usually one to two hours. Each person recorded his judgments in the following form:

Sample	Slant	Alignment	Spacing of words	Formation of letters	Spacing of lines	Heaviness	Spacing of letters	Neatness	Size
1	10	10	13	12	10	10	9	11	9
2	4	2	1	4	3	2	5	4	2
3	16	15	16	16	16	16	16	16	16
4	12	9	12	10	8	9	10	12	11
5	13	13	11	13	14	12	15	14	15
6	8	7	7	6	6	7	7	7	4
7	15	14	15	15	15	15	14	15	14
8	6	5	5	5	5	5	4	5	7
9	1	1	3	1	2	1	1	1	3
10	9	11	10	9	13	14	11	10	10
11	2	4	2	2	1	3	3	2	5
12	14	16	13	14	12	13	12	13	13
13	11	12	9	11	11	11	8	9	8
14	7	8	8	7	9	6	6	8	12
15	5	3	6	8	7	8	7	6	5
16	3	6	4	3	4	4	2	3	6

Signed: J. C. I.

This data was formulated as shown in Table 27. It will be noted that this table shows graphically the correlation between "general merit" and "spacing of letters." Forty-five such tables are required:

TABLE 27

Showing correlation between "general merit" and "spacing of letters." The column at the left indicates the different ranks for "general merit." The row at the top indicates the ranks for "spacing of letters."

	1	1.5	2	2.5	3	3.5	4	4.5	5	5.5	6	6.5	7	7.5	8	8.5	9	9.5	10	10.5	11	11.5	12	12.5	13	13.5	14	14.5	15	15.5	16
1	34	3	4	2	3	1	1		1	1																					
2		1	20	6	10	1	5	2	3				2																		
3	3	1	8	7	19	1	5	1	2	1	1		1																		
4.5	1	1	4	1	3	1	7	5	10	1	6		1	2	2		1	1	2				1								
4.5			5	4	6	1	10	5	9	1	4		2		2	1															
6	1		1			2	2	1	2		4	2	10	4	11		6	2	1		1										
7				1	2		5	1	9	1	13		8	2	6	1	1														
8					1	1	1		3	1	15	2	12	3	6		2	1	1								1				
9							1	1					3	2	8		18	3	4		7	1			2						
10													1		2		8	1	13		11		8	1	3			1			1
11											1		1		1		5	3	15	1	8	2	11		1		1				
12													1		1		1	1	3	1	14	1	20	1	4	1	1				
13																	1		1		2	1	6	2	28	2	5	1	1		
14									1														2		3	2	19	2	19		2
15													2												1	1	16	3	21		6
16																					1				1		2		6		40

Applying the formula $r=1-\frac{6\Sigma D^2}{n(n^2-1)}$ the following table of correlations is obtained:

TABLE 28

	Formation of letters	Neatness	Spacing of letters	Spacing of words	Size	Spacing of lines	Slant	Alignment	Heaviness
General merit	95	94	94	91	82	91	90	94	77
Formation of letters		91	92	91	80	91	89	91	77
Neatness			90	88	78	87	89	91	77
Spacing of letters				89	80	89	90	90	78
Spacing of words					76	88	88	90	77
Size						75	76	77	70
Spacing of lines							87	89	76
Slant								90	74
Alignment									77

The probable error of these correlations is found by the formula: $P.E.=.706\frac{1-r^2}{\sqrt{n}}$

Applying this formula to the lowest correlation (70), the probable error is found to be .091. Since "$_n$" remains constant, the other P.E.'s will not be greater than this. This value of P.E., one-eighth of the coefficient of correlation, is quite satisfactory.

Attention is called to the order accorded the different rubrics on the basis of the correlations with general merit. The most interesting point is that "alignment" has the same rank as "neatness" and "spacing of letters," which is very much higher than accorded it in any of the previous results. The average of the intercorrelations for "alignment" gives it a rank of three. Attention is also called to the fact that "size" is ranked eighth either by its correlation with "general merit" or by its intercorrelations which is lower than the rank accorded it in the other results.

One objection which may be raised to the judgments upon which these coefficients are calculated is that the opinions upon any one point are not independent of the influence of the other

elements, i. e., the judgments upon "formation of letters" are not independent of "slant," "spacing of letters," etc.

The regression equation gives the value which may be attached to any one point, independent of any relation it may have with any other element. The equation will be of this general form:

General merit$=(b_1)$slant$+(b_2)$size$+(b_3)$formation of letters $+$——etc. This equation would require that nine different coefficients be determined. The work for determining such coefficients is so involved that an equation with more than four variables is seldom used. This necessitates the grouping of the elements in the following manner on the basis of the intercorrelations.

Group one is composed of "formation of letters," "spacing of letters," "spacing of words," and "spacing of lines." Group two contains "slant," "alignment," and "neatness," and group three has in it "heaviness" and "size." The regression equation now becomes: General merit $(x_1)=b_1$ (formation of letters) $(x_2)+b_2$ (slant) $(x_3)+b_3$ (heaviness) (x_4) or in a more simple form it is, $x_1=b_1x_2+b_2x_3+b_3x_4$.

The first step in determining the coefficients b_1, b_2, and b_3 is to find the correlation coefficients of the first order in terms of the coefficients of zero order found in Table 28. The equations for this have the following form:

$$r_{12\cdot3}=\frac{r_{12}-r_{13}\cdot r_{23}}{\sqrt{1-r_{13}^2}\sqrt{1-r_{23}^2}}$$

Other equations of the same type must be used for $r_{13\cdot2}$, $r_{23\cdot1}$ etc. These calculations are to be followed by the second step which is the determination of the correlation coefficients of the second order in terms of the coefficient of the first order. The equations used here have this form:

$$r_{12\cdot34}=\frac{r_{12\cdot3}-r_{14\cdot3}\cdot r_{24\cdot3}}{\sqrt{1-r_{14\cdot3}^2}\sqrt{1-r_{24\cdot3}^2}}$$

Again, other equations must be used for $r_{13\cdot24}$, $r_{23\cdot14}$ etc

The third step is to determine the standard deviation of higher orders. The equations used here have this form:

$$\sigma_{12\cdot34}=\sigma_1\sqrt{1-r_{12}^2}\sqrt{1-r_{13\cdot2}^2}\sqrt{1-r_{14\cdot23}^2}$$

Other equations of the same general type must be used for $\sigma_{2\,134}$, $\sigma_{3\cdot124}$ etc.

Since the desired results should not be proportional to σ_1, σ_2 and σ_3 these are all made equal to unity. This data[3] can now be used for calculating the coefficients $b_1b_2b_3$. The equations used here take the form

$$b_{12\cdot34}=r_{12\cdot34}\frac{\sigma_{1\cdot234}}{\sigma_{2\cdot134}}$$

Others similar to this must be used for $b_{13\cdot24}$ and $b_{14\cdot23}$. The following table gives the results obtained:

TABLE 29

Showing values of the different coefficients required in the solution of the first regression equation.

Zero order coefficients		First order coefficients		Second order coefficients		
						$\sigma_{1\cdot234}$=.279
12	.95	12.3	.77	12.34	.73	$\sigma_{2\cdot134}$=.291
13	.90	13.2	.39	13.24	.26	$\sigma_{3\cdot124}$=.408
23	.89	23.1	.26	.....	.....	$\sigma_{4\cdot123}$=.661
14	.77	14.2	.20	14.23	.13	$b_{12\cdot34}$=.693
24	.77	24.1	.20	24.13	.16	$b_{13\cdot24}$=.244
14	.77	14.3	.36	.....	.....	$b_{14\cdot23}$=.058
34	.74	34.1	.17	34.12	.12	
24	.77	24.3	.36	.....	.....	
34	.74	34.2	.19	.....	.....	

The equation then becomes x_1=.693x_2+ .244x_3+ .057x_4

If 100 points are divided among the three groups before mentioned in the ratio indicated by these coefficients, 69.6 is the value given group one, 24.5 is the value for group two, and 5.9 is given group three.

In order to determine how the 5.9 points are to be distributed between "size" and "heaviness" another regression equation of three variables is used. The solution of this gives "heaviness" equal to 2.5 anad "size" equal to 3.4.

The distribution of the 24.5 points in group two is determined

3. The regression equation has been worked out with the product moment coefficient, but for all practical purposes it is thought that the rank coefficients are sufficiently accurate.

by another regression equation of four variables. The solution of this gives "neatness" equal to 9.1, "alignment" equal to 11.4 and "slant" equal to 4.

The distribution of the 9.5 points in group one is also determined by a regression equation. In this group "spacing of words" and "spacing of lines" are considered of equal value on account of their intercorrelations. The solution of the equation gives "formation of letters" equal to 29.3, "spacing of letters" equal to 20.2, "spacing of words" and "spacing of lines" each to 10.

The results of the investigation can now be summarized in the following table:

TABLE 30

Showing values and ranks obtained for the different rubrics by the different methods.

	Ranks							Values				
	All Judges	Students	Elementary School Teachers	Writing Teachers	Total correlation	Inter correlation	By regression equation	All Judges	Students	Elementary School Teachers	Writing Teachers	By regression equation
Heaviness	9	9	9	5	9	9	9	3	3	3	12	3
Alignment	8	7	8	9	2	2	3	5	10	5	3	11
Slant	7	8	7	3	7	6	7	7	7	7	15	4
Spacing of lines	6	5	6	8	5	7	5	8	10	9	4	10
Size	5	6	5	4	8	8	8	10	10	10	13	4
Spacing of words	4	3	4	7	5	5	5	12	12	14	8	10
Spacing of letters	3	2	3	6	2	2	2	16	16	15	12	20
Neatness	2	4	2	2	2	4	6	17	12	17	15	9
Formation of letters	1	1	1	1	1	1	1	22	20	20	18	29
Parts added	5	5	5	5	----	----	----	1	1	1	1	----
Parts omitted	4	2	4	4	----	----	----	4	6	3	3	----
Letters not closed	3	3	3	3	----	----	----	4	4	4	3	----
General form	1	1	1	2	----	----	----	7	6	7	5	----
Smoothness	2	4	2	1	----	----	----	6	3	5	6	----

Final value may now be gotten by taking the average of the value given by the regression equation and "all judges." Such values expressed in whole numbers are as follows:

Heaviness	3
Slant	5
Size	7
Alignment	8
Spacing of lines	9
Spacing of words	11
Neatness	13
Spacing of letters	18
Formation of letters	26
Sum	100

The value given to "formation of letters" is 1.17 times as great as that given to the same rubric by "all judges." To get final values for the points subsidiary to "formation of letters" the values given for these various elements on page 43 may be multiplied by 1.17. Such a procedure gives the following results:

Parts added	2
Parts omitted	5
Letters not closed	5
Smoothness	6
General form	8
Sum	26

USES AND FORMS OF THE SCORE CARD

In addition to the scientific uses which have already been suggested there are many other uses for the score card. Teachers of writing can use it to stimulate interest by scoring the writing of each pupil or by having the pupils score their own writing or the writing of other pupils. This would call the attention of the pupils to the elements of good writing and the relative merits of each point. It would also give the pupils a definite idea of the progress which they are making. Supervisors might use it for comparison of teachers and grades as well as for judging different methods of teaching. For any one of these purposes the author suggests the following form:

STANDARD SCORE CARD FOR THE MEASUREMENT OF HANDWRITING

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
---------- 3															
2. Slant ---------- 5															
Uniformity Mixed															
3. Size ---------- 7															
Uniformity Too large Too small															
4. Alignment ---------- 8															
5. Spacing of lines---------- 9															
Uniformity Too close Too far apart															
6. Spacing of words----------11															
Uniformity Too close Too far apart															
7. Spacing of letters----------18															
Uniformity Too close Too far apart															
8. Neatness ----------13															
Blotches Carelessness															
9. Formation of letters----------(26)															
General form---------- 8															
Smoothness ---------- 6															
Letters not closed---------- 5															
Parts omitted---------- 5															
Parts added---------- 2															
TOTAL SCORE----------															

It can also be used as a permanent record for the grades of pupils in writing. For such a purpose it would probably be best to make it the same size as the white card recommended by the United States Bureau of Education. For such a purpose the following abbreviated form is recommended:

Pupil_____ Age_____ Grade_____

	Values	1st mo.	2nd mo.	3rd mo.	4th mo.	5th mo.	6th mo.	7th mo.	8th mo.	9th mo.	10th mo.
1. Heaviness	3										
2. Slant	5										
3. Size	7										
4. Alignment	8										
5. Neatness	13										
6. Spacing of											
Letters	18										
Words	11										
Lines	9										
7. Formation of letters	(26)										
Smoothness	6										
General form	8										
Parts added	2										
Parts omitted	5										
Letters not closed	5										
TOTAL SCORE											

Another important use which suggests itself for the score card is in making a careful and detailed study of the writing of a single individual. Such a clinical study is often highly desirable when a pupil does not make proper progress in writing.

The scoring of a sample of handwriting by means of the score card is a simple process. If the score for slant is desired from the value shown in the last mentioned form, it is only necessary to examine the sample carefully for uniformity and degree of slant and then to assign a value in accordance with this examination. The scoring for any other point is similar to this.

OBJECTIONS TO THE SCORE CARD.

In addition to the objections which have already been suggested no doubt others will be urged. Some will argue that the time required for grading by it is a decided disadvantage.

This will doubtless be true when a teacher begins the use of the method, but some preliminary experiments by the author show clearly that a very little practice reduces the time required for the use of the score card very much. It is possible that the extra time required will give more accurate results. If such should prove to be true, its advantage would be established.

Others may argue that such grading will be formal in every respect, and so no better than the usual grading. If such is the case, it cannot be used as an objection to the method, but rather against the person who uses it.

The last objection to be noticed is that the grading of any single point such as slant harks back to the old percentile method. The only answer which need be made to this is to call attention to the very accurate and scientific work done by the agriculturalists in work very similar to this.

EXPERIMENTAL WORK WITH THE SCORE CARD.

The problems which it is possible to attack by means of the score card are many, and only a few can be mentioned in addition to those suggested in the preceding pages.

One of the most interesting problems in connection with the score card is the effect it will have upon the grading of teachers. This problem has been studied by Kelly (10) for other methods of grading, and it is hoped that the present method can be compared with all other methods in the near future. Another problem might deal with the effect of practice in the use of the score card. This problem has been dealt with by the author (7) in connection with the Ayres Scale, and the same general plan should be used with the score card.

Still another problem is suggested by certain training given in agricultural courses known as judging. Briefly, this means that after a student has been trained for a considerable period of time in the use of the score card he is then given the problem of judging. In judging he evaluates the product without the aid of the score card. In the same manner it would be very interesting to train, say, six judges in the use of the score card, and then allow three of them to judge the writing while the other three continued the use of the score card. If such

training will produce experts in the judging of handwriting it would be worth while.

The table of correlations on page 40 suggests another very interesting problem. This table indicates clearly that several of the elements correlate with general merit in about the same degree. From this it may be argued that all the elements here proposed are not needed in order to get an accurate measurement of handwriting. The first regression equation used gives values which could be put in score card form. A comparison of grades gotten by means of such an abbreviated form and the forms already proposed gives a basis for some very interesting work.

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