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A STATISTICAL STUDY OF THE RELIABILITY OF
SCALE GRADING

by

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INTRODUCTION

The purpose of this paper is to determine the reliability of a series of grades obtained by the use of the Ayres Measuring Scale for Handwriting. In order to make clearer the meaning of the results of the study, which are given in terms of the scale, a brief description of the scale and also of the samples graded, will precede the report of the study itself.

The Ayres ¹ scale was constructed by measuring the speed of reading of a large number of samples of childrens' writing by ten different persons. Eight degrees of legibility are represented by typical samples selected from the entire number graded by the ten persons. The eight steps are supposed to be equal and are designated by 20,30,40,- 90. Each step has three styles of writing of approximately equal quality. The three styles of writing are vertical, medium slant, and full slant. Though the scale was constructed on the basis of legibility, in practice it is used, just as is the Thorndike ² scale, to measure the quality of a sample rather than its legibility alone. To grade a sample one is instructed to "slide it along the scale until a writing of corresponding quality is found."

1. Ayres, L.P., A Scale for Measuring the Quality of Handwriting of School Children.

2. Thorndike, E.L., Handwriting, Teachers College Record Vol II No. 2 March, 1910.

The samples, upon which this study is based, were obtained from writing tests that were given in connection with a public school survey of a city of about eight thousand inhabitants. The writing tests were given April 3, 1916 to all pupils in school on that particular day in grades I to IX inclusive of all the schools of the city. To secure uniformity, in so far as possible in the work, duplicate copies of carefully worked out instructions for giving the tests were given to each of the grade teachers. Ruled paper of a uniform size and quality was used by all of the pupils. Writing was done in ink in all grades except the first three. The children, after having written their name, age, the school and the grade or division of a grade in which they were enrolled respectively, and the date, were to write repeatedly the sentence " Mary had a little lamb" from the time that they were told to begin until they were told to stop. All members of a class were to begin together and to stop promptly at the end of exactly two minutes.

The samples were collected by classes, with the names of the children in a class arranged in alphabetical order and with the name of the teacher, the name of the school and of the grade written on the top sheet of each bundle. The samples for all of the classes of one school were further bound together into one large bundle. There were in all five of these bundles representative of the five schools of the city. There were 1,248 samples collected and graded. These were the papers for sixty-eight classes. However of this number the grades for seventeen classes were lost; thus leaving the marks or grades for fifty-

one classes with a total of 936 pupils distributed according to school grades as shown in the following table.

Table I

Distribution of Pupils in Grades and by Classes in Each School

Grade	I	II	III	IV	V	VI	VII	VIII	IX	Special	Total
School A	9	11	10	7	9	7			4		57
School B		18	16	16	19	18	25	17		12	
" "			33			31	27	30			
" "			15								
" "			33								310
School C	28	28		33	21	15	24	26			
" "		12			20	21	12				240
School D		12	20	21	9	16					
" "						12					90
School E		22	10	18	16	16	19	25			
" "		10	23		22	12	15				
		28									239
Total a	37	141	160	95	116	151	122	98	4	12	936
Total b	2	8	8	5	7	9	6	4	1	1	51

In the above table the five schools of the city are designated by the letters A, B, C, D, and E. The totals marked " a " and " b " refer to the number of pupils and to the number of classes respectively in each grade. The first horizontal line of the table is to be read: School A had one class of 9 pupils in Grade I, one class of 11 pupils in Grade II, one class of 19 pupils in Grade III, etc. with a total of 57 pupils.

The samples were scored for both speed and quality. The speed of writing was determined by counting the number of letters written in two minutes time by each pupil. The quality of a sample was measured by comparing it with the Ayres scale and determining to

what step in the scale it was nearest. If the sample was not nearly as good as quality 40 on the scale but as good or a little better than quality 30 it was given a mark 30 by the grader. The only exception to this was in the grading of two or three individuals in a few cases in the three lower grades, where five point steps were used instead of ten as given on the scale; thus if a sample was thought to be not as good as 40 but quite a bit better than 30, these graders gave it the mark 35. However it was thought that these few gradings using the five point step would not vitiate the results of the study.

The 936 samples were each graded by twenty-one individuals, making a total of 19,656 marks. These twenty-one persons, who did the grading, were members of a class in Statistical Measurements in Education in the University of Missouri during the Summer Session of 1916. All but one of the twenty-one had taught either in public school or elsewhere. In the class little time had been devoted to the study of either the Ayres or the Thorndike scale. No samples had been graded in class previous to the grading of this set.

The grading was done independently of course. Each grader recorded the marks he had given the samples belonging to a class on a separate sheet of paper from the other graders so that no grader knew what other mark had been assigned to a particular sample. The twenty-one ratings of a class were then all copied by one person on a single sheet of paper. At the top of each sheet was written the name of the school, the grade or division of a grade and the teacher's name. Just below this in a horizontal array were written the names of the twenty-one graders in alpha-

betical order. To the left and in a vertical column was written the names of the pupils, likewise in alphabetical order. In the column adjacent to the names of the pupils was recorded the number of letters written by each pupil. In the succeeding columns were recorded the marks of the graders under their respective names for the pupils in the order in which their names were written. Finally to the right and at the bottom of the page were given the the medians and the arithmetic mean respectively of each pupil and of the class by each grader, together with the four averages of the averages. The ^{arith.} mean of the mean is taken in this study as the "true grade" of the class; and the mean grade of a pupil as the "true grade" of the pupil. On the following page in Table II is given a typical page of grades with the exception that capital letters have been substituted in place of the names of the graders and small letters in place of the names of the pupils. The median grades were not used in any of the computations of the study.

With the above described data at hand the problem of this paper may be outlined as follows:

(a). To study the variation of marks in classes in the various school grades.

(b). To study the reliability of a mark for a class and also for an individual belonging to a class in

(1). Any grade chosen at random.

(2). Each of the eight grades.

(c). To study the reliability of the graders

(d). To criticise the Ayres scale from the facts brought out in (a). (b). and (c).

Table II

A Typical Page of Marks of the Twenty-one Graders for a Class

----- School						Grade II																		----- Teacher			
	No of Letters	A	B	C	D	<i>grades</i>																		Mean			
						E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U					
a	56	20	20	20	20	20	20	20	20	20	20	20	20	20	30	20	20	20	20	20	20	20	20.5				
b	38	20	30	20	20	20	20	20	30	20	20	20	20	30	30	20	20	10	20	20	20	20	21.4				
c	60	30	30	20	30	30	30	30	40	30	30	30	30	30	30	30	30	30	30	30	30	30	30.0				
d	31	30	20	20	30	20	20	30	30	30	30	20	20	20	30	30	30	20	30	30	30	20	25.7				
e	36	30	30	30	30	30	30	30	40	30	30	30	30	30	30	30	30	20	30	30	30	30	30.0				
f	72	20	30	20	20	20	20	20	30	20	20	20	20	20	30	20	30	20	30	20	20	20	22.4				
g	99	20	40	30	30	20	30	30	30	20	20	30	20	30	30	20	20	20	30	20	20	20	25.2				
h	54	20	20	20	20	20	30	30	20	20	20	30	20	30	30	20	20	20	20	20	20	20	22.9				
i	90	30	30	30	20	10	20	20	40	30	30	20	20	20	30	30	20	10	30	20	30	20	24.3				
j	84	20	20	20	20	10	20	20	30	20	20	20	20	20	30	20	30	10	20	20	20	20	20.5				
k	33	30	30	30	30	30	30	30	40	30	30	30	30	30	30	30	30	30	30	30	30	30	30.5				
Mean	61	24.5	27.3	23.6	24.5	21	24.5	25.4	31.8	24.5	24.5	24.5	22.7	25.5	30	24.5	25.4	19.1	26.4	23.6	24.5	22.7	24.8				

Chapter I

VARIATION OF THE MARKS OF PUPILS IN THE EIGHT SCHOOL GRADES

In Table III, the distribution according to quality of the samples belonging to each of the fifty-one classes by steps of five units each, is given. The last three columns to the right of the table contain the number enrolled, the average quality, and the average number of letters written in two minutes, respectively, for each of the classes. The classes are arranged by grades, and for each grade the distribution by numbers and also ~~also~~ by percentages, is given. On account of their great length, Table III and also Table XI are placed at the end of the study.

From Table III one is impressed with the wide variation of the marks of the classes in a grade and also with the variation of marks of pupils within a class. For instance, in a class of 31 pupils in Grade VII of School B, the quality varies from 17 to 53 units as measured on the Ayres scale. This range of 36 units is approximately one and a half times the difference between the averages of Grades I and VIII. Equally wide ranges exist in other classes belonging to different grades.

Another class in Grade VI has an average no better than the average of the entire second grade. The small improvement in quality of one grade over the preceding one is also seen from Table III. Probably this is better illustrated by means

of Graph 1, which contains the histograms of quality of each of the eight school grades. The averages of the successive grades are denoted by red lines. The average of Grade II is 29.0; that of Grade III is 29.1. Thus there is a difference or a gain of only a tenth of a unit or one one hundredth of a step on the Ayres scale, neglecting the probable errors of the two averages. The gain in speed however is 27 letters per minute considering the same two grades.

It is seen that the difference between the averages of Grade I and Grade VIII, which are 24.5 and 44.5, respectively, is twenty units. This makes an average improvement of less than three units or three tenths of a step between the successive grades. This improvement is very much less than it should be according to the standard proposed by Starch³ after an examination of samples of writing from nineteen schools from Grades II to VIII inclusive. His standard requires an average improvement of five units or one half of a step as measured on the Ayres scale, per grade. Freeman⁴, in an examination of samples from fifty-six cities, found an average improvement of four units or two-fifths of a step per grade, considering the upper half of samples in each grade.

Tables IIIa and IV are summaries of results obtained from Table III. Table IIIa is simply a statement of the average quality and speed for each of the eight grades and

3. Starch, D., Ed. Measurements, 1, p. 83.

Journal of Ed. Psych. Vol. IV, p. 445.

4. Freeman, F.N. Fourteenth Yearbook, Part I, chapter V, p. 76

of the entire school as judged from the 936 samples.

Table III a

Average Quality and Speed of Each of the Eight School Grades
and the Entire School

Grade	I	II	III	IV	V	VI	VII	VIII	^{Average} Total
Quality	24.5	29.0	29.1	31.1	35.0	36.0	40.9	44.5	33.3
Speed	18	23	50	69	69	70.5	70.5	73	59.5

Table IV gives a more detailed summary of Table III. It contains the highest and lowest quality in each of the grades, the number of pupils ~~in each grade~~, the average, the standard deviation, and the probable error of each grade. The calculations for Grades IX and VI and VII Special are not tabulated since the average and the standard deviation of each is not at all reliable due to the fact that there were only four and twelve students enrolled in them. The total however includes both Grade IX and Grade VI & VII Special in Tables IIIa, Table IV and all Tables that follow. The number enrolled in each grade is given to enable one to calculate the probable errors in the results given.

From this table and also from Graph I, one sees the overlapping of quality in the successive grades. Another thing to be noted is that the range of quality increases with successive grades, with the exception of Grades VI and VIII; the standard deviation likewise increases with successive school grades with the exception of the three grades, namely,

Quality of Writing of the Eight School Grades.

A Summary of the Distributions by School Grades of the Deviations of the True Marks* of Individual Samples from the Mean of the Grade to Which the Samples Belong.

Grade	I	II	III	IV	V	VI	VII	VIII	Total
No. of Pupils	37	141	160	95	116	151	122	98	936
Highest Mark	34	43	41	43	58	53	66	62	67
Lowest Mark	15	13	19	13	19	17	23	23	13
Arith. Mean	24.5	29.0	29.1	31.7	35.0	36.0	40.9	44.5	33.3
Standard Dev.	4.7	5.3	5.0	6.3	7.6	6.9	8.0	7.9	6.6
P.E.	3.2	3.5	3.3	4.2	5.1	4.6	5.4	5.3	4.5

Grades III, VI and VIII, each of which show a slight decrease over the grades just preceeding. The person receiving the highest mark in the first eight grades was enrolled in Grade VII. The one receiving the lowest, in Grade II. The highest mark given in the entire school was 67 units. This mark was given in Grade IX. The range for the entire school was found to be 54 units.

In Table V are given the distributions of the deviations of the true marks of individuals from the true mark of the class to which they belong; these deviations are arranged by school grades. In considering the deviations from the average of a class rather than from the average of the entire grade, the measurements are rendered more nearly homogeneous, by eliminating the effect due to differences in instruction by different teachers. It is true that the same person supervised the writing of the entire school system. But the regular teacher of one class of a grade might stress speed,

* Results in Table IV were calculated from the original gradings sheets, where marks are given to tenths of a unit instead of the distribution by steps of five units each.

** True mark of a class and of an individual were defined in the introduction, page 5.

Table V

Distribution by School Grades of Deviations of True Marks of
Pupils within the Fifty-one Classes

Dev.	I	II	III	IV	V	VI	VII	VIII	IX	Sp.	Total
21								1			1
19							1				1
18					2		1				3
17						1	1				2
16							2				2
15						1	3	2			6
14						1	2	1			4
13					1			3			4
12			2	1	3	3	5		1	1	16
11		1	1	2	4	4	3	3			18
10			3	3	3	2	2	1			14
9			3	2	1	6				1	13
8	1	5	2	3	3	3	3	3			23
7	1	1	3	4	5	6	1				21
6	2	9	7	3	2	7	5	5		1	41
5	1	10	8	3	4	5	5	6			42
4		10	8	3	2	10	8	4			45
3	5	3	10	8	5	9	10	1		2	53
2	4	7	8	7	14	7	6	1			54
1	4	13	17	4	3	5	3	12			61
0	3	10	16	9	6	8	6	5		2	65
-1	2	17	11	8	8	9	6	6		1	68
-2	3	19	10	6	8	4	3	6	1	2	62
-3	3	14	13	5	6	12	4	6	1	1	65
-4	1	7	13	7	11	10	5	4			58
-5	1	8	7	4	6	11	6	6			49
-6	3	2	7	3	2	8	4	7			36
-7	1	3	3	3	1	4	6	6	1		28
-8	1	1	5		3	9	8	2		1	30
-9				2	1	1	3				7
-10			3		3	3	4				13
-11	1	1		1	4	1	2	2			12
-12					2	1	2	1			6
-13				3	2						5
-14				1	1			3			4
-15								1			2
-16							1				1
-18							1				1

while another teacher of the same grade might put more emphasis upon quality of writing. This difference is at least partly overcome by the method stated in the beginning of this paragraph.

Table VI is a summary of Table V. The total number of pupils in each grade, the median, the 25 percentile, the 75 percentile, the quartile, the standard deviation and the probable error of the deviations of each of the eight school grades and for the entire school are given in this table.

Table VI

A Summary of the Distributions by School Grades of the Deviations of the True Marks of Individual Samples from the True Mark of the Class to Which the Sample Belongs.

Grade	I	II	III	IV	V	VI	VII	VIII	Total
No. of pupils	37	141	160	95	114	151	122	98	936
25 percentile	3.5	5.0	3.8	4.9	2.7	5.3	6.0	4.8	4.5
Median	1.0	2.6	3.5	0.0	0.0	1.5	1.6	1.2	2.2
75 percentile	2.3	2.8	2.8	3.7	2.3	4.0	3.5	4.5	4.1
Quartile	2.9	3.9	3.4	3.8	2.6	4.6	4.7	4.6	4.3
P.E.	3.3	2.8	3.2	4.1	4.0	4.6	5.2	4.7	4.1

From the above table it is seen that the deviations of individual marks from class marks also increase with the successive higher school grades. The only exception here is in Grades II, III and VIII. Grade II has a standard deviation equal to that of Grades VII. Grade I and III have the same standard deviation as has also Grades VII and VIII. Graph 2, which gives the percentage distribution of the deviations of the true marks of individuals from the class marks to which the respective pupils belong, shows quite distinctly the wide variation of quality in each of the eight

Percentage Distribution of Deviations of True Marks of Pupils from
True Marks of Classes to Which the Pupils Belong

grades.

A study of the foregoing tables shows that there are individuals in most classes that might clearly just as well belong to a grade above or below the one in which they are enrolled in so far as quality of writing is concerned. It is seen from Table III that there are entire classes that might interchange grades. It has already been pointed out that there was one class in the sixth grade whose average in quality of writing was no higher than the average quality of the entire second grade. Two classes in Grade II have a higher average than the average of the entire fourth grade. However it should be noted in this connection that although the quality of writing in the classes enrolled in the higher grades just mentioned is no higher than that of classes in the second, the speed of writing is very much greater in the upper grades.

Chapter II

THE RELIABILITY OF A MARK OF AN INDIVIDUAL AND OF A CLASS

To determine the reliability of the mark for an individual pupil as well as to determine the reliability of grading of an individual grader, it was necessary to calculate the deviations of the marks assigned to each sample by each of the twenty-one graders from the true mark of each of the samples. There were in all 936 samples each graded once by each of the twenty-one graders; so there were 19,656 deviations. In making this study the first thing that was done was to tabulate these deviations by classes. Fifty-one sheets corresponding to the original grading sheets of the fifty-one classes were made out with the deviations from the true mark of each sample written in place of the mark itself, which was assigned by each of the twenty-one graders. In other respects these sheets were exactly similar to the original grading sheets, of which Table II is a sample.

From these sheets a frequency-distribution of deviations of each grader for each of the school grades was made out. The five schools were not kept separate in the study since the number of samples in each was so small as to render the results more unreliable than if totals for each grade were considered together. The distributions of the total deviations from the true marks in each case of individual marks assigned by the twenty-one graders for each of the school grades is given in table VII. In this table is given also the percentage distribution of the deviations in each of the school grades;

11 10	9	1	22	1	48	1	21	1	37	2	53	1	48	2	41	2	3	1	202	1		
9	23	3	94	3	81	2	53	3	74	3	74	2	58	2	33	2	9	4	492	1		
4	28	4	189	7	163	5	72	4	63	3	143	4	135	5	68	3	21	8	882	4		
3	18	2	196	7	99	3	114	6	97	4	153	5	88	3	121	6	20	24	17	7	923	5
2	54	7	162	6	214	6	122	6	72	3	92	3	145	6	116	6	12	5	989	5		
1	110	14	194	7	379	11	125	6	183	8	148	5	86	3	118	6	23	9	1366	7		
0	53	7	317	11	351	11	190	10	255	10	288	9	222	9	137	7	14	6	1827	9		
-1	70	9	305	10	271	8	218	11	352	14	312	10	151	6	89	4	23	9	1791	9		
-2	53	7	126	4	197	6	192	10	172	7	262	8	197	8	90	4	10	12	1299	6		
-3	67	8	180	6	227	7	143	7	148	6	224	7	93	4	78	4	8	10	1168	6		
-4	28	4	105	3	211	6	66	3	171	7	221	7	157	6	172	6	15	6	1146	6		
-5	28	4	157	5	130	4	72	3	116	5	142	4	147	6	109	5	12	14	907	5		
-6	16	2	125	4	145	4	67	3	47	2	142	4	157	6	74	4	27	11	800	4		
-7	8	1	101	3	49	2	83	4	81	3	103	3	63	2	104	5	12	14	621	3		
-8	23	3	44	2	85	3	64	3	50	2	59	2	111	4	100	5	9	4	545	3		
-9	19	2	48	2	85	3	28	1	37	2	68	2	52	2	82	4	8	3	427	2		
-10	5	1	31	1	32	1	21	1	38	2	47	1	65	2	23	1	2	1	264	1		
-11	9	1	30	1	17	1	15	1	33	1	32	1	46	2	18	1	8	3	208	1		
-12	2	0	6	0	5	0	11	1	10	0	28	1	25	1	27	1	4	5	120	1		
-13	5	1	12	0	20	1	10	1	8	0	19	1	13	1	15	1	3	4	105	1		
-14	3	0	11	0	8	0	3	0	6	0	8	0	6	0	27	1	4	2	76	0		
-15			11	0	3	0	1	0	4	0	3	0	6	0	4	0	1	0	32	0		
-16			7	0	4	0			10	0	1	0	5	0	7	0	1	0	26	0		
-17			3	0	1	0					1	0	2	0	3	0	2	2	12	0		
-18			2	0	1	0							5	0	1	0			10	0		
-19			1	0			2	0					3	0	4	0			10	0		
-20			2	0	1	0							1	0					4	0		
-21			1																1	0		
-22					1	0	1	0					1						3	0		
Total	777		2961		3360		1995		2436		3171		2562		2058		84		252		19656	

Table VII

Distribution of the 19656 Deviations by School Grades

Grade	I	II	III	IV	V	VI	VII	VIII	IX	SP.	Total
Dev.	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %	No. %
38						1 0					1 0
32							2 0			1 0	3 0
31				1 0							1 0
29					1 0						1 0
28							1				1 0
27					1 0	1 0	1 0	3 0			1 0
26					1 0	1 0	1 0	3 0		1 0	7 0
25		22 00			2 0	2 0	1 0	3 0			10 0
24		11 00			1 0	4 0	4 0	1 0		1 0	12 0
23			1 0	3 0	3 0	2 0	6 0	2 0			17 0
22		2 0		2 0	2 0	1 0	3 0	5 0			15 0
21		1 0			1 0	1 0	5 0	1 0		1 0	10 0
20			1 0		7 0	8 0	9 0	4 0		1 0	30 0
19			2 0	3 0	7 0	12 0	12 1	6 0		1 0	43 0
18		6 0	4 0	6 0	8 0	17 1	13 1	9 0	1 1		64 0
17		9 0	8 0	8 0	17 0	16 1	9 0	10 1	1 1		68 0
16	11 00	2 0	6 0	3 0	10 0	16 1	18 1	27 1		1 0	84 0
15		5 0	8 0	5 0	11 0	9 0	28 1	12 1			78 0
14	1 0	8 0	17 1	7 0	9 0	21 1	30 1	16 1		4 2	113 1
13	4 1	17 1	8 0	12 1	16 1	15 0	12 1	18 1	4 5	7 3	113 1
12	16 2	9 0	14 0	14 1	5 0	20 1	44 2	32 2		3 1	157 1
11	8 1	19 1	48 1	14 1	9 0	27 1	12 1	25 1		4 2	166 1
10	9 1	22 1	48 1	21 1	37 2	53 1	48 2	41 2		3 1	282 1
9	23 3	94 3	81 2	53 3	74 3	74 2	58 2	33 2		9 4	492 3
4	28 4	189 7	163 5	72 4	63 3	143 4	135 5	68 3		21 8	882 4
3	18 2	196 7	99 3	114 6	97 4	153 5	88 3	121 6	20 24	17 7	923 5
2	54 7	162 6	214 6	122 6	72 3	92 3	145 6	116 6		12 5	989 5

and also of the entire school. The percentage distribution follows immediately after the distribution of numbers in each grade. In table VII too, we see an extremely wide range of deviation; the twenty-one graders show a wide difference of opinion as to the quality of a sample. However the range in the lower half of the school is not ~~as great as~~ in the upper half.

Graph 3 shows the distribution of deviations from the true marks, of the marks assigned by each of the twenty-one graders for the entire school. Though the curve is slightly irregular in shape it is seen to be a fair approximation to the normal error curve. The graph was plotted from the figures given in next to the last column of table VII. Had the points of division been less finely made in the tabulation of the deviations, or in drawing the graph some of the irregularities of the figure would have disappeared. Also had a larger number of samples been considered no doubt the curve would have been a closer approximation to the probability curve.

Table VIII is a summary of table VII. It should be noted here that the calculations in this table as well as those of tables IV are made on the assumption that the curve is ^{approximately} a normal error curve. Otherwise the results have no meaning. As a matter of fact not enough measurements were made to make ^{the} results of tables VI and IV very reliable. The reliability of these tables will be discussed in greater length in the last chapter of this paper. In Table VIII the errors of the average and of the standard deviation of the deviation are small since in no case was the number of measurements less than 777.

Frequency-distribution of 19,656 Deviations of

Individual Marks

Vertical- number of samples

Horizontal- deviations of marks in units on Ayres scale

The error of the average and of the standard deviation obtained in any one of the tables can be calculated easily from formulae given in Yule's Introduction to the Theory of Statistics.⁵

$$\left. \begin{array}{l} \text{Standard error of} \\ \text{standard deviation in a} \\ \text{normal distribution} \end{array} \right\} = \frac{\sigma}{\sqrt{2n}} \quad (1)$$

In this formula σ represents the standard deviation of the deviation, and n is the total number of measurements in the distribution. The above formula has a meaning only when the frequency-distribution follows the normal form.

The standard error⁶ of the average, or, to be more exact, the standard error of the arithmetic mean, is given by the following formula and has a meaning no matter what the form of distribution is.⁷

$$\sigma_m = \frac{\sigma}{\sqrt{n}} \quad (2)$$

In this formula σ and n have the same meaning as in (1).

σ_m means the standard deviation of the arithmetic mean.

The probable error is found by multiplying the standard error by .6745 in each case.

The probable error of the average and of the standard deviation of the deviations of the marks from the true marks in grade I are ± 1.13 and ± 1.09 respectively. For the other school grades the errors of both measures, since the values of n are in all cases greater thanⁱⁿ grade I, are not greater than those of

5. Yule, G. U. Statistics. (12) pp. 351.

6. " " " " (5). p. 344.

7. " " " " 1.23-27. p. 344.

Grade I even though the standard deviation does increase with successive grades. Hence in Table VIII the errors of the average and of the standard deviation may be neglected without seriously affecting the results of the study.

The important thing to be seen from Table VIII is the reliability of a mark of a pupil belonging to any one of the eight grades or of a pupil taken at random in the school. The chances that the mark assigned by any one of the twenty-one graders to a pupil chosen at random from the school at large, will differ by 3.7 units from the true mark of the sample are one to two. Stated in other words fifty percent of the deviations were more than 3.7 units from the true marks and fifty percent were less than or equal to 3.7 units from the true mark. The chances are approximately two to three

Table VIII

A Summary of the Distributions of Deviations of the Marks Assigned by each of the Twenty-one Graders from the True Marks of Individual Samples.

Grade	I	II	III	IV	V	VI	VII	VIII	Total
No. of Marks	777	2961	3360	1995	2436	3171	2562	2058	19656
Largest Dev.	16	25	23	31	29	38	32	26	38
Smallest Dev.	14	21	22	21	16	17	22	19	22
Range	30	46	45	52	45	55	54	45	60
25 percentile	3.9	3.7	3.3	3.0	3.1	3.6	4.0	4.1	3.4
Median	.5	.0	.0	.5	.7	.7	.7	.4	.4
75 percentile	2.7	3.4	3.3	3.1	3.3	3.9	5.0	5.4	4.1
A.D.	4.1	4.2	4.1	4.3	4.2	4.6	5.5	6.0	4.6
Standard Deviation	5.3	5.5	5.4	5.7	5.9	6.3	7.1	7.3	5.6

Table IX

Distribution by School Grades of Deviations Of Class Marks of
Graders from the True Class Marks

Dev.	I	II	III	IV	V	VI	VII	VIII	Sp. IX	Total
18.5							1			1
17.0						1				1
16.5		1	1					1		3
15.0					1					1
13.0					1					1
12.5				1			2			3
12.0						1	2			3
11.5						1	1	1		3
11.0						2	2	2		6
10.5								1	1	2
10.0						1				1
9.5			1			1				2
9.0				1					2	3
8.5			1	1	3	3	1			9
8.0			2	1				1		3
7.5	1	1				3		2		7
7.0		1		2	2	1	2	1	1	10
6.5		2	3	2	2	3	2	1		15
6.0			1	1		3	1	1		7
5.5	2	8			2	1	1	2	1	17
5.0	1	5	3	2	2	2	1			16
4.5	2	6	8	1	2	3	2	2	1	27
4.0	2	7	4	1	5	1	1	2	1	24
3.5		8		1	4	10	3	3		29
3.0	1	3	9	5	6	4	5	1	1	39
2.5	6	8	8		3	5	4	2		36
2.0	1	9	8	6	5	4	3	4		42
1.5	2	5	7	4	8	4	4	2	2	38
1.0	2	13	13	2	6	15	8	4	1	64
.5	2	12	14	11	14	9	6	3		74
-.5		18	12	9	20	9	5	5	2	80
-1.0	2	6	12	6	3	7	6	1	1	44
-1.5	7	9	9	13	10	17	9	2		76
-2.0	1	3	12	5	8	24	13	5	2	75

Table IX cont.

-2.5		7	9	6	7	10	7	9	3	1	59
-3.0		1	8	10	8	8	6	5			46
-3.5	55	10	7	2	7	11	3	4	2		51
-4.0		7	5	4	6	8	6	4			40
-4.5	1	9	4	2	3	5	7	2		1	34
-5.0	1	1	2	1	4	7	1	5	1		23
-5.5		2	1	2	2	4	5	1			17
-6.0	2	2	1		2	1	2	3			13
-6.5	1		1	1				1	1		5
-7.0							1			1	2
-7.5			1	1	1		3		1		7
-8.0											
-8.5			1								1
-9.0								1			1
-9.5		1								1	2
-10.0		1									1
-10.5		2									2
-11.0				1							1
Totals	42	168	168	105	147	189	126	84	21	21	1071
Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total

Graph 4

— Deviations of Class Marks of Graders Distributed by School Grades ²⁴

that the mark of the sample will deviate less than 5.6 units from the true mark. In chapter IV of this study Table XV gives the various chances in a thousand that the mark of an individual will differ from the true mark by not more than 1, 2, 3, 4, 5 and 6 units respectively. Chances are computed for each of the eight school grades.

In the tabulations considered so far in this chapter, the deviations of marks of individual pupils were dealt with. Table IX and X are tabulations of class marks analogous to Tables VII and VIII. Graph 4 is a pictorial representation of the frequency distribution of the deviations of class marks assigned by the graders from the true class marks for each of the grades and also for the entire school. Each of the dots in the figure represents a deviation and the magnitude of the deviation is represented by the horizontal distance of the dot from the vertical line denoting zero. The steps are one half unit each. In each case the distribution has roughly the shape of the normal curve.

Table X

A Summary of the Deviations of Class marks Assigned by Each of the Twenty-one Graders from the True Class Marks.

Grade	I	II	III	IV	V	VI	VII	VIII	Total
No. of Dev.	42	168	168	105	147	189	126	84	1071
25 percentile	2.8	2.9	2.3	1.8	2.1	2.5	2.3	2.8	2.9
Median	.2	.9	.4	-.77	.72	-1.0	-1.2	-1.0	-1.1
75 percentile	-2.7	-2.6	-2.4	-2.8	-2.2	2.7	2.6	3.1	2.6
Quartile	2.8	2.8	2.4	2.3	2.2	2.7	2.6	3.1	2.6
A.D.	3.0	2.9	2.8	2.8	2.7	3.2	3.4	4.3	2.8
Standard Dev.	3.3	3.8	3.4	3.7	3.6	4.0	4.6	4.6	3.8

The summary given in Table X shows that there is less variation in the deviations of class marks than in the deviations of marks of individuals. One might naturally expect this to be true, since in grading a class, the tendency on the part of the grader is to grade some samples above the average and others below the average, thus making the average of the class deviate less from the true class average than it would have, had all of the grades been above or all below the average. The total number of deviations of class averages considered was 1071, or the grades assigned by twenty-one graders to the fifty-one classes. The standard deviation of this distribution of deviations was found to be 3.8 as is shown in the last row and last column of Table X. The probable error of the distribution is found by multiplying the standard error by .6745 as is explained in Yule's Introduction to the Theory of Statistics, Chapter XV, page 310. In a distribution represented by the form of a normal error curve, one half of the area under the curve is included between $\pm .6745$ times the standard deviation. The .6745 times the standard deviation has no meaning however unless the distribution is a normal one. The P.E. of the deviations of the class averages is roughly 2.6. Or expressed in other words the chances that the deviation of a class ≤ 2.6 is one half. It is seen from the standard deviations of the deviations by school grades given in Table X that the variation of marks of individuals in the upper grades is greater than in the lower grades. The same thing was found true of class marks.

Chapter III

THE RELIABILITY OF THE MARKS OF EACH OF THE TWENTY-ONE GRADERS

In the preceding study, in chapter II, the reliability of a mark assigned by any one of the twenty-one graders, chosen at random, to a pupil and to a class have been found. In this study the reliability of each of the graders taken separately has been calculated for each of the eight school grades and for the school as a whole. The frequency distribution of deviations for each of the graders is given in Table XI. A summary of table XI is given in table XII, which contains the distribution of the total 936 deviations for each of the graders. Table XII differs from table VII in that in the latter the distributions for each of the twenty-one graders is given, while in the former the distributions are by school grades. From this table the results of Table XIII have been computed. The 25 and 75 percentile, the median, the mean, the quartile, the standard deviation and the probable error of the deviations of each of the graders for the entire school are given in the last named table. (XIII).

A more detailed study of each of the graders was made from the data given in table XI; the average and the standard deviation of each of the graders for each of the school grades including Grade IX and Grade VI and VII Special have been calculated and are included in tables XIV and XV. The averages of Grade IX and Grade VI and VII Special were included so as to be able to check the averages of the totals easily. However it is to be remembered

Table XII

Deviations of Each of the Twenty-one Graders' Marks from the True Marks of 936 Samples

Dev.	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	Total
-38																						
-32								1									1					1
-31																	1					1
-30																						
-29																	1					1
-28								1														1
-27					1																	1
-26					3			1									3					7
-25					4										1		2		1	1	1	10
-24					5			1							1		2			1	2	12
-23					5			2			1						5	2		1	1	17
-22					3		1	3					1		2		2	1		1	1	15
-21					3			1							1		3	2				10
-20					12			5	1						1		7	2	1		1	30
-19				1	15			10					3	11			4	6	1		2	43
-18		1	3		23	1	1	5	1	1			1	1	2	2	8	6	5	2	1	64
-17			1	1	18	1	2	10		2		1	2	1	5	2	5	10	5	2	2	68
-16	1	3	1		22		1	10	1	1	2	1	2	1	2	1	10	8	7	3	7	84
-15		3	2		16		1	19	1	2			3			2	7	10	3	4	5	78
-14	3	2	3	1	20	1	3	21	1	1	1	3	7	1	2	2	9	14	4	6	8	113
-13	1	2	5	2	18	1	3	11	1	1	3	1	5	2	6	2	17	23	10	3	6	113
-12	2	5	2	1	26		1	24	1	4	3	5	6	6	5	7	12	18	12	8	9	157
-11		2	3		18	1	1	25	4	8	9	4	13	8	5	4	8	21	18	5	9	166
-10	4	10	8	5	47	3	3	48	4	2	5	6	22	8	11	11	22	27	21	6	9	282
-9	14	25	14	11	49	5	10	56	16	19	10	13	29	26	21	17	27	54	36	25	22	499
-8	23	23	11	9	31	6	14	47	12	17	13	15	20	13	9	11	32	42	28	10	12	398
-7	26	23	24	12	30	5	16	50	10	22	25	15	40	18	31	33	25	54	39	25	29	552
-6	21	34	21	12	32	11	15	48	19	20	21	16	41	19	25	27	28	51	29	23	25	538
-5	37	38	33	34	37	25	25	58	34	36	32	39	42	39	45	42	46	62	54	28	44	830
-4	45	48	23	37	41	23	40	53	28	41	46	42	48	35	48	43	44	60	64	40	33	882
-3	48	50	36	42	38	44	37	50	33	49	46	49	52	36	39	42	41	49	60	41	41	923
-2	55	58	55	55	36	52	46	39	42	44	44	50	48	40	44	44	47	49	55	42	44	989
-1	77	66	63	78	60	81	82	63	56	64	60	63	48	54	62	76	59	64	63	66	61	1366
0	108	97	100	91	40	80	71	45	101	113	110	106	100	93	92	81	66	70	91	91	81	1827
-1	93	75	99	96	65	122	122	68	88	87	95	96	74	70	73	88	74	67	81	85	73	1791
-2	63	64	67	77	33	84	74	34	70	61	72	64	62	63	69	66	47	41	56	68	64	1299
-3	65	58	59	73	38	74	65	30	67	61	63	70	48	62	51	53	47	30	48	56	50	1168
-4	61	57	62	80	27	87	71	22	70	64	61	65	45	56	59	50	35	23	42	62	47	1146
-5	54	50	47	53	30	53	60	17	40	51	57	55	38	45	49	43	33	15	33	52	41	907
-6	44	29	51	47	26	66	39	15	58	39	37	44	30	55	36	44	27	15	22	36	40	800
-7	28	26	33	33	17	37	40	16	42	31	29	33	26	45	37	37	24	8	14	35	30	621
-8	22	30	28	25	13	25	32	13	41	35	31	22	30	34	29	32	22	10	12	29	30	545
-9	14	21	27	19	9	18	22	7	28	20	21	24	21	29	25	24	22	9	13	25	29	427
-10	11	13	13	13	8	9	12	2	21	12	12	11	10	23	21	16	19	6	2	16	14	264
-11	6	9	14	13	3	8	7	1	15	6	11	6	8	19	17	18	14	4	2	7	20	208
-12	3	5	9	2	3	2	4	3	9	10	6	9	2	10	11	9	2	3	2	8	8	120
-13	3	2	8	3	4	6	7		9	5	5	7	2	6	4	3	9		2	8	12	105
-14	3	2	5	5	3	2	7	1	6	3	2	1	3	9	1	2	9		2	5	5	76
-15		3		1	2	3	1		4	1			3	3	2	1	3			2	3	32
-16		2	4	2	1				1	1	2		1		1		5			1	5	26
-17	1			2	1				1	1						1	3			1	1	12
-18														2			2			3	3	10
-19			1							1	1			3			1			1	2	10
-20			1														1				2	4
-21																					1	1
-22																	1			2		3
Total	1936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	936	19656

Table XIII

Some Results Obtained from a Study of Table X

Grader	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
25 percentile	2.3	3.2	2.8	1.3	1.0	2.2	1.3	3.9	2.1	2.3	2.2	1.9	4.4	2.0	3.2	3.8	3.5	3.1	5.2	2.5	3.4
Median	-4.5	-.3	-.6	-.13	.41	-.16	-.13	.43	-.18	-.47	-.6	-.9	.2	-.15	-.4	-.7	.5	+.36	.12	-.4	-.7
75 percentile	3.7	3.9	5.0	4.3	3.3	4.6	4.5	4	3.5	4.3	4.4	3.2	3.2	3.6	3.4	4.4	2.5	3.5	2.2	4.5	4.8
Quartile	3.0	3.5	3.9	2.8	6.7	3.4	2.9	4.7	2.3	3.3	3.2	2.6	3.8	3.3	3.3	4.1	4.0	4.4	3.7	3.5	4.1
Mean	-.7	-.6	-.13	-.15	.46	-.13	-.12	.44	-.19	-.3	-.10	-.10	.7	-.15	-.4	-.9	.12	3.8	.18	-.6	-.8
Standard Dev.	4.4	5.3	5.7	5.0	8.2	4.2	5.1	6.9	4.1	5.3	5.2	4.9	5.9	5.5	5.9	6.0	8.1	6.3	5.6	6.2	6.9
P.E.	2.9	3.5	3.3	3.3	5.5	2.8	3.3	4.7	2.7	3.5	3.5	3.2	3.9	3.7	4.0	4.0	5.5	4.2	3.7	4.1	4.6

This table is to be read as follows; The 25 percentile of the deviations of grader A is 2.3 units measured on the Ayres scale, that of grader B, 3.2 units, etc. The median deviation of grader A is -.5 units, of grader B, -.3, etc.

that since the number of pupils enrolled in the grades named are only four and twelve, respectively, the results for these two grades are not dependable.

In this classification of average deviations made in table XIV, it is seen that only three out of the entire twenty-one graders have an average consistently above the true mark for each grade or consistently below the true mark. Graders H and R have their averages in all of the school grades above the true averages for the respective grades; grader F's averages are below the true averages in each grade; grader S has an average an all cases above the ^{true} average except in Grade VI and VII Special. This table shows then that the "constant error" of each grader is not really constant after all; or in other words, it cannot be said that if a grader picked at random from the twenty-one, marks a class above the true average in one case, that he will do so in the next class that he marks.

The standard deviations of the deviations of the marks of the graders for the various school grades show a wide range of variation. Grader E has a standard deviation of 2.8 in Grade I and a deviation of 11.5 in Grade VIII, as seen from table XV. The lowest standard deviation is 2.3; this occurs in Grade I and is the deviation of grader D. The highest deviation is 14.9; this occurs in Grade VIII, and is the deviation of grader 2.

In the foregoing tables of the study of this chapter, the distributions and results were for the marks of individual pupils. Graph 5 gives the frequency distribution of the deviations of

Mean Deviations of the Twenty-one Graders by School Grades

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total
Pupils	37	141	160	95	116	151	122	98	12	4	936
Grader											
A	-3.7	-1.2	-0.1	-0.8	-0.2	-1.3	-1.1	1.3	-1.9	3.0	-0.6
B	0.1	-1.0	0.3	1.0	-0.8	0.3	-2.3	-3.3	3.1	-2.0	-0.6
C	-1.7	-1.7	0.3	-0.6	-1.6	1.0	-2.0	-4.5	-2.7	-2.1	-1.2
D	-2.6	-0.8	-2.3	-0.7	-3.5	-1.9	1.8	-2.9	1.4	3.0	-1.3
E	-4.3	-2.8	2.4	3.2	7.3	6.6	11.1	7.9	10.6	8.0	4.6
F	-2.3	-1.2	-1.0	-1.7	-0.7	-3.0	-2.3	-4.3	-5.2	-2.0	-2.0
G	-4.6	-1.3	-0.7	1.2	-0.8	-2.9	-2.8	-1.7	-3.6	0.5	-1.0
H	0.1	1.8	3.6	5.1	4.7	7.5	6.6	9.2	8.9	0.5	4.1
I	-4.4	-3.9	-1.6	-2.3	-0.5	-2.9	-1.1	2.5	-6.5	-4.5	-1.7
J	4.1	2.7	0.4	-2.5	-1.8	-3.2	-2.5	-2.8	-7.7	-7.0	-1.0
K	1.0	0.2	-0.8	-2.0	-2.8	-0.3	-1.5	-3.4	-1.8	3.0	-1.1
L	2.0	-0.5	-1.2	-2.5	-2.7	-0.4	-0.1	-1.9	1.5	3.0	-1.1
M	2.8	1.4	1.7	-0.3	0.3	2.3	0.2	-0.7	-1.0	5.5	1.0
N	4.4	4.3	-1.2	-2.1	-1.6	-2.2	-2.4	-4.1	-2.4	-2.0	-0.9
O	3.7	3.2	-0.1	-0.3	-2.0	-1.7	-4.4	-1.0	-3.7	0.5	-0.4
P	3.3	0.8	0.2	-1.2	-1.2	-1.7	-3.7	0.5	-2.7	-7.0	-0.7
Q	-3.2	-2.9	-1.4	1.4	3.3	1.3	0.0	2.5	9.0	-9.5	0.3
R	4.1	2.4	4.5	4.6	2.0	2.7	7.1	8.6	0.8	8.0	4.3
S	1.7	2.7	3.1	0.7	1.4	1.9	4.3	3.5	-0.2	8.0	2.0
T	1.7	2.3	-1.2	-4.0	0.1	-2.7	-1.1	-3.9	-0.7	-2.0	-1.2
U	-2.9	-3.3	-3.1	2.1	1.4	0.1	-1.7	-0.2	4.0	-4.5	-0.6

Table XV

Standard Deviations of the Deviations of Each of the Twenty-one

Graders by School Grades

Grade I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total
Pupils 37	141	160	95	116	151	122	98	12	4	936
Grader										
A	4.3	4.1	4.1	4.1	4.6	4.3	4.7	5.1	3.9	3.1 4.4
B	4.3	5.5	5.5	4.3	5.2	5.3	5.3	4.7	4.5	3.6 5.2
C	3.4	4.1	5.9	5.0	5.2	5.9	5.4	4.9	4.3	6.9 5.7
D	2.3	3.7	3.4	4.6	3.9	4.6	5.8	5.6	5.3	3.9 4.9
E	2.8	5.2	4.3	7.2	6.8	8.9	9.0	11.5	6.4	3.6 8.2
F	4.2	4.6	3.3	3.9	4.4	4.7	4.5	2.1	3.9	3.4 4.2
G	4.4	4.3	3.9	6.4	4.4	3.7	4.8	6.5	3.6	5.1 5.0
H	4.0	4.8	5.0	6.9	5.1	6.5	7.4	4.0	4.1	4.1 6.9
I	3.8	5.7	4.4	4.3	4.6	3.9	5.9	5.3	4.9	5.4 4.1
J	5.3	4.4	4.7	4.0	4.2	3.8	4.1	3.7	5.0	9.9 5.2
K	2.9	4.6	4.5	5.1	4.7	4.4	5.8	6.1	6.1	4.3 5.2
L	4.0	4.1	4.9	4.3	4.4	4.5	5.5	5.4	4.1	3.9 4.8
M	4.9	4.6	6.0	5.5	5.4	5.8	6.3	6.3	5.8	2.2 5.8
N	4.4	4.7	4.7	4.0	5.1	5.2	6.4	6.3	4.6	8.0 5.5
O	4.1	5.6	5.1	5.3	4.3	5.9	4.5	7.0	3.5	7.3 5.9
P	4.0	5.1	5.5	4.7	4.9	6.0	6.1	6.4	4.2	3.2 5.7
Q	4.6	7.0	7.2	7.2	7.5	8.2	8.5	10.9	14.9	5.7 8.2
R	5.3	5.1	4.9	5.2	6.0	5.5	6.2	5.6	4.9	3.6 5.8
S	3.9	4.7	6.0	4.8	5.2	5.2	2.9	8.6	6.0	3.8 5.6
T	4.9	5.7	5.4	6.0	4.4	4.5	9.2	5.3	5.0	7.4 6.2
U	5.5	8.0	4.0	5.6	6.3	6.4	7.3	7.4	8.7	2.3 6.9

Distribution of Deviations of Class Marks of Each of the Twenty-one
Graders from the True Class Marks

of the fifty-one class marks of each of the twenty-one graders. The frequency-distribution is given by steps of a half unit each. This graph shows quite well the tendency in the grading of classes by the various individuals. For instance graders R and H have their averages above the true averages of every class except one; the deviations of grader L are almost evenly distributed on either side of zero, showing that grader L's tendency to grade above the average is not any greater than his tendency to grade below the true average. From the figure it is seen also that the ranges of the graders vary considerably. Grader E has an extremely wide range while L has a comparatively narrow range.

Table XVI gives the results obtained from the study of the distributions represented in graph 5 together with various measures of reliability given in tables already described. This table was made to enable one to compare easily the grading of the twenty-one graders. The mean, the probable error, the highest, the lowest mark and the range of deviations of class marks and also of individual marks are given for each of the graders. In addition to measures of reliability already mentioned, the number of class marks that differ from the true average by 1.5 units or less, is given for each of the twenty-one graders. It has been found, as stated in connection with the study of the first chapter, that the average difference in successive school grades of this particular school is approximately three units as measured on the Ayres scale. Then the averages of a class, as assigned any one of the graders, that

are within 1.5 units of the true average would be considered reliable, since the class would then be placed within the proper school grade. The percentage of classes whose averages are within 1.5 units of the true averages is also given for each grader. From Table XVI, Table XVII has been made. The latter gives the ranks of the twenty-one graders in order of the most reliable marked one, etc. for each of seven measures of reliability given in Table XVI. Graders E and H rank lowest as seen from Table XVII. Grader A ranks first.

Table XVI

Various Measures of the Reliability of the Twenty-one Graders

Grader	Av. Dev. of Class Marks	P.E. of Class Marks	No. of Dev. of Classes Not > 1.5	Percentage "	Highest) Dev. of Class) Marks Lowest)	Range of Dev. of Class Marks	*Av. Dev. of Individual Marks	P.E. of Individual Marks	Highest } Individual } Marks Lowest }	Range of Individual M
A	.6	1.5	27	53	3.5 -6.0	9.5	.7	2.9	16 -17	33
B	.6	1.8	19	37	6.0 -6.0	12.0	.6	3.5	18 -16	34
C	1.2	2.6	19	37	10.0 -7.5	17.5	1.3	3.8	18 -20	38
D	1.3	2.1	23	45	8.5 -7.5	16.0	1.5	3.3	19 -17	36
E	4.6	5.3	9	18	16.0 -10.5	26.5	4.6	5.5	27 -17	44
F	2.0	1.8	21	41	4.0 -6.5	10.5	1.8	2.8	18 -15	33
G	1.0	1.8	23	45	5.5 -6.5	12.0	1.2	3.3	22 -15	37
H	4.1	4.5	9	18	12.5 -3.0	15.5	4.4	4.7	32 -14	46
I	1.7	2.7	11	22	6.5 -10.5	17.0	1.9	2.7	20 -17	37
J	1.0	2.5	13	26	8.5 -8.0	16.5	.8	3.5	18 -19	37
K	1.1	1.7	23	45	3.5 -6.0	9.5	1.0	3.5	23 -19	42
L	1.1	1.6	27	52	3.5 -5.0	8.5	1.0	3.2	17 -14	31
M	1.0	2.3	20	39	8.0 -6.0	14.0	.7	3.9	22 -16	38
N	.9	2.3	14	27	6.5 -9.0	15.5	1.5	3.7	19 -19	38
O	.4	2.5	16	31	7.5 -7.0	14.5	.4	4.0	25 -16	41
P	.7	2.1	22	43	7.0 -7.5	14.5	.9	4.0	18 -17	35
Q	1.3	3.1	12	24	9.5 -9.5	19.0	1.2	5.5	38 -22	60
R	4.3	3.8	10	20	13.0 -1.0	14.0	3.8	4.2	23 -12	35
S	2.0	2.3	19	37	8.8 -4.0	12.8	1.8	3.7	25 -14	39
T	1.2	2.7	15	29	10.5 -11.0	21.5	1.6	4.1	25 -22	47
U	.6	3.0	12	24	8.5 -13.0	21.5	.8	4.6	25 -21	46

* The averages of the class marks were calculated from distributions consisting of tenths ^{of} a unit steps; the distributions of individual marks were made by steps of one unit each. This accounts for the slight differences in some cases between the two averages.

Table XVII

The ranks of the Twenty-one Graders in the various Measures
of Reliability

Grader	Rank in Av. Dev. of Class Marks	Rank in P.E. of Class Marks	Rank in No. of Dev. of Class Marks 1.5	Rank in Range of Class Marks	Rank in Av. Dev. of Individual Marks	Rank in P.E. of Individual Marks	Rank in Range of Individual Marks
A	3	1	1.5	2.5	3.5	3	2.5
B	3	5	10	5.5	2	8	4
C	12.5	14	10	17	14	12	13
D	14.5	7.5	4	14	15.5	5	8
E	21.5	21	20.5	21	21	20.5	17
F	17.5	5	7	4	17.5	2	2.5
G	8	5	4	5.5	9.5	5	10
H	19	20	20.5	12.5	20	19	18.5
I	16	15.5	18	16	19	1	10
J	8	12.5	15	15	5	8	10
K	10.5	3	4	2.5	7.5	8	16
L	10.5	2	1.5	1	7.5	4	1
M	8	10	8	8.5	3.5	13	13
N	6	10	14	12.5	15.5	10.5	13
O	1	12.5	12	10.5	11.5	14.5	15
P	5	7.5	6	10.5	7	14.5	18
Q	14.5	18	16.5	18	9.5	20.5	21
R	20	19	19	8.5	20	17	5.5
S	17.5	10	10	7	17.5	10.5	15
T	12.5	15.5	13	19	16	16	20
U	3	17	16.5	21	5.5	18	18.5

Chapter IV

CRITICISM OF THE AYRES SCALE FROM THE FACTS BROUGHT OUT IN STUDIES

I, II AND III

From the values of the standard deviation of the deviations of the marks of individuals and of classes given in Tables VII and X, and from the use of a table of values of the fraction of the area of the normal probability integral⁸ between the limits 0 and x/σ , Tables XVIII and XIX were constructed. Table XVIII gives the number of chances in a thousand that the mark of a class assigned by any one of the twenty-one graders differ from the true mark by no more than 1, 2, 3, 4, and 5 units respectively. Table XIX differs from Table XVIII in that the latter has to do with marks of individual pupils while the former has to do with class marks; in the latter table the chances that the mark of an individual assigned by any one of the graders differ from the true mark of the individual by not more than 1, 2, 3, 4, 5, 6, 7, 8, and 9 units respectively are given.

Some explanation of the table of values of the probability integral should probably be given. The curve of error or the normal probability curve has the equation

$$y = \frac{N}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$$

The area under the curve is given by the value of the integral of the function. The area under the curve between the limits

0 and x/σ is written $\int_0^{\frac{x}{\sigma}} \frac{N}{\sqrt{2\pi}\sigma} e^{-\frac{x^2}{2\sigma^2}}$

8. Thorndike, E. L., Mental Meas. 2, Table 51 p. 219.

Table XVIII

Chances in 1,000 that the Mark of a Class Assigned by Any One of the Twenty-one Graders will Differ from the True Mark by Not More than the Following Amounts

Units	I	II	III	IV	V	VI	VII	VIII	Entire School
1	235	205	223	213	221	197	174	159	205
2	451	404	445	411	413	383	333	318	404
3	637	570	621	582	593	547	484	458	570
4	774	711	758	720	733	683	606	583	711
5	871	813	858	823	835	789	724	692	813
6	930	886	922	895	905	866	806	774	886
σ	3.3	3.8	3.4	3.7	3.6	4.0	4.6	4.2	3.8

This integral cannot be evaluated by any of the elementary methods of integration, so that tables giving the approximate area between given limits have been made. One such table is given in Davis' Calculus on page 54, table G of the appendix. A longer table, and the one used in making Tables XVIII and XIX is given in the second edition of Thorndike's Introduction to the Theory of Mental and Social Measurements, page 218. As in other formulae already quoted, σ means the standard deviation of the deviations of the marks from the true marks in each case; N represents the total number of chances or the number of measurements made, and in the table in Thorndike is taken to be 10,000; x means the distance

$\frac{x}{\sigma}$ N was changed to 1,000 in Tables XVIII and XIX since the probable error of σ in some of the grades is as much as 0.1.

Table XIX

Chances in 1,000 that the Mark of an Individual Assigned by any One of the Twenty-one Graders will Differ from the True Mark by no More than the Following Amounts.

Units	I	II	III	IV	V	VI	VII	VIII	Entire School
1	150	144	148	140	134	126	112	108	193
2	296	281	291	273	263	249	222	214	277
3	429	411	425	404	383	369	326	318	404
4	553	528	547	522	497	478	425	411	522
5	658	630	646	621	599	576	516	503	621
6	741	724	737	711	638	653	599	588	711
7	813	796	806	785	762	733	678	653	735
8	883	853	864	841	820	776	742	724	841
9	911	897	907	888	869	847	796	781	888
0	5.3	5.5	5.4	5.7	5.9	6.3	7.1	7.3	5.6

measured from 0 which is also the arithmetic mean of the deviations of the marks from the true marks in this case.

The fact that the normal error curve was properly used is justified from the forms of distribution given in graphs 3 and 4. In table XVIII the probable error of the mean and of the standard deviation are rather large due to the fact that not a great many class marks were considered in each School Grade. The numbers for the respective grades are 42, 163, 163, 105, 147, 139, 126 and 84. The probable error of the standard deviations are .26, .15, .13, .19.

.15, .14, .20 and .25 respectively for the eight school grades. The probable error of the average in each case is larger, being just $\sqrt{2}$ times as great as is seen from the formulae for the probable error of the two measures of dispersion:¹⁰

$$\text{P.E. true } \sigma - \text{obt. } \sigma = .6745 \sigma / \sqrt{n}$$

$$\text{P.E. true Av.} - \text{obt Av.} = .6745 \sigma / \sqrt{n}$$

The probable error of the standard deviation of the deviations of the marks of individual pupils is in no case larger than .1 as has already been pointed out in an earlier part of the paper.

With the results of the calculations which have been made, at hand, one is able to criticise the Ayres scale. However in making any criticism the following things should be kept in mind.

1. The probable error of the arithmetic mean and of the standard deviation in the tables of class measurements are rather large due to the fact that there were not many classes in some of the school grades.

2. The class of twenty-one students in Statistical Measurements who did the grading of all of the samples of writing used in this study had had no practice in the use of the Ayres scale previous to this time. Just how much the variations in judgments might have been reduced by practice, or how much practice would have been necessary to reduce the variation a given amount, the data does not show.

10. Thorndike, E.L., Mental Meas. 2, p. 104.

Practically these same formulae were given in Chapter II of this paper.

If the class average is considered as the unit of measurement, the Ayres scale does fulfill one of the requirements usually demanded of an objective scale. This criterion which is stated by Starch,¹¹ for example, in Educational Measurements, is that in order for a scale to be a valid objective scale, at least three fourths of the measurements of the same object must fall within a step of the scale. It is seen from table XVIII, that in each of the eight school grades practically three fourths of the class averages as measured by the twenty-one graders do fall within one step of the scale. Stated in other words, the chances are more than three to four that a class average will deviate by no more than five units from the true class average in each of the school grades with the exception of Grades VII and VIII. The exception of Grades VII and VIII need scarcely be mentioned since the chances are so very near to being three to four. The chances are 724 and 692 in a thousand, respectively, for the two grades.

However if the mark of an individual sample is considered as the unit of measurement, the scale does not satisfy the requirement of an objective scale just mentioned. Not in a single school grade do three fourths of the marks deviate from the true marks by less than a step on the Ayres scale. From Table XIX it is seen that only 62 percent of the marks of the entire school lie within a step. In fact a step of

11. Starch, D., Ed. Measurements, 1, p. 100

fourteen units would not include as many as three fourths of the marks in all of the school grades. In Grade VIII, for instance, it is seen from this same table, that three fourths of the marks have a range of almost eighteen units or very nearly two steps on the Ayres scale. Only fifty percent of the marks of Grade VIII are within plus or minus five units of the true marks of the samples of that grade. Hence for a sample selected at random, the chances are roughly only three to five that the mark assigned by one of the twenty-one graders will deviate by less than five units from the true mark of sample.

It is true that in this study the results are not based upon the measurements of a single object or sample, but as explained before, upon the ratings of 936 samples by twenty-one graders. However since the deviations of the marks from the true marks of each of the samples approximate the normal error curve rather closely, the quantities measured may be considered as homogeneous at any rate. The difficulties involved in having the samples graded by a sufficiently large number of graders of equal training and general experience as would be necessary, in order for a single sample to furnish a basis of study, made it more expedient to use the data just described.

So from the results obtained from the study, it may be said, that for graders having had no more experience in the use of the Ayres scale than the twenty-one graders, that the steps of the scale are of sufficient size if the class average is considered as the unit of measurement; but the steps

are too short for a valid objective scale for measuring the quality of individual samples.

If four units is considered as being roughly the difference to be expected between successive school grades,¹² it is seen from Table XIX that the chances that the average mark assigned to a class will deviate from the true mark of the class by no more than ± 2 units, is rather small. The chances are about two to five.

From this study, one should be able to determine the dependence a school superintendent, for instance, could put in the marks of a grader in measuring the improvement in the quality of writing of two successive school grades. That is if a grader gets a difference in the average of a class in Grade III this year and the average of this same class next Grade IV next year, of three units, what is the probability that this does not denote any improvement? Also if a difference of as much as 5 units is found what is the probability that this indicates good teaching?

To answer these questions use must be made of the following theorem. "The square of the standard deviation of the difference Z of two variables X and Y equals to the sum of the squares of the deviations of the two variables taken separately, provided the two variables are uncorrelated."¹³

$$\sigma^2 = \sigma_1^2 + \sigma_2^2$$

12. Freeman, F.N., Fourteenth Yearbook, Part I, p. 76.

13. Yule, U.G., Introduction to Statistics, p. 211

where σ_1 , σ_2 and σ denote the respective standard deviations.

Let x denote the deviation of the mark X of a class from the true average of a class in Grade III for instance; let y denote the deviation of the mark Y from the true average of a class in Grade IV. Then the deviation of the difference

$$z = x - y.$$

Squaring both sides of the equation

$$z^2 = x^2 + y^2 - 2xy.$$

Letting Σ denote the summation of terms

$$\Sigma z^2 = \Sigma x^2 + \Sigma y^2 - 2 \Sigma xy.$$

Dividing both sides of the equation by n where n denotes the number of measurements

$$\sigma^2 = \sigma_1^2 + \sigma_2^2 - 2 \Sigma \frac{xy}{n \sigma_1 \sigma_2}$$

But $\frac{\Sigma xy}{n \sigma_1 \sigma_2} = r$

where r denotes the coefficient of correlation.

$$\therefore \sigma^2 = \sigma_1^2 + \sigma_2^2 - 2r\sigma_1\sigma_2 \quad (1)$$

In case there is no correlation between the measurements of the classes of the two grades, the formula reduces to

$$\sigma^2 = \sigma_1^2 + \sigma_2^2 \quad (2)$$

If there is a correlation between the marks of the two grades, the standard deviation is decreased or increased according to whether the correlation is positive or negative as is shown

by formula (1) of the preceding page.

The standard deviation of the class averages of Grades III and IV, given in Table XV, are 3.4 and 3.7 respectively. Thus assuming that there is no correlation between the marks assigned to a class when in Grade III and when in Grade IV

$$\sigma = \sqrt{(3.4)^2 + (3.7)^2} = 5.0.$$

The probable error of the difference between the two marks is then $.6745 \times 5.0$ or approximately 3.4 units. From Table 51 of Thorndike's Educational Measurements, which has already been explained in connection with Tables XVIII and XIX of this paper, the area under the normal error curve between the average 0 and various amounts of deviations x/σ , where x is measured from the average, is given. The total area under the curve is taken to be 10,000. Thus if σ equals 5, the area under the curve and between the point $x = 0$ and $x = 3$ is 2257. Then the area under the curve beyond the point $x = 3$ is $5000 - 2257$ or 2743. Expressed in other words the chances that the error in the measurement of the difference between the marks of the class in the two grades be greater than three unit are 2743 in 10,000. Then in answer to the first question proposed, it can be said, the chances that a difference of three units in the marks of the class in the two grades is due to errors of measurement and does not therefore denote any improvement in quality, are one to four approximately.

The second question, namely what is the probability that a difference of five units between successive grades signifies

good teaching, remains to be answered. To be up to the standard set by Starch,¹⁴ the average improvement between successive grades must be four units. So far a difference of five units to signify good teaching, the errors in measurement must not exceed one unit. The chances for this to happen are $5000 \div 793$ in 10,000. Roughly speaking, the chances that a difference of five units indicates good teaching, then are about three to five.

The conclusions which have been reached from this study may be summed up as follows.

1. The variation of the true marks of individuals within a school grade from the average mark of the grade is wide. The overlapping of marks in successive is striking.

2. The quality of writing of the school is below the standard set by either Freeman or Starch. The speed, however, is up to or above standard in most of the grades.

3. The twenty-one graders showed a wide difference of opinion as to the quality of individual samples. The marks deviate from + 38 to -22 units from the true marks of samples. With one or two exceptions, the deviations of both individual marks and class marks increase with successive school grades. The standard deviation of class marks, ^{and of} individual samples from the school as a whole are 3.8 and 5.6 respectively.

4. A detailed study of the reliability of each of the twenty-one graders by school grades, shows that there were only

14. Starch, D., Educational Measurements, 1, p. 83.

three out of the twenty-one whose average deviations for the various grades were consistently above^{or below} the true average of the grade. The standard deviations by grades vary from 2.3 in Grade I to 11.5 in Grade VIII. Hence it may be said that the results of the grading of individual graders are not very reliable.

5. Considering the class average as a unit of measurement, the Ayres scale satisfies the criterion usually demanded of an objective scale, namely that three fourths of the measurements of an object do fall within a step on the scale.

*Thesis approved 5/14/17
W. B. Westfall*

TABLE III cont.

Data Concerning the Quality and Speed of the Fifty-one Classes

School	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	Total	Average Quality	Average Speed
Grade IV															
A					6	1							7	32.8	139
B			3	4	5	3	1						16	31.1	116
C			4	3	12	6	7	1					33	34.2	159
D	1	1	5	5	5	4							21	27.6	152
E				8	7	2	1						18	31.7	113
Total	1	1	12	20	35	16	9	1					95	31.1	138
%	1	1	13	21	37	17	9	1							
Grade V															
A			1	2	6								9	30.2	141
B			3	1	7	1	4	3					19	35.3	141
C				3	3	4	5	4	1				20	39.0	128
C			1	4	3	5	2	2	3	1			21	38.5	120
D		2	2	2	2	1							9	27.2	164
E			1		13	2	5		1				22	32.2	121
E			2		10	3	1						16	35.1	121
Total		2	10	12	44	16	17	9	5	1			116	35.0	138
%		2	9	10	38	14	14	8	4	1					
Grade VI															
A			2	1	3	1							7	29.0	114
B			1	2	7	5	2	1					18	35.3	138
C				2	4	5	3	1					15	36.5	167
C				2	8	3	3	4	1				21	37.9	172
E		1	1	2	6	9	7	4	1				31	37.4	180
D			2	3	8	3							16	30.0	165
D			1	2	4	3	2						12	33.3	150
E					6	1	10	2					19	38.7	115
E					2	3	6		1				12	40.2	108
Total		1	7	14	48	33	33	12	3				151	36.0	141
%		1	5	9	31	22	22	8	2						
Grade VI & VII Special															
B				1	1	6	3	1					12	37.7	164

TABLE III cont.

Data Concerning the Quality and Speed of the Fifty-one Classes

School	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	Total	Average Quality	Average Speed
Grade VII															
B			1	7	4	5	4	1	3				25	36.7	187
B				2	7	9	5	2	2				27	38.8	189
C					4	4	3	4	2	5	1	1	24	46.6	149
C					3	2	5		2				12	40.2	140
E					1	7	6	3		2			19	41.7	147
E					2	2	5	5		1			15	41.8	137
Total			1	9	21	29	28	15	9	8	1	1	122	40.9	151
%			1	7	17	24	23	12	7	6	1	1			
Grade VIII															
B					2	4	7	2		1	1		17	42.8	137
B	1	1	3	10	7	3	2	3					30	41.2	205
C				1	2	5	10	2	3	3			26	48.6	175
E			1		6	4	10	3	1				25	44.5	141
Total	1	1	4	13	19	19	24	8	5	4			98	44.5	156
%	1	1	4	13	19	19	25	8	5	4					
Grade IX															
A								1	2			1	4	54.5	151
Grand Total	2	15	99	187	255	151	116	63	27	14	5	2	936	33.3	119
%	0	2	10	20	27	16	12	7	3	1	1	0			

* The average quality and the average speed of each class was calculated from the original grading sheets, one of which has been reproduced in table II.

Table XI.-Grader A

Distribution by School Grades of the Deviations of
Marks from the True Marks of Each Sample

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
16								1			1	
14		1						2			3	
13					1						1	
12					1		1				2	
10			1	1			1	1			4	
9		1	5	1	3		2	2			14	1
8			2	3	5	5	4	4			23	2
7	2	3	5	3	4	3	2	3		1	26	2
6	1	2	4		3	3	5	3			21	2
5		7	8	3	9	2	7	1			37	4
4	1	5	8	4	4	8	9	5	1		45	5
3		8	5	5	4	9	8	7		2	48	5
2		6	13	8	5	6	8	8	1		55	6
1	4	12	19	8	12	10	3	7	2		77	8
0	2	20	16	9	15	15	16	14	1		108	12
-1	2	13	15	11	17	19	10	4	2		93	10
-2	3	9	10	10	6	10	10	4		1	63	7
-3	2	12	15	10	5	12	5	4			65	7
-4	2	7	10	4	8	17	7	9	1		61	7
-5	4	11	7	3	4	10	6	9			54	6
-6	1	12	10	3	2	5	7	2	2		44	5
-7	2	6	2	6	4	3		3	2		28	3
-8	5	4	1			2	6	4			22	2
-9	2	1	3	1	1	4	2				14	1
-10			1	2	1	4	3				11	1
-11	3	1			1	1					6	1
-12						3					3	
-13					1	2					3	
-14	1					2					3	
-17								1			1	
Total	37	141	160	95	116	121	122	98	12	4	936	

Table XI cont.-Grader B

	I	II	III	IV	V	VI	VII	VIII	Sp	IX	Total	%
Dev.												
18			1								1	
16			1		1			1			3	
15		1			1			1			3	
14			2								2	
13			1	1							2	
12	1		3				1				5	1
11				1		1					2	
10			4		1	1	3	1			10	1
9		3	6	1	2	8	2	1	2		25	3
8		2	4	3	5	5	2	1	1		23	2
7	2	2	3	4	2	7	1	1		1	23	2
6	1	3	10		5	7	5	2	1		34	4
5		3	9	4	7	9	5	1			38	4
4	2	10	8	6	1	9	8	1	3		48	5
3	2	6	8	9	5	11	3	6			50	5
2	3	9	12	11	5	4	5	7	2		58	6
1	5	12	19	7	5	10	1	7			66	7
0	4	19	18	11	11	18	8	7	1		97	10
-1	3	13	11	10	16	11	8	3			75	8
-2	3	10	5	9	9	10	11	6		1	64	7
-3	2	14	9	14	7	10	7	4		1	58	6
-4	4	5	8	3	9	6	9	11	2		57	6
-5	2	11	5	3	5	6	12	6			50	5
-6	1	4	1	2	5	3	8	5			29	3
-7		3	3	1	3	4	5	6		1	26	3
-8	1	3	3	1	3	5	6	3			30	3
-9	1	3	3	3	3	2	3	3			21	2
-10		2	3		2	2	3	1			13	1
-11		1		1	3	1	1	2			9	1
-12						1	2	2			5	1
-13		1					1				2	
-14								2			2	
-15		1					1	1			3	
-16							1	1			2	
Total												
-	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader C

Grade	I	II	III	IV	V	VI	VII	VIII	So.	IX	Total	%
Dev.												
18			1			2					3	
17						1					1	
16			1								1	
15		1					1				2	
14			1			1	1				3	
13			1	1	1	2					5	1
12			1			1					2	
11			2			1					3	
10			3	2		3					8	1
9			6	1	2	4	1				14	2
8			2	2	3	2		1		1	11	1
7	1	5	3	1	2	8	2	1		1	24	3
6		1	5		3	10		2			21	2
5		3	6	3	6	4	9	2			33	3
4		3	5	2		8	4		1		23	2
3		4	4	7	3	7	6	4	1		36	4
2	3	9	9	6	4	5	13	6			55	6
1	4	11	17	4	8	10	4	4	1		63	7
0	5	22	17	10	12	13	14	6	1		100	11
-1	6	19	18	11	15	14	9	5	2		99	11
-2	5	8	8	11	8	12	12	3			67	7
-3	6	10	12	9	8	7	4	3			59	6
-4	3	7	10	5	9	9	8	10	1		62	7
-5		11	6	4	7	6	4	7	2		47	5
-6	1	11	5	5	5	9	9	5	1		51	6
-7		8	2	1	6	2	3	8	1	2	33	3
-8	1		5	5	2	4	3	7	1		28	3
-9		3	5	3	2	2	4	8			27	3
-10	1	2	1		4	1	1	3			13	1
-11	1	1		1	4	1	6				14	1
-12			2	1	1		1	4			9	1
-13		2	1			2	1	2			8	1
-14					1		1	3			5	1
-16							1	3			4	
-19								1			1	
-20			1								1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader D

Grade	I	II	III	IV	V	VI	VII	VIII	IX	Sp.	Total	%
Dev.												
19							1				11	
17							1				1	
14							1				1	
13							2				2	
12							1				1	
10				1			4				5	1
9				2		4	4	1			11	1
8				4	1	1	1	1	1		9	1
7		2	1	2		3	3	1			12	1
6		2		1	1	1	3	3		1	12	1
5		9	4	3	3	4	7	4			34	4
4		8	2	2		8	14	2		1	37	4
3	1	8	4	9	2	5	6	4	2	1	42	5
2	2	9	9	7	2	5	10	10		1	55	6
1	6	12	16	5	8	11	11	7		2	78	8
0	3	18	21	10	14	12	7	5		1	91	10
-1	6	18	15	10	17	17	5	6		2	96	10
-2	4	7	13	9	10	17	13	4			77	8
-3	5	12	18	9	8	13	3	4	1		73	8
-4	3	9	16	5	12	16	8	11			80	9
-5	3	8	13	3	7	7	6	6			53	6
-6	2	7	13	5	6	7	2	4		1	47	5
-7		8	3	1	7	6		7		1	33	3
-8	2	1	5	2	4	4	4	3			25	3
-9		1	6	3	2	2		5			19	2
-10		2	1	1	4	2	1	2			13	1
-11				1	6	2	4				13	1
-12								2			2	
-13						2		1			3	
-14					1	1		2		1	5	1
-15					1						1	
-16								2			2	
-17						1		1			2	
Total	37	141	160	95	116	151	122	98	4	12	936	99

Table XI cont.- Grader E

Grader	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
27						1					1	
26					1	1	1				3	
25						2	1	1			4	
24						2	3				5	1
23				1	1		3				5	1
22				1	1		1				3	
21							3				3	
20					3	3	4	2			12	1
19					2	6	6	1			15	2
18				2	4	7	8	1		1	23	2
17			1	2	5	6	3	1			18	2
16			2		3	5	4	7	1		22	2
15				1	5	2	7	1			16	2
14			1	1	2	5	8	1	2		20	2
13				1	3	3	4	4	2	1	18	2
12			1	5		5	8	6	1		26	3
11			2	3		5	2	4	2		18	2
10			7	5	7	9	10	9			47	5
9		1	5	8	17	6	7	3	2		49	5
8		1	2	2	6	8	5	6		1	31	3
7		3	8	1	3	5	3	6		1	30	3
6			6	4	6	7	5	4			32	3
5		4	5	5	6	5	6	6			37	4
4		5	12	4	3	5	5	7			41	4
3		7	5	6	3	9	1	7			38	4
2	2	4	9	2	4	4	5	6			36	4
1	2	9	23	6	10	6		4			60	7
0	3	11	8	5	4	5	3	1			40	4
-1	4	21	15	5	5	9	2	4			65	7
-2	2	6	10	9	1	3	1	1			33	3
-3	6	9	8	7	2	5	1				38	4
-4	3	7	6	2	1	4	1	3			27	3
-5	3	13	6	2	3	2		1			30	3
-6	2	9	7	2	1	4		1			26	3
-7	1	9	2	2	2	1					17	2
-8	2	6	3		1		1				13	1
-9	3	2	3		1						9	1

Table XI cont.- Grader E cont.

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
<u>10</u>		4	2			1			1		8	1
<u>11</u>	2	1									3	
<u>12</u>	2	1									3	
<u>13</u>		2	1	1							4	
<u>14</u>		2							1		3	
<u>15</u>		2									2	
<u>16</u>		1									1	
<u>17</u>		1									1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader F

Grader	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
18						1					1	
17										1	1	
16												
14					1						1	
13							1				1	
11		1									1	
10		1		1				1			3	
9		2			1		2				5	1
8					2	2	1	1			6	1
7			1	1	2	1					5	1
6		4	3	1	1	1	1				11	1
5	1	6	4	3	5	2	4				25	3
4	1	6	5	2	3		5	1			23	2
3	1	8	8	6	6	5	3	6		1	44	5
2	3	8	12	7	5	5	5	5	2		52	5
1	5	7	26	7	13	9	5	9			81	9
0	2	14	16	7	10	11	13	7			80	9
-1	3	21	21	14	24	21	10	7	1		122	12
-2	5	7	14	13	10	14	13	7		1	84	9
-3	3	10	15	10	8	15	6	6		1	74	8
-4	2	10	16	4	13	15	11	15	1		87	9
-5	2	6	7	3	7	10	10	7	1		53	5
-6	2	11	9	6	2	14	11	9	2		66	7
-7	1	10		4	2	8	4	6	2		37	4
-8	1	1		3		3	10	6	1		25	3
-9	2	3	2	1		5	3	2			18	2
-10	1	3			1	3	1				9	1
-11	1			1		1	2	1	2		8	1
-12						2					2	
-13	1	1	1			1	1	1			6	1
-14		1				1					2	
-15				1		1		1			3	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader G

Grader	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
22								1			1	
18				1							1	
17				2							2	
16				1							1	
15							1				1	
14				2	1						3	
13				1				2			3	
12							1				1	
11				1							1	
10				1				2			3	
9		2	1	3	2	2					10	1
8	1			4	2	1	3	3			14	1
7		2	5	4	1	2	2				16	2
6		2	3	3	3		2	2			15	1
5		5	5	2	5	3	2	3			25	2
4	1	8	11	5	2	3	6	4			40	4
3	2	11	3	5	2	3	4	5	1	1	37	4
2	1	6	13	7	3	5	6	5			46	5
1	6	8	26	6	10	10	6	9	1		82	9
0	1	11	15	7	11	13	9	3	1		71	8
-1	3	22	18	13	23	21	12	8	2		122	13
-2	1	9	14	7	13	15	10	4		1	74	8
-3	3	10	13	4	9	16	4	5		1	65	7
-4	2	10	12	3	9	16	9	9	1		71	8
-5	3	13	7	4	6	10	12	5			60	6
-6	1	6	5		1	11	9	3	3		39	4
-7	2	5	3	3	8	8	4	5	1	1	40	4
-8	3	3	1	3	4	3	8	6	1		32	3
-9	1	6	2	1	1	2	3	5	1		22	2
-10	2	1				2	6	1			12	1
-11	2	1	1			1	2				7	1
-12				1		2		1			4	
-13	1		1	1		1	1	2			7	1
-14	1		1			1		4			7	1
-15								1			1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader H

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
32							1				1	
28							1				1	
26								1			1	
24						1					1	
23				1				1			2	
22				1			1	1			3	
21						1					1	
20					1	2	2				5	1
19				1	2	4	1	2			10	1
18					1	3		1			5	1
17			1	2		3	2	2			10	1
16				1	1	2	3	3			10	1
15		1	2	2	1	4	7	2			19	2
14		1		3	2	8	6	1			21	2
13			1	1		4	1	2	2		11	1
12			2	2	1	4	8	6	1		24	2
11			12	1	1	5	1	3	2		25	2
10		3	4	4	4	14	11	7	1		48	5
9		6	7	9	12	12	6	2	2		56	6
8	1	2	8	9	7	10	7	3			47	5
7	2	6	11	5	9	12	4	1			50	5
6	1	5	8	4	7	12	6	4	1		48	5
5	1	10	12	2	11	8	7	7			58	6
4	1	9	14	4	4	8	7	5	1		53	6
3	2	13	4	5	7	8	6	6		1	50	5
2	3	8	10	6	3	3	4	2			39	4
1	6	12	18	6	11	2	5	3			63	7
0	3	7	9	4	8	5	5	3	1		45	5
-1	5	19	12	7	11	6	5	3			68	7
-2	3	7	5	2	3	4	6	3		1	34	3
-3	2	8	7	4	1	2		5		1	30	3
-4	2	2	5	1	1	2	3	6			22	2
-5	2	7	1	2	3		2				17	2
-6	1	7	3				2	2			15	2
-7		3	2	3	2	2	1	2		1	16	2

Table XI cont.- Grader H cont.

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
_8	1	3	1	1	1	1	1	4			13	1
_9	1	1	1	1				3			7	1
_10					1			1			2	
_11		1									1	
_12				1		1		1			3	
_13												
_14									1		1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI. cont.- Grader I

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
20							1				1	
18							1				1	
16							1				1	
15							1				1	
14		1									1	
13										1	1	
12								1			1	
11	1							3			4	
10		1			1			2			4	
9		5	2		4	2	2	1			16	1
8		1	2		3		3	3			12	1
7		2	1	1	2		2	2			10	1
6		3	3	1	2	1	1	8			19	2
5		8	3	2	6	3	6	6			34	4
4	1	5	4	4	4	1	7	2			28	3
3	1	3	4	4	7	6	2	5		1	33	3
2	2	6	8	8	4	3	3	8			42	4
1	2	6	17	4	10	6	5	5	1		56	6
0	3	12	18	10	17	16	16	9			101	11
-1	4	11	18	11	15	16	7	5	1		88	9
-2	2	6	11	11	8	17	10	4		1	70	8
-3	3	8	14	8	7	17	4	5		1	67	7
-4	3	2	20	5	9	17	9	4	1		70	8
-5	3	4	7	3	4	8	6	4	1		40	4
-6	2	10	10	3	2	12	11	6	2		58	6
-7	2	10	2	6	3	7	5	6	1		42	4
-8	4	4	6	4	2	6	11	3	1		41	4
-9	2	9	3	4	2	4	1	2	1		28	3
-10		7	2	3	1	5	2	1			21	2
-11		5		2	2	2	1	1	2		15	2
-12		4	1	1			1	1	1		9	1
-13	1	3	3		1		1				9	1
-14	1	1	1				1	1	1		6	1
-15		3					1				4	
-16		1									1	
-17								1			1	
Tptal	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader J

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
18			1								1	
17		2									2	
16		1									1	
15		1	1								2	
14			1								1	
13	1										1	
12	3		1								4	
11	2	1	4			1					8	1
10		1	1								2	
9	3	8	1	1	2	1		3			19	2
8	3	4	6	2	1		1				17	2
7	3	5	8	1		3	2				22	2
6	2	4	6	1	3	2	2				20	2
5	3	16	6	2	3	2	2	2			36	4
4	2	14	9	4	4	3	3	2			41	4
3		15	5	6	6	5	3	7	1	1	49	5
2	1	10	11	6	2	2	7	5			44	4
1	4	10	19	7	9	5	5	5			64	7
0	3	18	21	11	15	14	20	11			113	11
-1	2	12	12	13	19	17	8	3	1		87	9
-2	1	4	7	10	9	14	9	7			61	7
-3	3	8	9	8	10	13	4	6			61	7
-4	1	3	8	4	11	15	10	12			64	7
-5		2	7	5	7	11	12	7			51	5
-6		1	6	2	1	10	12	5	2		39	4
-7		1	1	5	4	8	6	5	1		31	3
-8			5	4	4	6	8	7	1		35	4
-9			4		3	5	1	5	2		20	2
-10				1	1	7	2		1		12	1
-11						1	2	2	1		6	1
-12					1	4	3	1		1	10	1
-13				1		2		1		1	5	1
-14								2	1		3	
-15					1						1	
-16									1		1	
-17										1	1	
-18				1							1	
Total	47	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader K

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
16							1	1			2	
14									1		1	
13		1			1	1					3	
12		1				1		1			3	
11	1	1	1		1	2	2	1			9	1
10	1				1	2	1				5	1
9	1			2	1	2	3	1			10	1
8	1	2	3	2		1	3	1			13	1
7	5	10	1	4		2	2			1	25	3
6	1	1	2		2	6	7	2			21	2
5	3	10	8	2	2	5	4	3			32	3
4	2	10	7	2	1	12	9	3			46	5
3	1	9	5	6	4	10	5	5		1	46	5
2	4	5	14	3	3	6	6	2	1		44	5
1	6	7	19	6	8	4	5	4	1		60	6
0	2	20	25	11	10	20	14	7	1		110	12
-1	4	18	15	12	15	17	7	5	2		95	10
-2	3	8	11	12	9	17	9	2		1	72	8
-3	1	7	15	6	8	14	7	5			63	7
-4	1	6	12	4	11	10	5	11	1		61	6
-5		9	6	7	9	7	12	7			57	6
-6		6	8	4	4	4	6	3	2		37	4
-7		3	1	3	6	3	3	7	2	1	29	3
-8		4	2	5	4	1	6	9			31	3
-9		1	3	2	2	3	2	7	1		21	2
-10			1	1	6	1	2	1			12	1
-11		2			5		3	1			11	1
-12							1	5			6	1
-13				2	1			2			5	1
-14				1	1						2	
-16					1			1			2	
-19								1			1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader L

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
17			1								1	
16							1				1	
14							2	1			3	
13							1				1	
12						1	2	1	1		5	1
11			1			1	1	1			4	
10	1	2				1	2				6	1
9	2	1	4	2		2	2				13	1
8	1	1	2		3	2	4	1		1	15	2
7	3	4	1	1		5	1				15	2
6	2	1	4	1		3	3	2			16	2
5	3	8	7	2	5	6	4	4			39	4
4	2	10	4	1	2	9	6	6	2		42	4
3	1	11	5	4	1	10	6	7	2	2	49	5
2	4	9	9	4	2	6	9	6	1		50	5
1	7	9	19	6	7	5	4	5	1		63	7
0	2	19	19	9	13	21	15	7	1		106	11
-1	3	16	11	12	21	17	8	6	2		96	10
-2	3	6	10	12	6	16	8	3			64	7
-3	2	11	13	10	11	10	5	7		1	70	7
-4	1	7	11	3	11	12	8	11	1		65	7
-5		11	9	7	7	7	9	5			55	6
-6		7	11	6	3	6	7	3	1		44	5
-7		4	2	6	9	4	2	6			33	3
-8		1	5	3	3	1	4	5			22	2
-9		2	6	2	3	3	3	5			24	3
-10			2		5	1	1	2			11	1
-11		1	1	1	2		1				6	1
-12			1	1	2		1	4			9	1
-13			2	1		2	2				7	1
-14				1							1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader M

66

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
22		1									1	
19			1	1		1					3	
18			1								1	
17						1		1			2	
16					1		1				2	
15			2			1					3	
14			2		2	1	1	1			7	
13	1	1		1			1		1		5	1
12	1		2	1		1	1				6	1
11		3	4	4	1	2	2				13	1
10	1	2	7		3	4	4	1			22	2
9	3	5	5	1	3	6	3	3			29	3
8	1	2	2	2	2	7	2	1		1	20	2
7	2	10	6	5	3	7	1	5		1	40	4
6	4	4	8	3	5	12	2	3			41	4
5	1	11	4	4	5	7	6	4			42	4
4	2	12	8	4	3	10	5	3	1		48	5
3		12	5	4	6	7	8	7	1	2	52	6
2	3	10	10	3	3	6	7	6			48	5
1	6	6	16	6	3	4	1	5	1		48	5
0	2	20	17	9	14	17	11	9	1		100	11
-1	2	13	6	11	17	12	8	3	2		74	8
-2	2	5	7	11	10	11	10	6			62	7
-3	4	6	11	5	7	9	5	1			48	5
-4		5	9	2	7	4	9	8	1		45	5
-5	2	5	5	3	6	4	5	6	2		38	4
-6		4	8	3	1	3	8	3			30	3
-7		2	2	6	3	6	1	5	1		26	3
-8			4	5	5	1	7	7	1		30	3
-9		1	4	1	3	3	3	6			21	2
10			1	3	1	1	4				10	1
11			2		1	2	2	1			8	1
12			1				1				2	
13						1	1				2	
14								3			3	
15		1			1		1				3	
16							1				1	

Table XI cont.- Grader N

Grade I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.											
19		1								1	
18	1									1	
17	1									1	
16					1					1	
14	1									1	
13	1			1						2	
12	1	4				1				6	1
11	2	5		1						8	1
10	2	2	2	1	1					8	1
9	2	17	1	1	2	3				26	3
8	2	3	1	2		4			1	13	1
7	4	9	2	2		1				18	2
6	3	6	4	1	3	1	1			19	2
5	3	16	6	1	4	5	1	3		39	4
4	2	14	4	1	4	4	2	3	1	35	4
3	1	15	4	1	3	6	4		1	36	4
2	4	4	8	6	3	5	4	6		40	4
1	5	9	20	5	5	5	1	2	2	54	6
0	1	14	18	11	15	15	11	7	1	93	10
-1	3	5	12	10	18	13	6	2	1	70	8
-2	1	5	10	11	8	13	9	6		63	7
-3		3	16	8	8	14	8	5		62	7
-4		1	10	4	7	14	10	9	1	56	6
-5		2	7	5	7	7	12	5		45	5
-6		2	14	6	3	10	13	5	2	55	6
-7		1	4	10	6	7	4	12		45	5
-8			7	4	4	4	9	5	1	34	4
-9		1	3	1	3	8	6	7		29	3
-10			3	3	3	3	7	4		23	2
-11			2	3	2	5	2	4	1	19	2
-12					2	1	4	2	1	10	1
-13					2	1		2		6	1
-14					2		3	4		9	1
-15		1				1		1		3	
-18							1	1		2	
-19							1	2		3	

Table XI cont.- Grader P

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
18		1						1			2	
17		1				1					2	
16						1					1	
15		1				1					2	
14								2			2	
13		1			1						2	
12	2	1			1		2	1			7	1
11			1			3					4	
10		1	4	1	3	1			1		11	1
9	2	3	6	2	1		2		1		17	2
8	1	2	5			1	1	3			11	1
7	3	3	8	6	1	5	2	5			33	3
6	2	1	5	1	5	6	2	5			27	3
5	3	13	11	4	4	1	5	1			42	4
4	2	12	8	3	2	7	3	3	3		43	4
3	1	11	4	3	3	9	1	9	1		42	4
2	3	9	8	4	1	4	8	6	1		44	4
1	6	12	17	8	11	8	5	7	2		76	8
0	3	16	14	9	12	13	6	8			81	9
-1	3	15	12	10	22	14	5	6	1		88	9
-2	2	4	9	11	10	13	11	5		1	66	7
-3	3	8	10	5	9	9	5	4			53	6
-4		5	5	5	6	10	11	7	1		50	5
-5		5	6	2	7	9	7	7			43	5
-6		5	7	4	4	8	13	3			44	5
-7		4	3	7	5	5	7	3	1	2	37	4
-8		3	7	5	3	5	5	4			32	3
-9	1	1	7		1	4	5	5			24	3
-10			3	1		3	8	1			16	2
-11		2	1	2	1	5	6	1			18	2
-12				2	1	3	2			1	9	1
-13			1		1	1					3	
-14					1			1			2	
-15						1					1	
-16		1									1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader 2

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
37						1					1	
32							1	1			2	
31				1							1	
29					1						1	
26								2	1		3	
25					1			1			2	
24						1			1		2	
23				1	2	1		1			5	1
22					1	1					2	
21					1			1	1		3	
20					3	3		1			7	1
19				1	1		1	1			4	
18		1		1	1	1	2	2			8	1
17			1			2		2			5	1
16			1		1	2	1	5			10	1
15			2		2		1	2			7	1
14		2	3			1	3				9	1
13		2		1	2	1		1			7	1
12	2		1	2	1	2	3	1			12	1
11		1	2			1	1	3			8	1
10		1	3	1	3	5	5	4			22	2
9	2	1	5		5	9	3	1	1		27	3
8	1	1	1	5	5	10	6	3			32	3
7	3	3	2	4	2	5	3	3			25	3
6	2	1	3	4	6	6	4	2			28	3
5	3	8	4	4	6	8	9	4			46	5
4	2	3	8	3	4	10	7	6	1		44	5
3	1	10	1	6	3	9	4	5	2		41	4
2	2	12	8	4	4	4	8	5			47	5
1	5	8	15	5	8	8	2	7	1		59	6
0	3	15	12	10	11	7	5	2	1		66	7
-1	3	15	8	12	12	12	9	3			74	8
-2	3	4	10	7	6	9	4	3		1	47	5
-3	2	9	10	6	8	8	3	1			47	5
-4		5	9	1	3	7	6	4			35	4
-5		9	5	3	3	6	5	2			33	3

Table XI cont.- Grader 9

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
_6		5	7	4	2	3	3	2	1		27	3
_7		4	6	2	1	3	3	4		1	24	2
_8		2	8	3	1		3	5			22	2
_9	2	2	7	2	2	2	3	2			22	2
_10		5	4	1		1	6	2			19	2
_11		2	4		3	1	1	2	1		14	1
_12						1	1				2	
_13	1		2	1	1		1	2		1	9	1
_14		4	4					1			9	1
_15		1	1				1				3	
_16		3	1				1				5	1
_17		1					1			1	3	
_18			1				1				2	
_19							1				1	
_20		1									1	
_22			1								1	
Total	37	141	160	95	116	151	122	98	12	4	936	

Table XI cont.- Grader R

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
23							2				2	
22								1			1	
21							2				2	
20							2				2	
19					1	1	2	2			6	1
18				1	1	1	1	2			6	1
17		1	2	1			2	4			10	1
16				1	1	1	2	3			8	1
15				1			5	4			10	1
14	1		3			2	4	4			14	1
13	1	2	3	5	3	1	2	4	1	1	23	2
12	1		1	3	1		5	7			18	2
11	1		7	3	3	1	1	5			21	2
10	1		7	1	5	5	4	4			27	3
9	2	7	13	10	6	6	5	5			54	6
8	2	4	6	6	4	8	7	4		1	42	5
7	2	9	17	6	5	9	3	2		1	54	6
6	3	8	8	3	5	10	5	8	1		51	6
5	2	14	12	5	8	8	8	5			62	7
4	1	14	11	5	5	9	10	4	1		60	6
3		12	5	5	4	11	3	7	1	1	49	5
2	3	10	12	6	3	5	7	3			49	5
1	6	12	16	5	7	9	4	4	1		64	7
0	3	11	10	8	10	13	8	6	1		70	8
-1	2	15	8	6	15	12	7	1	1		67	7
-2	2	3	6	5	5	10	6	4			41	4
-3	3	7	2	3	6	7	2				30	3
-4		1	5	1	5	5	4	2			23	2
-5		4	1	1	4	3	1	1			15	2
-6		1	2	2	1	5	2		1		15	2
-7			1		2	2	1	1			8	1
-8		1	1	2	1	2	3				10	1
-9	1	1			1	3	1	1	1		9	1
-10		3	1		2						6	1
-11		1			1		1		1		4	
-12					1	2					3	

Table Xi cont.- Grader S

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
25								1			1	
20			1								1	
19							1				1	
18		1			1	2		1			5	1
17		1	1		1						3	
16					1	2		4			7	1
15			1				1	1			3	
14			2				1	1			4	
13		1	2		1	1		3	1	1	10	1
12		1	1	1		2	2	5			12	1
11		2	8	1	2	2		3			18	2
10	1	1	4	1	4	4	2	4			21	2
9	1	7	9	3	6	2	3	5			36	4
8	3	4	8	4		3	1	4		1	28	3
7	1	7	13	4	2	4	1	6		1	39	4
6	2	3	7	1	1	6	3	5	1		29	3
5	2	11	10	7	5	6	8	5			54	6
4	2	14	14	6	5	11	8	3	1		64	7
3	2	13	6	8	7	10	6	6	1	1	60	6
2	4	10	10	8	4	3	10	4	2		55	6
1	7	9	13	5	10	8	6	4	1		63	7
0	2	16	14	10	13	15	15	5	1		91	10
-1	4	12	9	13	15	17	8	3			81	9
-2	1	2	5	6	11	15	12	4			56	6
-3	4	6	5	8	7	11	6	1			48	5
-4		5	5	2	9	9	8	4			42	5
-5	1	7	3	1	6	6	6	3			33	3
-6		3	1		2	4	7	3	2		22	2
-7		2		2	1	3	2	3	1		14	2
-8			2	1	2	2	3	2			12	1
-9		2	4	1		2		3	1		13	1
-10			1					1			2	
-11		1					1				2	
-12				1			1				2	
-13			1			1					2	
-14				1				1			2	

Table XI cont.--Grader T

Grade	I	II	III	IV	V	VI	VII	VIII	Sp.	IX	Total	%
Dev.												
25		1									1	
24							1				1	
23							1				1	
22							1				1	
18		1			1		1				2	
17			1				1				2	
16							2				2	
15							4				4	
14			2		1		3				6	1
13		2						1			3	
12	1	2				2	3				8	1
11		2	1	1			4				8	1
10	1				2		1	2			6	1
9	2	10	3	1	3		5	1			25	3
8	1	3	1		1	1	2	1			10	
7	1	6	8	2	1	3	2	1			25	3
6	2	6	4	1	3	1	2	4			23	2
5	1	13	3		3	3	5				28	3
4	2	11	8	4	3	4	6	2			40	4
3	1	10	7	1	9	4	2	5	1	1	44	4
2	4	7	9	4	4	2	5	7			42	4
1	8	10	15	6	10	6	4	5	2		66	7
0	2	13	19	10	14	18	6	7	1		91	10
-1	2	11	13	9	18	20	6	5	1		85	9
-2	2	5	11	9	10	16	10	5			68	7
-3	5	8	7	8	8	13	2	5			56	6
-4		4	11	4	11	16	6	9	1		62	7
-5	2	6	9	7	6	10	3	9			52	7
-6		4	5	3	1	9	6	5	3		36	4
-7		3	1	9	2	9	3	6	1	1	35	4
-8		1	9	6	1	3	3	5	1		29	3
-9		1	6		2	4	5	6	1		25	3
-10			3	1	2	3	5	2			16	2
-11		1	1	2		1	2				7	1
-12				2		1	2	2		1	8	1
-13			1	2		1	3	1			8	1
-14			1			1	1	2			5	1
-15							2				2	
-16			1								1	
-17							1				1	
-18							3				3	
-19				1							1	
-22				1			1				2	

Table XI cont.- Grader U

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Notes	Equations are handwritten. Page 17 bound incorrectly. Data lost at margins. Some underlining throughout. Page discoloration and stains on pages. Page 28 is a foldout table.

Derivatives - Access copy

Compression	Tiff:compression: 1
Editing software	Adobe Photoshop CS5
Editing characteristics	
Resolution	300 dpi
Color	gray scale / color
File types	pdf
Notes	blank pages removed in pdf