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A METHOD OF COMMENSURATING MENTAL MEASUREMENTS

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I.—THE KENTAL PRINCIPLE

A problem that is always present with those concerned with the measuring of mental and social phenomena is that of reducing to common terms quantities stated in terms of incommensurate units. To use a simple illustration, how may a subject's performance in a test of attention and his performance in a test of perception be reduced to terms that make precise comparison possible? Clearly, the crossing of the letter 'A' in the one case bears no manifest numerical relation to the addition of integers in the other. A new and serviceable method of effecting such commensuration will doubtless be of some interest to investigators.

The device ordinarily employed in biological studies to effect commensuration is the Galton percentile, which furnishes a method of comparing the performances of subjects in a series of tests. The method herewith suggested will, I believe, be found superior in point of accuracy and adaptability to the purposes of educational measurement. The unit of the system has been named the *kental*.¹ A comparative demonstration of the two methods will serve to bring out their theoretical differences.

Tables I and II record the performances of two groups of subjects, U, a group from cities, and V, a group from villages, on two tests—Table I for the 'A' test of attention,² and Table II for the simultaneous adding test of perception. In these tables the third group, C, combines the groups U and V. Column S records the original scores of the subjects; column P gives their percentile; and column K their kental equivalents. The percentile, of course, represents the rank of a subject's performance in

¹ Adapted from the Latin *centum*.

² See Whipple: *Mental and Physical Tests*, Vol. 1, p. 305.

the series, expressed in percentage terms, the position of the highest score furnishing the base of computation. Thus, in a group of fifty, the subject who ranked first would be given a percentile rating of 100 because he was one hundred percent removed from the position of the lowest rank; the subject ranking tenth would be given a percentile rating of 80 because he was eighty percent removed from the position of lowest rank. In strict accuracy, these values should read 99.5 and 79.5, for in a group of one hundred the chances are even that the performance would be ranked 99 or 100, 79 or 80.

The kental equivalent of a measurement is obtained in an altogether different manner. The essential steps in the process are:

1. Determine the *range* of values represented in a given series of measurements. This is done by subtracting the lowest score from the highest.
2. Determine the *elevation* of each measurement in the series by subtracting from it the lowest score.
3. Express these elevations as percents of the range.

Here is a simple illustration of this procedure. Let the highest score be 150, the lowest, 75, and the given score be 120. The range will be $150 - 75$, or 75. The elevation of 120 is $120 - 75$, or 45. Reduced to a percent of the range 75, 45 becomes 60, which is the kental transversion of the measurement 120.

It may appear that the base of the kental unit might better be the span of the first and third quartiles or the first and ninth deciles rather than the extreme margins³ of the total range. This would, of course, give greater invariability to the standard range inasmuch as the extreme marginal variables would be eliminated. A range determined for a given test from a standard group in one laboratory might more nearly be supposed to be equal to the ranges for other tests determined from groups in other laboratories. The practical effect of this would be to introduce the 100+ transversion for all scores above the third quartile or the

³ "Margin" is here used as in economics to designate the items of extreme variation.

TABLE I.—PERCENTILE AND KENTAL EQUIVALENTS OF MENTAL MEASUREMENTS. SIMULTANEOUS ADDING TEST OF PERCEPTION

Key: U = urban group of subjects; V = village group; C = urban and village groups combined; S = original measurements or scores of subjects; P = their percentile equivalents; K = their Kental equivalents; M = median; Q₃ = upper quartile; Q₁ = lower quartile.

Sub- ject	C.			U.			V.		
	S.	P.	K.	S.	P.	K.	S.	P.	K.
1	419	100.0	100.0	419	100.0	100.0			
2	384	97.4	83.9				384	97.4	83.9
3	378	94.9	81.1	378	94.9	81.1			
4	372	92.3	78.4	372	92.3	78.4			
5	370	89.7	77.5				370	89.7	77.5
6	368	87.2	76.6	368	87.2	76.6			
7	365	84.6	75.2				365	84.6	75.2
8	362	82.0	73.9	362	82.0	73.9			
9	361	79.5	73.4	361	79.5	73.4			
10	353	76.9	69.8				353	76.9	69.8
11	348	74.4	67.5				348	74.4	67.5
12	341	71.8	64.3	341	71.8	64.3			
13	338	69.2	62.9				338	69.2	62.9
14	333	66.7	60.6	333	66.7	60.6			
15	332	64.1	60.2	332	64.1	60.2			
16	331	61.5	59.7	331	61.5	59.7			
17	324	59.0	56.5				324	59.0	56.5
18	323	56.4	56.1	323	56.4	56.1			
19	320	53.9	54.8				320	53.9	54.8
20	318	51.3	53.9	318	51.3	53.9			
21	310	48.8	50.2	310	48.8	50.2			
22	306	46.2	48.3	306	46.2	48.3			
23	300	43.6	45.6	300	43.6	45.6			
24	295	39.7	43.4				295	39.7	43.4
25	295	39.7	43.4				295	39.7	43.4
26	294	35.9	42.9				294	35.9	42.9
27	290	33.3	41.0				290	33.3	41.0
28	280	30.8	36.5	280	30.8	36.5			
29	277	26.9	35.1	277	26.9	35.1			
30	277	26.9	35.1				277	26.9	35.1
31	276	23.1	34.7				276	23.1	34.7
32	271	20.6	32.4				271	20.6	32.4
33	258	16.7	26.5	258	16.7	26.5			
34	258	16.7	26.5				258	16.7	26.5
35	255	12.8	25.1				255	12.8	25.1
36	226	10.2	11.9				226	10.2	11.9
37	212	7.7	5.5	212	7.7	5.5			
38	208	5.1	3.6				208	5.1	3.6
39	200	2.6	0.0	200	2.6	0.0			
Q _a	353	76.9	69.8	362	81.4	73.8	348	74.4	67.5
M.....	318	51.3	53.9	327	58.9	57.9	295	39.7	43.4

TABLE II.—PERCENTILE AND KENTAL EQUIVALENTS OF MENTAL MEASUREMENTS. A-TEST OF ATTENTION

Subject	C.			U.			V.		
	S.	P.	K.	S.	P.	K.	S.	P.	K.
1	106	100.0	100.0	106	100.0	100.0	105	97.2	97.3
2	105	97.2	97.3						
3	103	94.5	95.9	103	94.5	95.9			
4	101	91.8	93.2	101	91.8	93.2			
5	99	87.8	90.4	99	87.8	90.4			
6	99	87.8	90.4	99	87.8	90.4	95	81.1	84.9
7	98	83.8	89.0	98	83.8	89.0			
8	95	81.1	84.9						
9	94	78.4	83.6						
10	93	75.7	82.2	93	75.7	82.2			
11	92	71.6	80.8	92	71.6	80.8	89	64.9	76.8
12	92	71.6	80.8	92	71.6	80.8			
13	91	67.6	79.5	91	67.6	79.5			
14	89	64.9	76.8						
15	87	62.2	74.0						
16	82	59.4	67.1	78	48.6	61.6	82	59.4	67.1
17	81	56.8	65.8				81	56.8	65.8
18	80	52.7	64.4				80	52.7	64.4
19	80	52.7	64.4				80	52.7	64.4
20	78	48.6	61.6						
21	77	44.6	60.3	77	44.6	60.3	74	37.8	56.2
22	77	44.6	60.3						
23	76	40.5	58.9	76	40.5	58.9			
24	74	37.8	56.2						
25	73	35.1	54.8	73	35.1	54.8			
26	72	32.4	53.4	66	24.3	45.2	72	32.4	53.4
27	70	28.4	50.7				70	28.4	50.7
28	70	28.4	50.7				70	28.4	50.7
29	66	24.3	45.2						
30	63	21.6	41.1				63	21.6	41.1
31	62	18.9	39.7	62	18.9	39.7	60	14.9	37.0
32	60	14.9	37.0	60	14.9	37.0			
33	60	14.9	37.0						
34	57	10.8	31.9						
35	50	8.1	23.3	50	8.1	23.3			
36	40	5.4	9.6				40	5.4	9.6
37	33	2.7	0.0				33	2.7	0.0
Q ₃	93.5	79.7	92.9	99.0	87.8	90.4	87.0	62.2	74.0
M....	80.0	52.7	64.4	91.5	69.6	80.1	77.0	44.6	60.3
Q ₁	69	26.3	47.9	71.2	32.4	52.4	63.0	21.6	41.1

ninth decile, as the case might be, and the 0— transversion for all scores below the first quartile or the first decile. Thus, in Table I, if the quartiles instead of the margins determined the range, it would be 76 instead of 219. The kental equivalent of the score 419 would be 187, and the equivalent of the score 200 would be —101. In the practical application of the kental, these minus scores might be mistakenly interpreted by inexperienced workers to signify negative quality.

The underlying assumption of the kental method is that *the range of ability obtaining within a sufficiently large group of subjects conforming to given standards of age, sex, physical and mental condition, race, social status, and educational advantage is constant enough to serve as a standard unit for the measurement of mental abilities*. In other words, this is to say that mental abilities within social groups vary only within definite limits. This is but a special case of the general biological principle of the limitation of variation within the species. If the trait of intelligence can vary only within definite limits, then our measurements of the trait can vary by no wider interval.

It may be argued that while the kental method may serve to overcome difficulties in measurement due solely to the incommensurateness of the units of measurement, it still fails to reduce measurements of dissimilar processes to common terms. The assumed equivalence in range of all mental processes, it may be said, is fallacious by analogy with variations of other physical processes. Individual variations in height, for example, are by no means equal to variations in weight, and variations in cephalic index are by no means the same as variations in girth of chest. Therefore, the normal range of memory capacity, for example, may not be held to be equal to range in judgment capacity.

There are two replies that may be made to this line of argument. In the first place, it must be noted that inequality in range of mental processes is just as much an assumption as equality. Having units of measurement that enable us to measure physical traits in common terms, we can say definitely that differences

in variability exist. Lacking such units for the measurement of mental traits, we cannot speak with such finality in this field. Secondly, is it not fair to hold that a difference of 1 mm. in head circumference is more significant than a difference of 1 mm. in chest girth? The kental method aims to measure variations by percents. On this basis, a one percent variation in head circumference might be held to be equivalent to a one percent variation in girth of chest, and a one percent variation in memory

TABLE III.—QUARTILE COEFFICIENTS OF DISPERSION (Q.D.) AND SKEWNESS (Q.J.) FOR GROUP C OF TABLES I AND II

C-I				C-II.		
	S.	P.	K.	S.	P.	K.
Q. D.	.12	.48	.33	.15	.50	.32
Q. J.	-.07	.02	-.08	.10	.01	.27

capacity might be held equivalent to a one percent variation in judgment capacity. From a functional point of view, mental processes are at least as much alike in kind as such traits as cranial and thoracic circumference and therefore as comparable.

A point that is to be specially noted in the comparison of the kental with the percentile method of commensuration is that the kental may be given a fixed unitary value by standardizing the minimum and maximum scores marking the limits of the range for all tests in general use.⁴ The percentile can not be standardized in this way because its value is based on rank or position in series merely, without reference to the absolute value of the measurement for which it is the equivalent. Thus, in Table I any constant might be added to or subtracted from the values under S without altering the values under P. Indeed, any increase or decrease of the values under S that did not alter their position in the series, no matter how much their quantitative relations might be disturbed, would have no effect on the values

⁴ Scores near the margins of the series may be used to designate the limits of the range if the margins themselves vary widely from the general tendency of the dispersion.

under P. On the other hand, any change in the quantity of the values under S would be accurately registered under K.

In statistical terminology we may say that measurements of dispersion and skewness for a kental transversion of a series of values vary with measurements of dispersion and skewness for the original series. This means that we may obtain directly from a kental series coefficients of dispersion and skewness which will be as valid for comparative purposes as are similar coefficients derived from the original series. Table III gives the quartile coefficients of dispersion and skewness for the original scores and their percentile and kental transversions. It will be noticed that the coefficients derived from the percentile series do not measure either dispersion or skewness. This is due to the fact that percentiles indicate *rank* in series merely. Hence the intervals between the items of any percentile series are always equal and the distribution graph of such a series is always a straight line. Theoretically, the coefficient of dispersion of such a distribution is 0.5, and the coefficient of skewness 0. The slight variations from these theoretical norms noticeable under P in Table III are due to the small error incidental to the manipulation of figures.

All this clearly indicates the relatively greater accuracy of the kental as against the percentile method. It follows then that percentiles are less adaptable to the purposes of social measurement than are kentals. Obviously, $34p$ deduced from one series of measurements may stand for a performance that is markedly different from a $34p$ performance deduced from a different series of measurements. On the other hand, given the standardization suggested, $34k$ will always stand for the same degree of ability in subjects tested.

The kental is defined as *the unitary value attaching to the one-hundredth subdivision of the standard normal range of ability for any standard mental test*. Where large numbers of measurements are to be transverted into kentals, the scores may be arranged in the form of a frequency table with one hundred classes, the class interval being one-hundredth of the range of

scores. The number of a given class may then be assigned as the kental equivalent of all scores entered in that class. Thus, if the range were 250, the class interval would be 2.5. Suppose the limits of the 82nd class to be 90 and 92.5. Then all scores above 90 and not exceeding 92.5 would be given a rating of 82*k*.

The exactness of the results to be obtained by the method herein described will be dependent on the instrumental precision of the tests employed in making the original measurements. If measurements obtained from the application of tests S and T are to be commensurated, and S represents a very refined measurement of a given process, while T is only a rough approximation to such a degree of accuracy, then clearly the chances are that the range of ability exhibited by the results from S will be greater or less than the range of ability exhibited by the T measurements; and the 100*k* and the 0*k* measurements for the two tests represent degrees of ability that vary with the precision of the tests used. Granted equal instrumental precision for all tests employed, *nk* always stands for equivalence of ability.

Strict accuracy in the commensuration of measurements would further require that the processes measured be of the same value as factors in intelligence. A 100*k* performance for a test of attention would not necessarily be taken to signify adaptive capacity identical with that of a 100*k* performance for a difficult test of judgment; but merely that in each case the performance denoted maximal ability. However, the evaluation of mental processes as adaptive and the rating of tests with respect to instrumental precision are problems of experimentation and not of commensuration. Hence, while they enter into the consideration of the usefulness of the kental unit, they do not at all affect its theoretical validity.

II.—THE COEFFICIENT OF LEARNING

Let us now consider an application of the kental principle to the problem of educational measurement. In Table IV-A have been recorded the results of a study of seventh-grade pupils in a large city where educational research has been well organized.

All pupils were divided into six classes on the basis of their intelligence scores. The medians for these six classes have been recorded in column M.I. The upper and lower limits of the range have been parenthesized. Columns A., R.C., and L. record the median scores attained by the subjects in the six intelligence classes in tests of ability in arithmetic, reading comprehension, and language. The obvious value of such a table is to bring into prominence the relation between intellectual capacity and attainment in learning. If this relation can be reduced to the form of a numerical ratio, we shall have a real index of learning efficiency.

From Table IV-A it is evident that the practical results of instruction do not correlate one hundred percent with the potentialities of the group as indicated by measurements of intelligence. Some classes are obviously doing better than others for the intellectual capital they possess. Striking differences in degree of

TABLE IV.—MEDIAN SCORES OF INTELLIGENCE CLASSES FOR SEVENTH-GRADE PUPILS

Key: M.I. = intelligence scores; A = arithmetic scores; R.C. = reading comprehension scores; L = language scores. Scores in parentheses are individual scores marking the upper and lower limits of the range.

A. ORIGINAL SCORES.				B. KENTAL TRANSVERSIONS			
M. I.	A.	R. C.	L.	M. I.	A.	R. C.	L.
(90)	(8.0)	(37.0)	(26.7)	(100)	(100)	(100)	(100)
86	7.0	32.3	21.1	.91	.80	.79	.67
75	6.6	26.8	18.8	.68	.72	.56	.54
69	6.1	23.8	16.7	.55	.62	.43	.41
65	5.1	23.6	15.8	.47	.42	.42	.36
56	5.1	21.5	14.0	.28	.42	.33	.26
48	4.6	18.0	13.8	.11	.32	.14	.25
(42.5)	(3.0)	(13.6)	(9.5)	(0)	(0)	(0)	(0)

correspondence between intelligence and attainment are brought out by comparing the ratio of the intervals between medians for the intelligence series with the ratio of corresponding intervals between medians for the attainment series. Thus the ratio of the interval between the first and second intelligence classes to the

interval between the second and third intelligence classes is observed to be 11:6, while the corresponding ratio for the arithmetic series is 4:5. But while it is clear that there is relatively closer agreement between attainment and intelligence in some classes than in others, the exact degree of correspondence is obviously difficult to state. Table IV-B facilitates comparison by giving kental equivalents for the original scores. However, before discussing the use that is made of these attainment equivalents, it is necessary to justify the validity of the kental method in effecting such transversions.

If there were a correlation of one hundred percent between intelligence and educational attainment, we should be justified in holding the range of ability measured by the marginal intelligence scores to be identical with the range of ability measured by the marginal attainment scores. The ratio of a subject's attainment score to his intelligence score would then give us the learning efficiency of the subject, which, in the case assumed, would be one hundred percent. But, owing to the vicissitudes of class instruction and other factors conditioning learning, we do not get a correlation of one hundred percent between intelligence and attainment, as the results of Table IV have shown us. Statistical studies generally, however, have shown a rather high correlation between native intelligence and ability to learn. This suggests a rather close approximation between the ranges of intelligence and attainment, and gives us warrant for assuming, as a working hypothesis, their equivalence as units for the measurement of ability.

The main objection that is likely to be raised against the kental transversion of attainment measurements is the lack of an adequate logical justification for the assumed equivalence of ranges for attainment tests. While the constancy of the factors conditioning general intelligence, on the one hand, it may be said, may warrant us in assuming equivalence of range for a series of such tests, the variability of the factors conditioning learning, on the other hand, obliges us to concede the unequivalence of range in the case of attainment tests. For example, if the instructional

methods under which two groups of subjects have been schooled show a tendency for the one to favor the superior student and the other the inferior, the range of the results for any given test, as arithmetic, will vary in the two cases. Where the method favors the superior student, the range will be greater than where it favors the inferior. The difference in range is here discoverable. But if we compare results for two different tests, as arithmetic and language where the same possibility of variation in instructional method exists, in the absence of specific standards for the determination of the incidence of methods, how shall we be able to say which range is the greater and which the lesser? The problem is, then, to find a method of standardizing attainment ranges so that it will be possible to set these ranges in equation with one another and with standard intelligence ranges.

Suppose that, out of thousands of seventh-grade pupils, tested for intelligence and attainment in arithmetic, twenty-five should fall in the one hundredth kental intelligence class. The raw scores of these twenty-five subjects for the arithmetic test would vary within certain limits. This is the result of the tendency of individuals to vary more widely with respect to special than with respect to general capacity. The median attainment score of the twenty-five subjects may be taken as typical of the arithmetic ability of seventh-grade pupils of a 100*k* intelligence. We may, then, fairly hold that the attainment median scored by the maximal or one hundredth kental intelligence class and the attainment median scored by the minimal or first kental intelligence class mark the upper and lower limits respectively of the attainment range which may be taken as typical of the given range of intelligence.

From the theoretical point of view, under experimentally ideal conditions, the attainment scores of a group of subjects of a given class or level of intelligence, will vary within the limits $y_1 \dots y_n$. Following the law of probability, these items will be distributed in accord with the curve of normal frequency, which identifies the position of the measures of central tendency, the mean, mode, and median. If we let y_m stand for the central

tendency, then we can say that where any set of factors, such as superior instructional method, operates to produce a score exceeding the central tendency by the amount t , as $y_m + t$, a set of factors as, in this case, inferior instructional method, will operate equally by the amount t in the opposite direction to produce a score of $y_m - t$. It follows, then, that the intelligence medians, of n classes of subjects will correlate unity with the respective attainment medians, $y_{m1}, y_{m2}, \dots y_{mn}$ of these same intelligence classes. Hence, the range of ability measured by the attainment medians of the marginal intelligence classes is theoretically identical with the range of ability measured by the intelligence medians of these same classes. In this way, I believe, a satisfactory basis for the equation of the kental attainment range with the kental intelligence range is provided.

The method of marginal medians for computing the attainment range for Table IV was not followed for the reason that the necessary data concerning all subjects were not available. The range employed was obtained from the highest and lowest scores. While this method is not as strictly accurate as the one just discussed, it is sufficiently so to illustrate the principles with which this paper is concerned.

It may seem at first glance that the method of highest and lowest scores does not show the relation between intelligence and attainment for the subjects of highest and lowest rank respectively. If, for example, a subject receiving a kental intelligence score of 87, should receive a kental attainment score of 89, the ratio of the second to the first would be more favorable than it would for a subject whose score was 100 in both cases. Even if the second subject should advance his raw attainment score by a considerable amount while the raw score of subject one should remain unchanged, the ratio of his attainment to his intelligence score would still be 100:100. In other words, his raw attainment score would advance while his kental attainment score would remain the same. But while the raw score of the first subject remained absolutely the same, his kental attainment score would decline. This would be due to the fact that the absolute ad-

vance of the raw attainment score of the second subject (scores of other subjects remaining constant) would increase the range and so decrease the value of the constant scores when they were expressed as percents of the increased range. Similarly, the effect of decreasing the absolute score of the subject of lowest rank would be to increase the range and so increase the value of the constant scores when expressed as kentals.

Thus it will be seen that the method of highest and lowest scores does serve to develop and render comparable differences in attainment and intelligence when both kinds of measurement are transverted into kentals. It will be found to tell a fairly truthful story so long as the highest and lowest scores do not vary extremely from the positions which the general tendency of dispersion within the group would assign them.

The foregoing discussion will doubtless suggest to the reader the possibility of expressing the numerical relation between attainment and intelligence as a ratio. We can not, however, use the simple ratio of the kental attainment score to the kental intelligence score as an expression of this relationship; for, owing to the difference in the value of items in the lower and upper parts of the range, such a ratio would be inaccurate. A difference of ten points in the upper part of the range would give an index quite different from that resulting from a difference of ten points in the lower part of the range. For example, if the subjects should receive an intelligence score of $100k$ and an attainment score of $90k$, the ratio would be 0.9 ; but if his intelligence score should be $20k$ and his attainment $10k$, the ratio would be only 0.5 . Let us examine a way of improving on this crude ratio.

If we assume a perfect correlation between mental and educational ability, then the ratio between the attainment transversion of a given subject and his intelligence transversion would be an accurate index of his learning efficiency. If now we find *the difference between a subject's kental attainment score and his kental intelligence score*, noting the direction of difference by a plus or minus sign, we shall have a measure of the subject's devia-

tion from a perfect correlation. A deviation of $+10$, then, would mean that a subject's kental attainment score varied positively from his kental intelligence score by an amount equal to ten percent of the range. If now we let 100 stand for perfect correlation, and add to or subtract from this base, according to the sign, *the computed deviations from a perfect correlation*, we shall have a serviceable ratio of learning to intelligence. This ratio I have called the *coefficient of learning*. It signifies the efficiency to which a given subject or group of subjects have at-

TABLE V.—THE RELATION BETWEEN ATTAINMENT AND INTELLIGENCE SCORES

A. ATTAINMENT DEVIATIONS				B. COEFFICIENTS OF LEARNING			
M.I.	A.-I.	R. C.-I.	L.-I.	A.	R. C.	L.	AV.
86	-11	-12	-24	89	88	76	84.3
75	+4	-12	-14	104	88	86	92.6
69	+7	-12	-11	107	88	89	94.6
65	-5	-5	-11	95	95	89	93.0
56	+14	+5	-2	114	105	98	105.6
48	+21	+3	+14	121	103	114	112.6

tained in the use to which they have put their intellectual capital in the process of learning.

Since the kental range is always one hundred, this method of computing a coefficient of learning permits a record of all possible theoretical cases. As proof, consider the extreme possibilities. If the intelligence score is $0k$ and the attainment score $100k$, the deviation is $+100$ and the coefficient of learning is 200. If, on the other hand, the intelligence score is $100k$ and the attainment score $0k$, the deviation is -100 and the coefficient of learning is 0. Within these extremes lie all possible theoretical variations in learning efficiency.

In Table V-A are recorded the deviations of the attainment medians given in Table IV-B from the intelligence medians given in Table IV-B. In Table V-B the coefficients of learning have

been computed by the method just described. A study of Tables V-B and IV-A may serve as a test of the relative effectiveness of crude scores and coefficients of learning as a means of comparing attainment in learning with general intelligence.

The general conclusion to be drawn from Table V-B is that the resources of the pupils of highest intelligence have been taxed less severely by the learning process than have the resources of the pupils of least intelligence. The coefficient of learning appears to give an excellent check on the classification of pupils according to ability to learn. The desideratum certainly is that each pupil be given opportunity to advance educationally as rapidly as he may. It is bootless to argue in favor of a rigid classification according to intelligence alone, for it matters not so far as the organization of instruction is concerned whether a pupil's inability to advance is due to lack of intelligence, lack of interest, lack of instructional efficiency, or what not, so long as the fact of his inability is apparent. The coefficient of learning, to be sure, does not enlighten us as to the nature of the factors operating to accelerate or retard the pupil beyond the place which his intelligence would indicate he should occupy. It does, however, enable us to experiment intelligently with such factors and to determine their relative causal efficiency.⁵

In the elaboration of the method of this paper, the writer has aimed to facilitate the comparison of incommensurable quantities. According as it serves this end, the kental principle and its application in the computation of the coefficient of learning must be judged.

⁵ In the comparison of the coefficient of learning with the achievement quotient as developed by Buckingham and Monroe, I have found that the computation of the quotient from mental and achievement ages requires on the average from five to six times as long as the computation of the coefficient from kental intelligence and attainment scores. The operations involved in deriving the coefficient of learning are, indeed, so simple that they may be performed by the average teacher without the use of deviation tables. The only tables with which it would be necessary to supply the practitioner would be the tables for transverting raw scores into kentals. The preparation of such tables, as described on p. 145, is so much simpler than the preparation of the tables for obtaining achievement ages and achievement quotients that the fact may appeal to the experimenter concerned with the standardizing of tests. The factor of age does not enter into the calculation of the coefficient of learning. The relation it draws between attainment and intelligence is immediate.