1952

A survey of an x school in Newton, to discover the number of pupils working up to, above and below ability, according to a regression technique

Ed.
Thesis
Norton, F.A.
1952

BOSTON UNIVERSITY

SCHOOL OF EDUCATION

Thesis

A SURVEY OF AN X SCHOOL IN NEWTON, TO DISCOVER THE NUMBER OF PUPILS WORKING UP TO, ABOVE AND BELOW ABILITY, ACCORDING TO A REGRESSION TECHNIQUE

Submitted by

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In Partial Fulfillment of Requirements for
the Degree of Master of Education

1952

First Reader: William C. Kvaraceus, <u>Professor of Education</u>

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CHAPTER I

Statement of the Problem

In any school there is always the problem of whether or not pupils are working up to their ability. The teacher is constantly wondering if she is getting the most from the child according to his ability to achieve.

This study is aimed to survey the number of children in an X school in Newton who are working up to their ability, the number who are working significantly above their ability and the number who are working significantly below their ability. Using the Kuhlmann-Anderson Test as the measure of capacity and the Metropolitan Achievement Test, Form R as the measure of achievement, the results of these tests were figured scientifically according to a regression technique to determine which children were working up to, above and below capacity.

Source

Every year in this city the third grade is given the Kuhlmann-Anderson Intelligence and the Metropolitan Achievement Tests. Naturally the teachers of the second, fourth and fifth grades were anxious to find out whether or not their pupils were working up to ability and whether or not they were expecting too much of them. The helping class teacher was also anxious to obtain this information because she not only works with the mentally retarded children, but she is supposed to assist children in the regular grades who are not achieving "up to grade" and primarily those pupils "who are not working up to their ability". Therefore, in order to determine which children should go to the helping class for extra help and to give the regular grade teachers an idea of which pupils in their classes are not working up to their ability, this study was undertaken.

Justification

To the writer, any study which will help the teacher get a better understanding of the children with whom she is working is justified.

According to Hildreth,[1] some of the uses to which the teacher may put the results of the Metropolitan Achievement Test are as follows:

> "1. To determine the achievement level of each pupil in each subject with relation to age and ability, with equal emphasis on the gifted as well as on the slow or special problem cases.
>
> 2. To determine the average achievement level of a class at the beginning or end of the year.

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1. Gertrude Hildreth, Metropolitan Achievement Tests, Manual for Interpreting, World Book Company, Yonkers-On-Hudson, New York, 1948, p. 2.

3. To obtain a picture of the nature and range of individual differences within the group.

4. To group pupils within the class for instruction.

5. To diagnose an individual pupil's difficulties in learning.

6. To call attention to subject areas where more detailed testing is required to check on the effectiveness of teaching.

7. To provide a basis for counseling with parents regarding a pupil's achievement."

This study, since it intends to point up these very things, will attain these objectives, providing they can be attained, in relation to the ability of the pupil.

Scope of the Study

This study includes one hundred and eighty-eight children of grades two through five in an X school in Newton. The means and standard deviations of the children's ages for each grade are given below:

Table 1. Means and Standard Deviations of Ages of Children Included in this Study for Grades II through V

Grade	Mean	Standard Deviation
II	7-7	4 months
III	8-4	4 months
IV	9-9	4 months
V	10-10	2 months

This school is an atypical school of Newton in that children who are mentally retarded, physically handicapped or emotionally disturbed come from other sections of the city. In order to get a true picture of the school itself, all out-of-district children were excluded from the study. Because of absence at the time of testing, there were necessarily a few in-district children excluded, too. There was one first grade child, eight third grade, five fourth grade and one fifth grade child excluded from the study. Therefore the actual number of children included in the study were fifty-three or ninety-six per cent of the second grade children; forty-nine or eighty-five per cent of third grade children; forty-nine or ninety-one per cent of fourth-grade children and thirty-seven or ninety-seven per cent of fifth grade children. This is a high percentage and a representative sample of the pupils of the school.

Definition of Terms

Capacity.[1]--

"By 'capacity to achieve' is meant the potential ability to perform successfully in school subjects. It is ordinarily determined by one's score on an intelligence measure. It is a predictive measure in the sense that it measures the ability of a pupil to profit from instruction."

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1. George A. Prescott, The Development of An Improved Method of Making Capacity-Achievement Comparisons, Unpublished Doctor's Dissertation, Boston University, 1950, p. 4.

Achievement.[1]--

"The term 'actual achievement' refers to the amount and quality of school work in specific subject matter areas that has been learned by the pupil as measured by a standardized achievement test."

High, Average and Low Achievers.-- An average achiever is one whose regressed difference between his converted Metropolitan Achievement Test score and Kuhlmann-Anderson score falls within $\pm$ one standard error of estimate. A high achiever is one whose regressed difference between his converted Metropolitan Achievement Test score and his Kuhlmann-Anderson score is greater than + one standard error of estimate. A low achiever is one whose regressed difference between his converted Metropolitan Achievement Test score and his Kuhlmann-Anderson score is lower than - one standard error of estimate.

Summary:

This study is a survey of an X school in Newton to discover the number of pupils who are working up to their ability, above their ability and below their ability according to a regression technique for the purpose of assisting the grade teachers in understanding their pupils and the children who need extra help.

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1. Ibid p. 5.

CHAPTER II

Review of Research

Although there have been many different methods of comparing ability and achievement, the writer will dwell on only two methods, namely the Accomplishment Quotient and Dr. Prescott's Regression Technique.[1]

AQ Technique

The first article mentioning the achievement quotient was the one by Monroe and Buckingham[2] in the Illinois Examination which measured both intelligence and achievement, using group tests. Franzen[3] elaborated on its use the same year, calling it the accomplishment quotient. He used the Stanford Revision Individual Test.

Definition of AQ.-- Even though it is sometimes called the achievement quotient and at other times the accomplishment quotient, it is the same thing and is obtained in the same way. The formula used is as follows:

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1. Op. Cit.

2. N. S. Monroe and B. R. Buckingham, Illinois Examination Teacher's Handbook, University of Illinois, Bureau of Educational Research (July, 1920). Urbana

3. Raymond Franzen, "The Accomplishment Quotient", Teachers College Record, (November, 1920), 21:432-40.

$$AQ = \frac{EQ}{IQ} = \frac{\frac{EA}{CA}}{\frac{MA}{CA}} = \frac{EA}{MA}$$ [1]

where "AQ = Accomplishment or Achievement Quotient
EQ = Educational Quotient
IQ = Intelligence Quotient
EA = Educational Age
CA = Chronological Age
MA = Mental Age

Monroe and Buckingham[1] call the relationship between achievement and ability the achievement quotient and consider it "....as a measuring device for combining in an effective way the results of educational and mental tests into a measure of educational achievement relative to the pupil's capacity to progress." They[2] also consider it a "....simple method of comparing a pupil's achievement age with his mental age (learning capacity)". They go on to say that an AQ of 1.00 means[3] "....that the pupil has achieved exactly as well as the average of the pupils of his mental age". They further state that[4]

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1. Herbert A. Toops and P. M. Symonds, "What Shall We Expect of the AQ?" Journal of Educational Psychology, 13:514.

2. *Op. Cit.* p. 31.

3. *Ibid* p. 11.

4. *Ibid* p. 38.

> "....if a pupil's achievement is 0.75, we have evidence that he has achieved only 75 per cent as much as the average of t he pupils of his mental age. ....If the pupil's achievement quotient is 130, it means that he has achieved 30 per cent more than the average of the pupils of his mental age."

Franzen[1] considers the AQ as the "....degree to which a pupil's actual progress has attained to his potential progress by the best possible measures of both". He feels that an AQ less than 1.00 means that the pupil is doing work less than normal for his mentality and that an AQ of more than 1.00 is impossible.[2]

> "One's difference when EQ is subtracted from IQ are always positive when they are large enough to be significant and small enough to seem spurious when they are negative.... It is safe, therefore, for practical use to assume that the optimum accomplishment is 1.00."

Advantage of the AQ.-- In reviewing the research, the writer could find almost no advantages of the AQ; however, one was mentioned by Toops and Symonds[3] who said, "....the greatest value of the AQ is in getting teacher and pupil interested in progress."

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1. Raymond Franzen, Op. Cit., p. 436.

2. Op. Cit., p. 437.

3. Op. Cit., p. 522

Disadvantages of the AQ.-- There are many disadvantages of the AQ, foremost among which is the fact that both the EQ and IQ are not wholly reliable. Therefore,[1] "It is statistically sound that a quotient will tend to be more unreliable than either of the two tests from which it is derived." McCrory[2] goes on to say

> "Three factors seem to have decided influence on the reliability of the accomplishment quotient: the reliability of the intelligence test, the reliability of the achievement test, and the correlation between the intelligence and achievement tests. These three factors appear to affect the reliability of the accomplishment quotient in the following manner: increasing the reliability of the intelligence test increases the reliability of the accomplishment quotient; increasing the reliability of the achievement test increases the reliability of the accomplishment quotient; decreasing the correlation between the intelligence and achievement test increases the reliability of the accomplishment quotient. The converse of these latter statements also holds. With intelligence and achievement tests of high reliability, the correlation between intelligence and achievement tests is of minor concern."

According to Pintner:[3]

> "There is much doubt as to the value of the AQ for school purposes. It is a derived score depending upon at least two standardizations, one of a mental test and the other of an educational test. Unless

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1. John McCrory, "The Reliability of the Accomplishment Quotient", Journal of Educational Research, (January, 1932) 25:29

2. Ibid., p. 29.

3. Rudolph Pintner, Intelligence Testing-Methods and Results, Henry Holt and Company, New York, 1931, pp. 122-123.

these two standardizations are comparable, i. e., based upon the same kind of sampling, we have no means of knowing how to interpret the AQ, derived from the IQ and EQ of our two standardizations. The best results with the AQ technique would be obtained by the use of educational and intelligence tests standardized on the same populations."

Pintner[1] went on to say that Popenoe tried to measure the reliability of the AQ by giving two repetitions of the intelligence and educational tests, calculating two AQ's for each child. The resulting correlation was 0.28.

Again, Chapman[2] claims that a weakness of the AQ is its low reliability which results from the fact that a ratio between two measures which are themselves not highly reliable cannot be highly reliable because the quotient of two unreliable measures is less reliable than either of the measures.

The AQ assumes that the growth line is a straight one, whereas it actually is not. Prescott[3] says, "When age norms are plotted, the result is seldom a straight line, but a

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1. _Ibid_ p. 124.

2. J. Crosby Chapman, "The Unreliability of the Difference Between Intelligence and Educational Ratings", _Journal of Educational Psychology_, (February, 1923), 14:103-8.

3. _Op. Cit._, p. 44.

curve, which eventually becomes a straight line parallel with the base line." In other words, the rate of mental growth varies just as physical growth does. At some ages, pupils grow rapidly and at others, slowly.

Children[1] of high IQ's do not attain as high EA's as MA's, and so, therefore, do not achieve an AQ of 1.00 because they are generally found in a grade or grades below their intellectual level. Toops and Pintner[2] agree with this and say:

> ".....one very important reason for so many of the mentally advanced pupils being retarded in accomplishment is the fact that many bright pupils are promoted by chronological age rather than by ability to progress and so have not had the chance to come up to normal by being given opportunity to do advanced work."

Another reason for this is the fact that the instructional levels of most schools are geared to the average and inferior pupils and the curriculum often does not have enough ceiling to interest and motivate superior pupils. Greene, Jorgensen and Gerberech[3] say, "Therefore an AQ below 1.00 may indicate

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1. Rudolph Pintner, Op. Cit., p. 122.

2. Toops, H. A. and R. Pintner, "Mentality and School Progress", Journal of Educational Psychology (1919) No. 5-6 10:253-262.

3. Harry Greene, Albert Jorgensen and J. Raymond Gerberech, Measurement and Evaluation in the Elementary School, Longman, Green and Company, New York, 1942, p. 241.

poor effort, a high IQ, or both, and AQ of more than 1.00 may indicate unusual effort, or low IQ, or both."

To go back to the fact that superior children are generally not placed at their proper mental level, the point is that naturally their EA would be lower than MA because there would be many educational processes to which they have not been exposed. It follows that a child with a CA of twelve and MA of twelve placed in a sixth grade would have greater opportunity to be exposed to more educational experiences than a child with the same MA, but with a CA of ten and placed in a fourth grade. This point is important to keep in mind when comparing AQ's of pupils of the same mental age.

Correlations.-- Dr. Kvaraceus,[1] in a review of the correlation between tests of intelligence and achievement, reported that Gates found correlations of between .47 and 165 between group tests of general ability and composite scores on educational achievement tests in the elementary grades. Pintner compiled correlations of intelligence and achievement as reported by fourteen authors found a range of r from .28 to .60 with a mean r of .46. Hartson and Sprow, who studied the Otis, Terman, Henman-Nelson National, Kuhlmann-Anderson and Ohio

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1. William C. Kvaraceus, "Educational Measurements-Educational Psychology-124", Unpublished Boston University Bulletin.

State University Psychological, found the correlation between intelligence and scholastic achievement was about .40. These correlations have a low percentage of forecasting efficiency. The highest correlations found was .65 which shows some relationship but very limited use for prognostic purposes. The correlations below .30 show only slight relationship with no prognostic value for practical purposes.

Most authors stress the fact that the AQ is much less valuable than it was thought to be when it was first developed. As was mentioned above, there have been many techniques developed for comparing achievement and ability, but there will be only one other method discussed in this study, namely Dr. Prescott's regression technique.

Prescott's Technique

George A. Prescott[1] developed an improved technique of making capacity-achievement comparisons. He used the Pintner General Ability Test: Verbal Series as the capacity measure and the reading, vocabulary, arithmetic fundamentals, arithmetic problems, language usage and spelling tests of the Metropolitan Achievement Battery as the achievement measures. He did this for four grades, 4.5 to 8.5.

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1. *Op. Cit.* pp. 55-56.

<u>Guides used in developing the method</u>.-- The following guides were used by Prescott[1] for the development of such a technique.

> "1. Comparison of capacity and achievement should be restricted to specific areas of achievement, where, at least a reasonable amount of continuity of instruction exists from one level (age or grade) to another. A composite achievement measure, that is, an achievement score obtained by totaling or averaging achievement scores from a number of achievement tests, is meaningless under most circumstances.
> 2. The system of comparison must take into account the unreliabilities of whatever capacity and achievement measures are employed.
> 3. The computation of quotients obtained by dividing an achievement measure by a capacity measure should <u>not</u> constitute the method of comparison.
> 4. The derived score units must be equally variable from age (or grade) level to age (or grade) level.
> 5. The derived test score units must be equally variable from the capacity measure to the several achievement measures.
> 6. The derived score units of the capacity and achievement measures being compared must be relatively independent of the developmental curves through the mean scores of successive groups (age or grade) while reflecting accurately changes in the growth pattern of individual pupils.
> 7. Extrapolated values should be avoided.
> 8. The system should make allowances for the exposure differential.
> 9. Allowance must be made for differences in community level of achievement due to the operation of specific factors, such as curriculum differences, differences in methods, differences in length of school year, and differences in promotion policies.
> 10. Allowance must be made for the regression effect of a first score upon a second due to the imperfect correlation between the two measures."

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1. <u>Ibid</u>, pp. 51-52.

Prescott's Method.-- Prescott[1] describes his improved method of making capacity-achievement comparison as follows:

> "After capacity and achievement tests to be employed have been selected and a decision has been made regarding the population on which the norms shall be based, two major steps remain. The first step involves the setting up of comparable test score units for the capacity measure and the several achievement measures; the second is concerned with the method of comparing one's actual achievement with his expected achievement.
>
> To set up comparable score units that are equally variable from level to level (grade or age) and from the capacity to the achievement measures, the progression of both the mean scores and standard deviations of scores is determined for each of the measures separately. The developmental lines for the means provide the basis for determining the amount by which an individual deviates from the norm at his particular level. A correction for the unequal variability of test scores is determined by dividing an arbitrarily established standard deviation of 15 by the standard deviation of the test scores at each level. The deviation of any score from the norm multiplied by this ratio added to, or subtracted from, 100 results in a new deviation-type score that is constant regardless of grade or age. This procedure is applied independently to the capacity measure and the several achievement measures, thereby canceling out differences in the shapes of the developmental lines for the means. Thus it is possible to make direct comparisons of the capacity and achievement measures.
>
> Expected achievement scores are obtained by computing the coefficient of correlation between the capacity and achievement measure and determining the regression of achievement on capacity. This makes it possible to compare a pupil's actual achievement in each of several subject matter areas and the achievement that can be expected of him in light of his capacity to achieve."

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1. Op. Cit., pp 52-53.

Validity of method.-- The validity of this new method has not been determined. The author[1] says: "Final validation must always be in terms of how it actually works; hence, validation must await its application to a number of communities and at several grade levels."

The author claims that his method meets all the guides set up with the exception of the one which has to do with differences in curriculum, methods, length of school year and promotion policies. He says,[2]

> ".... This criterion is not met adequately. The norms which serve as the basis for the comparisons involved in this approach are truly national norms, representative of the country as a whole. No norms based on groups in which differential factors are operating to lower or raise the achievement level in any subject have been set up."

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1. Op. Cit., p. 137.

2. Op. Cit., p. 92.

CHAPTER III

PRocedure

Time of Testing

The Kuhlmann-Anderson Intelligence Tests and the Metropolitan Achievement Test, Elementary Battery were given to Grade III between the sixteenth of November and the fifteenth of December of 1950. During the week of April twenty-third of 1951, the same intelligence test suitable to grade were given to Grades II, IV and V. The Metropolitan Achievement Tests, Form R were also given in this same week. Primary Battery was given to Grade II, Elementary Battery to Grade IV and Intermediate (Partial) Battery to Grade V. Justifying the giving of achievement and intelligence tests at approximately the same time, Mildred Allen[1] says:

> "The validity of long range predictions from a group intelligence test given at an early age (first grade) is highly questionable. The content material of most first-grade intelligence tests is practically all non-verbal, since entering first-grade pupils have not learned to read. As pupils advance through the grades, it appears that a group intelligence test with content material of a verbal nature has greater validity for predicting successful achievement

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1. Mildred Allen, "Relationship Between Indices of Intelligence Derived from the Kuhlmann-Anderson Intelligence Tests for Grade I and the Same Tests for Grade IV", *Journal of Educational Psychology*, (April, 1945) 36:255.

in the tool subjects when administered at approximately the same time as an achievement test. Such a combination of testing is also significant in determining whether pupils are working up to their ability."

Metropolitan Achievement Test

According to Prescott,[1]

"Any discussion of the difficulties involved in making capacity-achievement comparisons must commence by considering the validity of the capacity and achievement measures being compared, for no method, regardless of how elaborate it may be, can compensate for lack of validity in the measures employed."

Standardization.-- In view of this, the Metropolitan Achievement Tests[2] were used because of the fact that they were standardized on a more representative population than the majority of tests. More than 500,000 tests were given and of this number, the norms were based on a 25 per cent random sample from each classroom tested. Another good feature of this test is that in the event that anyone is doubtful as to the usefulness of national norms, the World has put out tables of New England norms.[3]

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1. Op. cit., p. 40.

2. Gertrude Hildreth, Manual for Interpreting, World Book Company, Yonkers-On-Hudson, 1948, p. 9.

3. Margaret Allen, The Preparation of New England Norms for the 1947 Revision of the Metropolitan Achievement Tests and their Evaluation, Unpublished Master's Thesis, Boston University, 1949.

Reliability.-- A table showing the reliability coefficient based on raw scores for the batteries suitable to Grades II, III and V is shown below. This information is given for only one grade for each battery; therefore, it is not shown for Grade IV because the same battery, namely, the Elementary, is used for both Grades III and IV.

Table 2. Reliability Coefficients of Subtests of Metropolitan Achievement Tests, Form R, Batteries Primary II, Elementary and Intermediate[1]

Battery	Grade	N	Test	Reliability Coefficient
Primary II	2	363	Reading	.951
			Word Meaning	.947
			Arith.Fund.	.970
			Arith.Prob.	.852
			Spelling	.936
Elementary	3	374	Reading	.959
			Vocabulary	.927
			Arith.Fund.	.946
			Arith.Prob.	.871
			Language Usage	.924
			Spelling	.934
Intermediate	5	350	Reading	.954
			Vocabulary	.926
			Arith.Fund.	.914
			Arith.Prob.	.879
			English	.904
			Spelling	.933

1. Gertrude Hildreth, Adapted form Table 2, Op. Cit., p. 9.

Kuhlmann-Anderson Test

The Kuhlmann-Anderson Intelligence Test was chosen as the measure of capacity. There are thirty-nine tests in the scale arranged in order of difficulty which may be used for either individual or group testing. The following chart[1] shows the batteries for group testing:

Table 3. Batteries Used for Group Testing[1]

School Grade	Tests	Age Where Tests Fit Best
I (First Semester)	1 to 10	6-0
I (Second Semester)	4 to 13	6-6
II	8 to 17	7-6
III	12 to 21	8-6
IV	15 to 24	9-6
V	19 to 28	10-6
VI	22 to 31	11-6
VII-VII	25 to 34	13-0
IX-XII	30 to 39	15-6

In determining the battery to be used, one chooses the test suitable to the expected mental level of the group. If nothing is definitely known about the mental level, it is assumed that the probable mental level is the same as the average chronological age of the group.

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1. F. Kuhlmann and Rose Anderson, Kuhlmann-Anderson Intelligence Tests, Instruction Manual, Educational Test Bureau, Minneapolis, 1942, p. 2.

There[2] are two batteries of tests for the first grade because of the different minimum admission ages. When the minimum is five and a half years, the average age for the grade is about six, while, when the mimimum admission age is six, the average age for the grade is six and a half. These two tests contain twelve subtests, with two of them used for practice and not counted in the scoring. The authors[2] say, "At best, the results here must not be expected to be as reliable as in higher grades. In the first grade a larger number of unmerited low scores will occur, except under ideal conditions."

<u>Standardization</u>.-- The average age was determined at which one trial and no more, two trials and no more, etc. were passed. Over thirty thousand were examined with the tests. According to Marzolf,[3]

> "Standardization groups have been selected from supposedly representative communities of the North Carolina and Middle Atlantic States. Repeated revisions and the use of over five thousand subjects for the final revision have produced mental age norms which are doubtless quite dependable."

<u>Validity</u>.-- The authors have their own idea of determining validity of their test. They do not hold with the

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1. <u>Ibid.</u>, p. 1.

2. <u>Ibid.</u>, p. 1.

3. Stanley S. Marzolf, Third Mental Measurements Yearbook, Oscar K. Buros, Ed., Rutgers University Press, 1949, p. 236.

conventional ways of determining validity of a test. They[1] say,

> "In the present tests, chronological age is used as the criterion of what the tests propose to measure. We propose to measure mental development from the age of five to mental maturity. For this purpose that test is most valid which shows this development best, by having the highest rate of increase in score through successive years. This trait has been called the discriminative capacity of the tests, or the ability to make fine discrimination between small increments in mental development. The age norm table gives a rough indication of the discriminative capacity of each test. The thirty-nine tests included in the nine batteries of the scale were selected from over a hundred tried out, because, with a few exceptions, they gave the largest and most consistent increase in score for successive age levels. The exceptions were determined by such considerations as ease of administration, of scoring, and possibility of being influenced by coaching and special training."

The authors[2] say that if a test is used at an age level where pupils fail to pass it because of inadequate opportunity rather than lack of ability, the test ceases to be a measure of mental development and nothing else, and thus loses validity. Every effort has been made to avoid this.

Reliability.-- Authors[3] have attempted to make the tests reliable by adjusting the difficulty of the tests used at each age to the mental development found there. The tests become

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1. F. Kuhlmann and Rose G. Anderson, op. cit., p. 8.

2. Op. cit., p. 10

3. Ibid., p. 10

progressively difficult and each battery of tests presents the same difficulty at the age at which it is used as does any other battery at the age at which it is used. Marzolf[1] says:

> "These tests are probably much better than the authors' reasoning about validity and reliability would lead one to expect. They will continue to be widely used, largely because of their brevity. Perhaps the best reason for their continued use is that they are relatively less dependent upon reading skill than are most other group tests."

Factors Other Than Tests Necessary in This Technique

Mean.-- After both the Metropolitan Achievement and the Kuhlmann-Anderson Intelligence tests were given and corrected, the arithmetic mean of each subtest of the achievement test for each grade and of the Mental Units of the intelligence test of each grade were found using the following formula:[2]

$$M = m + C$$

where M is the guessed mean
C is the correction

The formula used for the correction for grouped data is the following:

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1. Stanley S. Marzolf, Op. Cit., p. 237.

2. J. P. Guilford, Fundamental Statistics in Psychology and Education, McGraw-Hill Book Company, New York, 1942, pp. 31 and 33.

$$C = i\left(\frac{\Sigma fx'}{N}\right)$$

Where i = size of the class interval
x' = deviation of a class interval from the guessed mean in terms of "i" as the unit
f = frequency within a class interval
Σ = sum of
N = total number of measurements

Standard Deviation.-- The standard deviation had to be found in order to find the standard error of estimate which is to be the criterion for discovering which children were working up to, below or above ability. Therefore, the next step was to find the standard deviation for each subtest of the Metropolitan Achievement Test and for the Kuhlmann-Anderson Mental Units for each grade, using the following formula for group data[1]:

$$\sigma = i\sqrt{\frac{\Sigma Fx'^2}{N} - c^2}$$

Where i = size of class interval
x' = deviation from the guessed mean in terms of the class interval as the temporary unit
c' = correction in the guessed mean, also in terms of the class interval as a unit

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1. J. P. Guilford, Op. Cit., p. 33.

2. J. P. Guilford, Op. Cit., p. 34.

<u>Otis Normal Percentile Charts</u>.-- The Otis Normal Percentile Charts are specially constructed charts, seventeen by eleven inches of cross-section paper marked off on a percentile scale ranging from 0.1 to 99.9. On the horizontal line, these units get larger as they go away from the 50th percentile toward the 99.9 percentile and toward the 0.1 percentile, whereas on the vertical line the units are equal, with a darker line at every fifth interval.

At the top of the chart, there are sections for recording such pertinent information as the grade, number of cases, name of test, form, date, examiner, maker of the graphs, school and city. At the left of the chart, there are columns for recording information necessary for plotting the charts, namely, score intervals, frequencies, subtotals and per cents for each of two variables, with a space at the bottom for the median of each variable. At the bottom of the charts, there is a standard deviation scale from -3 to +3, with tenths of a sigma marked.

The Otis Normal Percentile Charts were used to convert the Metropolitan Achievement Test scores to Kuhlmann-Anderson scores. Another expression for converting scores is finding the correspondence between scores. Otis and Durost[1] say:

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1. Arthur S. Otis and Walter N. Durost, "Statistical Methods Applied to Test Scores", <u>Test Method Help Number Four</u>, Department of Research and Test Service of World Book Co., Yonkers-On-Hudson, 1938, pp. 19-20.

"If two tests have been given to the same fairly large group of individuals (or approximately the same individuals) any score in one of the tests is considered as corresponding to the score in the other test which has the same percentile rank in the group. Thus the 50-percentile score (median) in one distribution corresponds to the 50-percentile score (median) in the other distribution, the 60-percentile score in one distribution corresponds to the 60-percentile in the other distribution, and so on. It will be seen, therefore, that in using the method described above, we are merely finding the scores in the two distributions which have the same percentile rank in those distributions."

The Otis Normal Percentile Charts were set up with the Kuhlmann-Anderson Mental Units scores as variable I and the Metropolitan Achievement Test Standard scores as Variable II. The next step was to find the Kuhlmann-Anderson scores corresponding to the Metropolitan Achievement scores. Taking reading of Grade V as an example, supposing the score 187 is at the 45-percentile, let your finger go down the 45-percentile until reaching the point where Kuhlmann-Anderson line crosses this percentile. Check back to the score intervals to find what score is on this point. Since it is 344, then that is the corresponding or converted score for the Metropolitan Reading score of 187 for Grade V in this study. This same procedure was followed for each score of each child in each subtest for his grade. An example is shown in Figure 1 showing how the Otis Normal Percentile Chart is set up to convert scores. Variable I is the fifth grade Kuhlmann-

NORMAL PERCENTILE CHART

By Arthur S. Otis

	Grade or group	No. of cases	Measure (Examination)	Form	Date	Examiner	Graphs by	School	City
Variable I	V	37	Kuhlmann-Anderson, Grade V		April, 1951	F Norton	F Norton	X	Newton
Variable II	V	37	Met. Ach. Test, Intermediate, Rdg	R	April, 1951	F. Norton	F Norton	x	Newton

Variable I				Variable II			
Score intervals	Freq'ncies	Sub-totals	Per cents	Score intervals	Freq'ncies	Sub-totals	Per cents
				228-232	2	37	100
				223-227	1	35	95
				218-222	3	34	92
				213-217	3	31	84
				208-212	1	28	76
				203-207	2	27	73
				198-202	2	25	67
				193-197	3	23	62
363-367	1	37	100	188-192	3	20	54
358-362	4	36	97	183-187	4	17	45
353-357	5	32	86	178-82	4	13	35
348-352	7	27	73	173-177	4	9	24
343-347	5	20	54	168-172	1	5	14
338-342	6	15	40	163-167	1	4	10
333-337	4	9	24	158-62	1	3	8
328-332	4	5	14	153-157			
323-327				148-152	1	2	5
318-322				143-147			
313-317				138-142			
308-312	1	1	3	133-137	1	1	3
Median				Median			

PERCENTILE SCALE

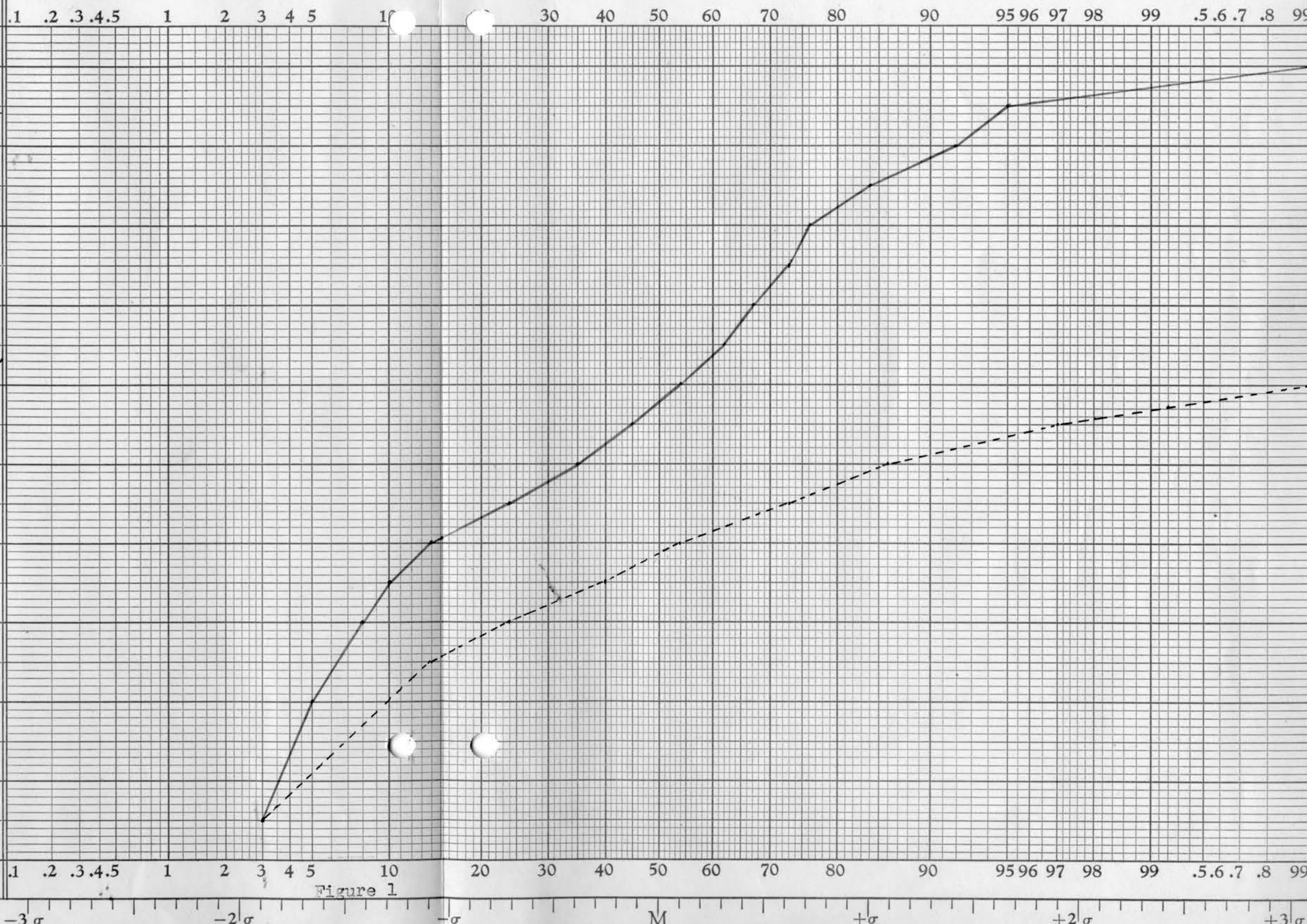

Figure 1

--- K.A.
— Met. Ach. Standard Deviation Scale

Anderson Mental Units scores and Variable II is the reading test of the Metropolitan Achievement Test.

Real Difference.-- After converting the Metropolitan Achievement standard scores to Kuhlmann-Anderson scores, the next step was to find the real difference between them, using the Kuhlmann-Anderson Mental Units scores as the anchor scores. For example, if the Kuhlmann-Anderson score is 321 and the converted Metropolitan standard score is 328, the real difference is+7, whereas if the Kuhlmann-Anderson score is 321 and the converted Metropolitan standard score is 316, the real difference is -5.

Correlation.-- Prescott[1] says, "The efficiency of the predictive measure may be determined by computing the coefficient of correlation between the capacity and achievement measures." The writer found the coefficient or correlation between the Kuhlmann-Anderson Test and the subtests for the Metropolitan Achievement Tests. There were five correlations for Grade II, six for Grades III, IV and V, making twenty-three in all. The coefficient of correlation was found between each Metropolitan Achievement subtest of each grade and the Kuhlmann-Anderson Intelligence Test for the corresponding grade. The Durost-Walker[2]

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1. George A. Prescott, Op. Cit., p. 41.

2. Walter N. Durost and Helen M. Walker, Durost-Walker Correlation Chart, World Book Company, Yonkers-On-Hudson, 1937.

Correlation Charts were used to compute these correlations, using the Directions for Use which come with each package of charts as a guide. A sample chart is shown in the appendix of this study.

Regressed Difference.-- The next step was to find the regressed difference between the converted Metropolitan Achievement subtest scores and Kuhlmann-Anderson scores. This was done by multiplying the real difference between the converted Metropolitan Achievement subtest scores by the coefficient of correlation between the Kuhlmann-Anderson scores and the Metropolitan Achievement subtest scores. An example is that in the Intermediate Metropolitan Achievement Test, Language, the real difference between the converted score and Kuhlmann-Anderson score is -11, with the coefficient of correlation between the Kuhlmann-Anderson scores for Grade V and the Language subtest of the Metropolitan Achievement Test, Intermediate Battery, Partial is 0.74, the regressed difference is -8. The above procedure was followed for all the grades involved in this study.

Lennon[1] says:

> "In general the greatest correlation tends to be between the reading measures and the intelligence measures; at the seventh, eighth and ninth grade levels, these correlations almost approach the

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1. R. T. Lennon, "The Relationship Between Intelligence and Achievement Tests - Results for a Group of Communities," Journal of Ed. Psychology (May, 1950), 41:306.

magnitude that one would expect to find between two measures of intelligence or between two reading tests."

In this study, the highest correlations were between Language and the Intelligence Test with Reading having the lowest correlation in Grade II, the second highest correlation in Grade IV and the third highest correlation in Grades III and V.

Table 4 shows an example of the procedure followed for finding the regressed difference between the converted Metropolitan Achievement Test standard reading scores and the Kuhlmann-Anderson Mental Units scores for Grade V.

Table 4. An Example of Procedure Followed to Find Regressed Difference Between Converted Metropolitan Achievement Reading Scores and Kuhlmann-Anderson Scores for Grade V

K.A. Scores	Met.Ach.Rdg. Scores	Converted Met.Ach. Rdg. Scores	Real Dif. Between Converted Met. Ach. Rdg.Scores and K.A. Scores	Regressed Dif.Between Converted Met. Ach. Rdg.Scores and K.A. Scores
312	135	311	-1	-1
329	150	317	-12	-8
331	170	329	-2	-1
332	189	345	+13	+8
332	197	349	+17	+11
333	165	325	-8	-5
333	214	354	+21	+13
335	183	341	+6	+4
337	178	337	0	0
339	159	322	-17	-11
340	193	347	+7	+4
340	192	347	+7	+4
340	190	345	+5	+3
341	187	344	+3	+2
342	174	334	-8	-5
343	178	337	-6	-4
343	183	341	-2	-1
344	181	340	-4	-3
345	201	350	+5	+3
346	221	359	+15	+10
349	184	342	-7	-4
349	204	351	+2	+1
350	178	337	-13	-8
350	177	337	-13	-8
351	205	351	0	0
351	219	358	+7	+4
351	197	349	-2	-1
354	209	352	-2	-1

Correlation between K.A. scores and
Met. Ach. Rd. scores of Grade V = .64
Standard Error of Estimate = ±8

Standard error of estimate.-- When predicting y, the following formula is used:[1]

$$\sigma_{yx} = \sigma_y \sqrt{1 - r^2_{yx}}$$

When predicting x the following formula is used:

$$\sigma_{xy} = \sigma_x \sqrt{1 - r^2_{xy}}$$

Since after converting the Metropolitan Achievement scores to Kuhlmann-Anderson scores, the standard deviation is the same, the writer used the following formula to find the standard error of estimate: $S.E.Est. = \sigma \sqrt{1-r^2}$

The standard error of estimate was found for each subtest of the Metropolitan Achievement Test. Using one standard error of estimate as the criterion, a child whose regressed difference was greater than plus one standard error of estimate was considered a high achiever, a child whose regressed fell between $\pm$ one standard error of estimate was considered an average achiever and a child whose regressed difference was less than minus one standard error of estimate was considered a low achiever.

The number of high, average and low achievers was counted and the children were identified. Copies of these findings were given to the principal and the teachers in the building.

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1. J. P. Guilford, Op. Cit., p. 216.

Summary

To summarize this regression technique for comparing achievement and capacity, the steps taken are shown below:

1. Choose, give and correct achievement and intelligence test.

2. Give each child a number or letter in order to identify him later.

3. Find the arithmetic mean and standard deviation of all subtests of achievement.

4. Find the arithmetic mean and standard deviation of intelligence scores.

5. Using the Otis Normal Percentile Charts, convert scores of achievement test scores.

6. Find the real difference between the converted achievement scores and intelligence scores.

7. Find the coefficient of correlation between each subtest of the achievement test and the intelligence test.

8. Multiply the coefficient of correlation by the real difference between the converted achievement test scores and the intelligence test scores. This gives the regressed difference.

9. Find the standard error of estimate of each subtest of the achievement test.

10. Look over the regressed differences in each subtest, and with $\pm$ one standard error of estimate as a criterion, identify those pupils who are working up to ability, those below ability, and those above ability.

CHAPTER IV

FINDINGS

As was stated earlier, this study is a survey of an X school in Newton to find out the number of children working up to, above and below capacity according to a regression technique.

Table 5 shows the Mean, Standard Deviation, correlation between the two tests and the standard error of estimate for the Kuhlmann-Anderson Mental Units Scores and the Metropolitan Achievement Subtest scores for each of the four grades tested in this study. As can be seen from the table, Arithmetic Fundamentals and Arithmetic Problems had the lowest standard deviations in each grade. Reading, Vocabulary and Language all had a high standard deviation, showing there was a greater spread of achievement in those areas.

Table 5. Statistics Used in this Study

Variable I			Variable II				
Test	M.	S.D	Test	M.	S.D	$r_{I\ II}$	S.E. of Est.
K.-A. - Gr. II	294	9.87	Met. Ach. Form R (Prim. II)				
			Reading	123	18.45	.36	±9
			Vocabulary	123	18.40	.46	±9
			Ar. Fund.	134	5.70	.52	±8
			Ar. Prob.	144	7.86	.54	±8
			Spelling	130	14.90	.38	±9
K.-A. - Gr. III	305	11.73	Met. Ach. Form R (Elem.)				
			Reading	138	22.60	.61	±9
			Vocabulary	140	21.70	.54	±10
			Ar. Fund.	137	5.31	.55	±10
			Ar. Prob.	151	8.55	.52	±10
			Language	145	22.90	.65	±9
			Spelling	141	16.74	.68	±9
K.-A. - Gr. IV	329	15.29	Met. Ach. Form R (Elem.)				
			Reading	178	23.11	.80	±9
			Vocabulary	181	27.16	.76	±10
			Ar. Fund.	160	7.80	.60	±12
			Ar. Prob.	170	11.65	.69	±11
			Language	178	24.45	.82	±9
			Spelling	175	19.29	.71	±11

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Table 5. (concluded)

Variable I			Variable II				
Test	M.	S.D	Test	M.	S.D	$r_{I\ II}$	S.E. of Est.
K.-A. - Gr. V	345	10.86	Met. Ach. Form R (Intermed.)				
			Reading	190	22	.64	±8
			Vocabulary	193	20.55	.66	±8
			Ar. Fund.	186	14.49	.44	±10
			Ar. Prob.	185	16.35	.45	±10
			Language	190	23.35	.74	±7
			Spelling	184	22.80	.64	±8

Grade II

Table 6 shows the regressed differences between the converted Metropolitan Achievement subtest and the Kuhlmann-Anderson Mental Units scores in Grade II. With the standard error of estimate for reading ±9, it was found that 50 pupils or 94 per cent of the classes were working up to their ability, one or 2 per cent was working above ability and two or 4 per cent were working below ability.

Going on to Vocabulary, the results of the regression technique showed that with a standard error of estimate of ±9, 49 or 92 per cent were working up to capacity, one or 2 per cent was working above capacity and three or 6 per cent were achieving below capacity.

The test of Arithmetic Fundamentals showed a standard error of estimate of ±8, with 48 or 91 per cent working up to capacity, three or 5 per cent working below and two or 4 per cent above. In Arithmetic Problems, a standard error of ±8 has been found with 49 or 92 per cent working up to ability, one or 2 per cent above and three or 6 per cent below. It was interesting to note that one pupil was working above capacity in both Arithmetic Fundamentals and Problems and one was working below in both.

In Spelling, with a standard error of estimate of ±9, it was found that 52 or 98 per cent of the pupils were working up to ability with none working above ability and only one or 2 per cent working below ability.

Table 6 shows the regressed differences for each child in each subtest for Grade II. It also shows whether, with one standard error of estimate as the criterion, the child is a high, average or low achiever in each subtest.

Table 6. Regressed Differences Between Converted Metropolitan Achievement Subtest Standard Scores and Kuhlmann-Anderson Mental Units of 53 Pupils of Grade II in an X School in Newton

Name of Subtest	Reading			Vocabulary			Arith. Fund.			Arith. Prob.			Spelling		
S. E. of Est.		± 9			± 9			± 8			± 8			± 9	
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 1a		+4			+5			+1			-1			+4	
2a		-4			-7			-1			+1				-14
3a		+3			+4		+9				+5			+2	
4a			-16		-4			+3				-25		-3	
5a		-8			-3			-4			-4			-6	
6a		+3			+3			0			+2			+1	
7a		-2			+1			-2				-18		+7	
8a		0			+3			-1			-1			+1	
9a		+1			0			+5			+4			+1	
10a		+3			+3			+4			+5			+2	
11a		-2			-4			0			-1			0	
12a		+2			0			-5			-8			+2	
13a		-2			-4				-9		-4			-4	
14a		+1			+3			+1			0			+3	
15a		0			-1			+1			-1			+1	
16a		-3			-6			+3			-1			-5	
17a		-2			-2			+2			+2			-2	
18a		-1			0			+2			-1			+2	
19a		+1			-3			-1			+1			0	
20a		+1			+5			+4			+2			+3	
21a		-1			-1			-2			-4			+1	
22a		-1			0			-3			-3			0	
23a	+13			+14			+21			+26				+6	
24a		+2				-11			-11			-13		-3	
25a		0			0			-1			-1			0	
26a		-6			-4			-4			-5			-7	
27a		+1			0			0			+1			-2	
28a		+3			+5			+3			-1			+3	
29a		+2			+3			0			-1			-1	
30a		-2			-5			-2			+1			-3	

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Table 6. (concluded)

Name of Subtest	Reading			Vocabulary			Arith. Fund.			Arith. Prob.			Spelling		
S. E. of Est.	± 9			± 9			± 8			± 8			± 9		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 31a		-3			-1			-2			-4			-1	
32a		+1			0			+5			0			+1	
33a		+3			+5			0			-1			+3	
34a		+3			+6			-1			+5			+6	
35a		0			+1			-4			+4			+3	
36a		-2			-4			-2			-3			-5	
37a		+2				-22		-2			+2			-2	
38a		+2			-5				-17		-4			-3	
39a		+3			+3			+3			-1			+1	
40a		0			-3			-1			-1			0	
41a		+4			+3			+6			+5			+2	
42a		0			0			+1			-5			-2	
43a		+2			+2			+1			+5			+1	
44a		+6			+7			+5			+1			+6	
45a		-3			0			0			-3			+1	
46a		+2			+2			+6			+4			0	
47a		-1			+1			+2			+2			+2	
48a			-13			-12		-4			-6			-6	
49a		+3			+5			+3			+5			+6	
50a		+2			+2			+2			-2			+1	
51a		+2			+1			-5			-7			+2	
52a		+3			+1			+5			+3			+3	
53a		-2			-2			-1			-3			-6	
Totals	1	50	2	1	49	3	2	48	3	1	49	3	0	52	1
		53			53			53			53			53	

In summarizing the achievement-capacity of Grade II, it has been found that in Reading, one child was working above ability and two were below; in Vocabulary, there were one above and three below; in Arithmetic Fundamentals, there were two above and three below; in Arithmetic Problems, there were one above and three below, and in Spelling there was only one below. It was also noted that there were actually only two pupils who were working above their ability; in other words, one pupil was above in one subtest and the other pupil was above in four subtests. Both of these pupils had Kuhlmann-Anderson IQ's below 100.

As for the low achievers in Grade II, there were actually eight pupils, five of whom were working below their ability in only one subtest, whereas two were working below in two subtests, and one was working below in three subtests. Of those working below ability, there were four with Kuhlmann-Anderson IQ's under 100 and four with IQ's above 100.

Table 7 identifies the high and low achievers and the areas in which they are working above or below their ability.

Table 7. High and Low Achievers of Grade II

	Pupil	I.Q.	Reading	Vocab.	Arith. Fund.	Arith. Prob.	Spelling
			Subtests				
High	No. 3a	91			+9		
	23a	76	+13	+14	+21	+26	
Totals	2		1	1	2	1	0
	Pupil	I.Q.	Reading	Vocab.	Arith. Fund.	Arith. Prob.	Spelling
Low	No. 2a	108					-14
	4a	90	-16			-14	
	7a	86				-18	
	13a	102			-9		
	24a	89		-11	-11	-13	
	37a	92		-22			
	38a	103			-17		
	48a	103	-13	-12			
Totals	8		2	3	3	3	1

Grade III

In Reading, with a standard error of estimate of ±9, there were 41 or 84 per cent of the total third grade tested who were working up to their ability. There were three or 6 per cent of the pupils working above and five or 10 per cent working below their ability. One class of the two grades tested has had a great deal of difficulty with its reading. One reason might be that because they had several teachers during the year, they were constantly adjusting to a new personality. Another might be that there was a wide range of ability in the group. Their IQ's ranged from 66 to 120, with a mean IQ of 100.

In Vocabulary, with a standard error of estimate of ±10, there were 44 or 90 per cent achieving up to capacity, two or 4 per cent above and three or 6 per cent below. There were three more pupils working up to ability than in Reading with one less working above ability and two less working below.

Both Arithmetic Fundamentals and Problems had standard errors of estimate of ±10 and both had 44 or 90 per cent of the group working up to ability. There were two or 4 per cent working beyond ability and three or 6 per cent working below ability in Arithmetic Fundamentals, whereas there were one or 2 per cent working above and four or 8 per cent working below ability in Arithmetic Problems. One pupil was a high achiever in both phases of Arithmetic and one was a low achiever in both. The other deviates were average in one phase and above or below in the other.

Language and Spelling both had a standard error of estimate of ±9. There were 39 or 80 per cent of average achievers in Language, with 37 or 76 per cent in Spelling. There were five or 10 per cent of high and low achievers in Language, with four or 8 per cent of high achievers and eight or 16 per cent of low achievers in Spelling. There were more low achievers in Spelling than in any other subtest in Grade II, with Language being second lowest.

Table 8 shows the regressed differences for each child in each subtest for Grade III. It also shows whether, with one standard error of estimate as the criterion, the child is a high, average or low achiever.

Table 8. Regressed Differences Between Converted Metropolitan Achievement Subtest Standard Scores and Kuhlmann-Anderson Mental Units of 49 Pupils of Grade III in an X School in Newton

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	±9			±10			±10			±10			±9			±9		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 1b			-18		-9			+1			+2				-13		-9	
2b			-16		-5			+4			-4			-2				-28
3b		+8		+15				-3			+1			+7		+11		
4b		+1			-5		+11				+4			+3			+3	
5b		+1			-1			-4			-2			+1			+2	
6b		+7			+5			-1			+4			+7			+1	
7b		+4			-4			-4			+1			-1			-1	
8b			-12		-10			-6			-4				-12			-10
9b		-9			-6			+1				-15			-10			-11
10b		+7			+1			+4			+8			+6			+6	
11b			-10		-2				-12		-9				-10		-8	
12b			-26		+1				-23			-21			-12		-1	
13b		-3			-10			+2			+1			-1			-5	
14b		+9			0			+9			+9			+2			+5	
15b		+5			+4			+4			+5			+5		+10		
16b		+1			0			-2			-4			-1			-3	
17b		+1			+1			+4			-1			-9				-23
18b		-2			-2				-12		-5			-6				-34
19b		-4			-6			-3			-1			-1			-3	
20b		-5			-1			0			-8			-3			-3	
21b		+3			-2			-5			+1			+3			-2	
22b		-5			-1			-1			-7			-6			-3	
23b		+7			+4			-4			+1			+4			+5	
24b		+2			-1			-2			-1			+3			+7	
25b		-2			+6			-1			-2			+1			+4	
26b	+16				-2		+30			+25			+13			+24		
27b		-1			-5			+1			-1			+1			+2	
28b		-9				-15		+1			+1			-6			-7	
29b		+3			+3			+4			+3			+4			+4	
30b		+4			+1			-6			-6			+1			+1	

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Table 8. (concluded)

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	± 9			± 10			± 10			± 10			± 9			± 9		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 31b		-2			+1			-1			+2			+1			+1	
32b		+1			-3			-3			+5			0			+6	
33b		+5			+1			+4			+3			-2			+3	
34b		-3				-12		-7				-11		-7			-5	
35b		+3			+10			-1			+2			+8			+4	
36b		+2			+2			-3			+2			-1			0	
37b		+4			+7			+2			+6			+7				-23
38b		-1			-1			+1			+2			0			+1	
39b		-7			-7			+7			+3			-6			-1	
40b		-8				-13		-7			-8			-4			-1	
41b		+4			+7			+4			-1			+3			+7	
42b		+1			0			-3			-1			-2			-2	
43b		+9			+9			+2			+10		+12				+3	
44b		+9			+9			+8			+7		+11				+7	
45b		0			+8			-1			+1			-4				-30
46b		-7			-3			+4			+2			+8			0	
47b	+12				+10			+10			+1		+11			+13		
48b	+15			+20				+4				-12	+10					-15
49b		-2			-3			+7			-3			-1			+5	
Totals	3	41	5	2	44	3	2	44	3	1	44	4	5	39	5	4	37	8
		49			49			49			49			49			49	

In summarizing, there were eight pupils working beyond ability. One pupil was above in five subtests, two in three, one in two, and four in one. Of these high achievers, one child had an IQ above 100 and seven had an IQ below 100.

There were 14 low achievers with one below in four subtests, three in three, five in two, and five in one. No low achiever in Reading was a low achiever in Vocabulary, but of those below in three subtests, two of them were low in Reading, as was also the child who was below in four subtests.

Table 9 identifies the high and low achievers for Grade III, showing the area or areas in which they were working beyond capacity or below capacity.

Table 9. High and Low Achievers of Grade III

	Pupil	I.Q.	Subtests					
			Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
High	No. 3b	85		+15				+11
	4b	94			+11			
	15b	85						+10
	26b	66	+16		+30	+25	+13	+24
	43b	89					+12	
	44b	93					+11	
	47b	101	+12				+11	+13
	48b	86	+15	+20			+10	
Totals	8		3	2	2	1	5	4

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Table 9. (concluded)

	Pupil	I.Q.	Subtests					
			Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
Low	No. 1b	111	-18				-13	
	2b	99	-16					-28
	8b	120	-12				-12	-10
	9b	115				-15	-10	-11
	11b	115	-10		-12		-10	
	12b	94	-26		-23	-21	-12	
	17b	95						-23
	18b	88			-12			-34
	28b	90		-15				
	34b	103		-12		-11		
	37b	78						-23
	40b	116		-13				
	45b	99						-30
	48b	86				-12		-15
Totals	14		5	3	3	4	5	8

Grade IV

Table 10 shows the regressed differences between the converted Metropolitan Achievement subtest scores and Kuhlmann-Anderson Mental Units scores. It shows which pupils are high, average or low achievers.

Reading, with a standard error of estimate of ±9, had the lowest number of average achievers, 36 or 74 per cent of the group. Of all the subtests, Reading had the largest number of high achievers, with eight or 16 per cent. There were five or 10 per cent who were low achievers.

In Vocabulary, with a standard error of estimate of ±10, there were 39 or 80 per cent who were working up to ability, four or 8 per cent who were working above ability, and six or 12 per cent who were working below ability. There were more working below ability in Vocabulary than in any other subtest of Grade IV.

Arithmetic Fundamentals, with a standard error of estimate of ±12, had 42 or 86 per cent of average achievers, two or 4 per cent of high achievers, and five or 10 per cent of low achievers.

In Arithmetic Problems, with a standard error of estimate of ±11, there were 45 or 92 per cent of average achievers, two or 4 per cent of high achievers, and two or 4 per cent of low achievers. Arithmetic Problems had the largest number of average achievers of any of the subtests for Grade IV. This was odd since there were the lowest number of average achievers in Reading and lack of reading ability is often considered one of the reasons why pupils are unable to do problems.

Language had the lowest error of estimate for Grade IV, being ±9. There were 43 or 88 per cent of pupils working up to ability, with three or 6 per cent working above, and the same number working below. Language, along with Spelling, had the second highest number of average achievers in the subtests for Grade IV.

In Spelling, with a standard error of estimate of ±11, there were 43 or 88 per cent of average achievers, two or 4 per cent of high achievers, and four or 8 per cent of low achievers.

Table 10. Regressed Differences Between Converted Metropolitan Achievement Subtest Standard Scores and Kuhlmann-Anderson Mental Units of 49 Pupils of Grade IV in an X School in Newton

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	± 9			± 10			± 12			± 11			± 9			± 11		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 1c	+16				+6			+8			+1			+2			+2	
2c		-3			-5			-9			+2			+6			+6	
3c		-6			-7			0			+1			-6				-13
4c		+2			+1			+7			+10			-3			-1	
5c	+18			+23				+4			+6		+11			+20		
6c		-4			-2			-4			-10			+1			-1	
7c		-3				-14		+9			-10			-3			-9	
8c		+9			+10			+7			+1			+8			+11	
9c			-10		-8			-7			-1			-6			+1	
10c	+12				-1			-6			+1			-5			-2	
11c			-10			-12		+8			+8			-5				-13
12c		+2			-2			+4			-3			+1			+4	
13c		-6			-4			-4			-6			+4			-4	
14c		+3			+4			+11		+20				0			+2	
15c	+10				0				-14		-3			-5			+5	
16c		+2			+5			+10			+6			+1			+3	
17c		+3			+5			+4			+1			-7			-7	
18c		-1			-2			+1			-8			-6			+4	
19c		-4			-4			+11			+10			-1			-3	
20c		+6		+13				+7			+3			+2			+4	
21c	+13				-1			+11			0		+15				+4	
22c		-2			-4			-12			-5			-5			-11	
23c	+18				+8			+1			+1			+7			+7	
24c		0			+1			-1			-1			0			+7	
25c		+3				-11		-4			-11				-12			-16
26c		+3			+3			0			+1			+2			-1	
27c		+4			+5			+3			-6			+5			+6	
28c		-2			+4			-11			-1			-2			-4	
29c		+2			0			+7			+8			-3			0	
30c		+4		+17				-9				-14	+11				+4	
31c			-17			-14		-8			-6				-11		-6	
32c		-2			-7			+6			+1			-8				-20

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Table 10. (concluded)

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	± 9			± 10			± 12			± 11			± 9			± 11		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 33c		0			-3		+13				0			0			-2	
34c	+15				+8			+5			+10			+6		+13		
35c			-10		-1			-4			-5			-4			-6	
36c		-6			-6			-12			-2			0			0	
37c		0			-1			+7			+5			+7			+1	
38c			-11		+3			+8			+3			+7			+8	
39c		-6			-8			+3			-4			-8			+1	
40c		-6				-11			-19		-11			-7			-9	
41c		+2			+2			+1			+7			+7			+11	
42c		-6			-2				-13			-13			-13		-9	
43c		-4				-11		+4			+7			+2			-9	
44c		+3			-4		+20			+16				-2			-6	
45c		+2			+8				-19		-10			-1			+9	
46c	+14				+5			+11			+10			+2			+1	
47c		-5			-6			-5			-5			-8			-7	
48c		-5			+2			+1			-2			-8			+1	
49c		-5		+11					-17		+2			+9			+11	
Totals	8	36	5	4	39	6	2	42	5	2	45	2	3	43	3	2	43	4
		49			49			49			49			49			49	

Table 11 shows the high and low achievers in Grade IV. It also shows in which areas they are high or low. There were 14 pupils in the group of high achievers, of whom one was high in four subtests, four in two, and nine in one. Of these pupils, six had IQ's over 100 and eight had IQ's below 100.

There were 16 different pupils who were not working up to ability, of whom four were below in three subtests, one in two, and 11 in one. Of the five below in Reading, only one had an IQ below 100, and of the six below in Vocabulary, only one had an IQ below 100, whereas of the five below in Arithmetic Fundamentals there were three with IQ's below 100. There were no low achievers with IQ's below 100 in Spelling, and only one below in both Language and Arithmetic Problems, and this was the same child in both subtests.

Table 11. High and Low Achievers of Grade IV

	Pupil	I.Q.	Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
			Subtests					
High	No. 1c	111	+16					
	5c	88	+18	+23			+11	+20
	10c	115	+12					
	14c	99				+20		
	15c	110	+10					
	20c	97		+13				
	21c	109	+13				+15	
	23c	103	+18					
	30c	113		+17			+11	
	33c	78			+13			
	34c	75	+15					+13
	44c	80			+20	+16		
	46c	88	+14					
	49c	89		+11				
Totals	14		8	4	2	2	3	2

	Pupil	I.Q.	Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
			Subtests					
Low	No. 3c	113						-13
	7c	76		-14				
	9c	111	-10					
	11c	104	-10	-12				-13
	15c	110			-14			
	25c	121		-11			-12	-16
	30c	113				-14		
	31c	104	-17	-14			-11	
	32c	100						-20
	35c	109	-10					
	37c	82	-11					
	40c	115		-11	-19			
	42c	97			-13	-13	-13	
	43c	112		-11				
	45c	83			-19			
	49c	89			-17			
Totals	16		5	6	5	2	3	4

Grade V

Table 12 shows the regressed differences between the converted Metropolitan Achievement subtests and the Kuhlmann-Anderson scores for each child in the group for Grade V. It shows which pupils, and the number of pupils who are high, average and low achievers.

Reading and Vocabulary had a standard error of estimate of ±8. In Reading, there were 31 or 84 per cent of the group who were working up to ability, three or 8 per cent who were working above ability, and the same number who were working below ability. In Vocabulary, there were 29 or 78 per cent working up to ability, four or 11 per cent working above ability, with the same number below ability. It was interesting to note that in both Reading and Vocabulary there were the same number working above as below ability.

For both Arithmetic Fundamentals and Problems, the standard error of estimate was ±10. In Arithmetic Fundamentals, there were 33 or 89.2 per cent working up to ability, two or 5.4 per cent above, and two or 5.4 per cent below. In Arithmetic Problems, there were 35 or 94 per cent working up to capacity, and one or 3 per cent working above and below ability. As in two other grades, there was a higher number of pupils who were average achievers in Arithmetic Problems than in Arithmetic Fundamentals.

In Language, with a standard error of estimate of ± 7, there were 28 or 76 per cent of the group who were average achievers, three or 8 per cent who were high achievers, and six or 16 per cent who were low achievers. This subtest had the lowest number of average achievers and the highest number of low achievers of any of the subtests for this grade.

In Spelling, with a standard error of estimate of ± 8, there were 33 or 89.2 per cent of the group who were working up to their ability, two or 5.4 per cent who were working above and below their ability.

Table 12. Regressed Differences Between Converted Metropolitan Achievement Subtest Standard Scores and Kuhlmann-Anderson Mental Units of 37 Pupils of Grade V in an X School in Newton

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	± 8			± 8			± 10			± 10			± 7			± 8		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 1d		-1			+5			+10			+6			+1			-2	
2d		-3			-5			+6			+5			+4			-3	
3d		-4				-9		+2			-1				-9		-3	
4d		-1			0			+2			+5			-1			-3	
5d		-4				-9		-2			-5			0			-8	
6d		+3			0			-2			-1			-4			-5	
7d		+8			-3			0			0			+2			-7	
8d		+1			+3			-2			0			+3			+6	
9d		-8			-6			-6			-5			-1			-6	
10d		-1			+1			-2				-13		+4			+3	
11d			-16		-7			-1			-5			-6			-3	
12d		+4			+4			+1			-3		+12				-3	
13d		+4			-1			-2			0			+3			-4	
14d	+13			+14			+11				+7			+7			+4	
15d		-8				-13		+5			+9				-8		-3	
16d		0			0			+4			+3			-6			-3	
17d		+4			+4			+4			0			-1			+4	
18d		+4			+3			+4			+4		+16			+15		
19d		-5				-11		-9			-10			0			+4	
20d		-1			-3			-7			-6				-10		-2	
21d		0			+5			-2			-1			-2			+4	
22d		+4		+9				0			-2			-1			+1	
23d		-4			-8			0			-2			+1			-1	
24d		-3			-4			-1			-2				-12		-4	
25d		-5			+3				-15		-7			+1			+3	
26d	+10				+7			+3			+9			+3			+6	
27d		-2			+1			+1			-2			-1			-4	
28d			-15		-8				-12		-8				-11		-8	
29d		-1			-1			-3			-3			-1			+5	
30d	+11			+9				-9			0			+1			-4	

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Table 12. (concluded)

Name of Subtest	Reading			Vocab.			Arith. Fund.			Arith. Prob.			Language			Spelling		
S. E. of Est.	± 8			± 8			± 10			± 10			± 7			± 8		
Pupils	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L	H	A	L
No. 31d		+2			-1			-5			-1			+1			-3	
32d		+8		+11				+3			+5			+3		+15		
33d			-11		-4			0			+1				-13			-16
34d		-1			0		+14			+12			+10				+3	
35d		+3			+3			-1			+1			-3			+3	
36d		+1			+3			+2			0			+5			+6	
37d		-8			-7			-2			-1			-4				-9
Totals	3	31	3	4	29	4	2	33	2	1	35	1	3	28	6	2	33	2
		37			37			37			37			37			37	

Table 13 shows which pupils were high and low achievers and the area or areas in which they achieved above or below their ability. There were eight pupils who were working beyond their ability, with two working above ability in three areas, three in two areas and three in only one area. There were more high achievers in Vocabulary, with Reading and Language tying for second place, while there was only one high achiever in Arithmetic Problems. There was one pupil with an IQ over 100 and there were seven with IQ's below 100.

There were 12 pupils who were low achievers in at least one area. Of this number, there were two who were low achievers in three areas, two in two areas and eight in one area. Four of the six low achievers in Language were low in at least one other subtest. In this group, there were nine pupils with IQ's over 100 and three with IQ's under 100.

Table 13. High and Low Achievers of Grade V

	Pupil	I.Q.	Subtests					
			Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
High	No. 12d	93					+12	
	14d	91	+13	+14	+11			
	18d	95					+16	+15
	22d	110		+9				
	26d	99	+10					
	30d	87	+11	+9				
	32d	91		+11				+15
	34d	89			+14	+12	+10	
Totals	8		3	4	2	1	3	2

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Table 13. (concluded)

	Pupil	I.Q.	Subtests					
			Reading	Vocab.	Arith. Fund.	Arith. Prob.	Language	Spelling
Low	No. 3d	105		-9			-9	
	5d	114		-9				
	10d	105				-13		
	11d	118	-16					
	15d	89		-13			-8	
	19d	83		-11				
	20d	103					-10	
	24d	107					-12	
	25d	98			-15			
	28d	113	-15		-12		-11	
	33d	102	-11				-13	-16
	37d	107						-9
Totals	12		3	4	2	1	6	2

Summary

Table 14 shows the number and per cents of high, average and low achievers of the total group tested. Of the total group tested, there were 158 or 84 per cent of average achievers, 15 or 8 per cent of high achievers and 15 or 8 per cent of low achievers in Reading. In Vocabulary, there were 161 or 86 per cent of average achievers, 11 or 6 per cent of high achievers and 16 or 8 per cent of low achievers. In Arithmetic Fundamentals, there were 167 or 89 per cent of pupils working up to ability, 13 or 7 per cent working below and eight or 4 per cent working above. Arithmetic Problems showed 173 or 91 per cent of average, five or 3 per cent of high and 10 or 5 per cent of low achievers. In Language, there were 110 or 81.4 per cent of average achievers, 11 or 8.2 per cent of high achievers and 14 or 10.4 per cent of low achievers. There were only 135 pupils tested in this area as no Language test was included in Battery Primary II. In Spelling, there were 165 or 88 per cent of pupils working up to their ability, eight or 4 per cent working above their ability and 15 or 8 per cent working below their ability.

Table 14. Number and Per Cent of High, Average and Low Achievers of Total Group Tested in Each Subtest

Subtest	Achievers						Totals	
	High		Average		Low			
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
Reading	15	8%	158	84%	15	8%	188	100%
Vocabulary	11	6%	161	86%	16	8%	188	100%
Arith. Fund.	8	4%	167	89%	13	7%	188	100%
Arith. Prob.	5	3%	173	91%	10	5%	188	100%
Language	11	8.2%	110	81.4%	14	10.4%	135	100%
Spelling	8	4%	165	88%	15	8%	188	100%

Of the 32 high achievers in the total group, there were eight or 25 per cent who had IQ's above 100 and 24 or 75 per cent with IQ's below 100. Of the 50 low achievers, there were 30 or 60 per cent with IQ's above 100 and 20 or 40 per cent with IQ's below 100. These findings seem to be similar to those of most research people in that[1]

> "....the greatest amount of waste exists among the brighter pupils in a class or among the better schools in a school system. It is, as a rule, the more intelligent pupils that are working below capacity even although they are keeping well up to the average level of the group....The bright child is the most retarded child in our schools. The dull child is the most accelerated."

Torgenson[2] concludes from an analysis of test results obtained in the West Allis Schools, Wisconsin, that: "....the average slow pupil is working at a higher rate of efficiency than the superior pupil."

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1. Rudolf Pintner and Helen Marshall, op. cit., p. 32.

2. T. L. Torgenson, "Efficiency Quotient as a Measure of Achievement," Journal of Educational Research (June 1922), 6: 25-32.

Table 15 shows the number and per cent of high, average and low achievers in each grade of the group tested. In Grade II, there were two high achievers or 4 per cent of that grade, forty-three or 81 per cent of average achievers and eight or 15 per cent of low achievers. Grade III had 8 or 16 per cent of high achievers, twenty-seven or 55 per cent of average achievers and fourteen or 29 per cent of low achievers. In Grade IV, there were fourteen or 28 per cent of high achievers, nineteen or 39 per cent of average achievers and sixteen or 33 per cent of low achievers. In Grade V, there were eight or 22 per cent of high achievers, seventeen or 46 per cent of average achievers and twelve or 32 per cent of low achievers.

There was 1 per cent of the total group tested who were high achievers in Grade II, 4 per cent in Grade III, 7 per cent in Grade IV and 4 per cent in Grade V.

There were 4 per cent of the total group who were low achievers in Grade II, 7 per cent in Grade III, 9 per cent in Grade IV and 6 per cent in Grade V.

Table 15. Number and Per Cent of High, Average and Low Achievers in Each Grade of Group Tested

Grade	Achievers						Totals	
	High		Average		Low			
	Number	Per Cent	Number	Per Cent	Number	Per Cent	Number	Per Cent
II	2	4%	43	81%	8	15%	53	100%
III	8	16%	27	55%	14	29%	49	100%
IV	14	28%	19	39%	16	33%	49	100%
V	8	22%	17	46%	12	32%	37	100%

CHAPTER V

Conclusions

Summary Statements

From this study, the following conclusions regarding the data were drawn:

1. There are thirty-six per cent more low achievers than high achievers in the school studied.

2. There are three times as many high achievers with IQ's below 100 as there are high achievers with IQ's below 100.

3. There are one and a half times as many low achievers with IQ's above 100 as there are low achievers with IQ's below 100.

4. Language has the largest percentage of low achievers of all the subtests and it also has the largest percentage of high achievers.

5. Reading, Vocabulary and Spelling have the next highest percentage of low achievers. (These three subtests have the same percentage.)

6. Arithmetic Problems has the lowest percentage of low achievers.

7. Arithmetic Fundamentals has the second lowest percentage of low achievers.

8. Reading has the second highest percentage of high achievers.

9. Vocabulary has the third largest percentage of high achievers.

10. Arithmetic Problems has the lowest percentage of high achievers.

11. Arithmetic Fundamentals and Spelling have the second lowest number of high achievers.

12. Grade IV has the highest percentage of both high and low achievers.

13. Grade II has the lowest percentage of both high and low achievers.

Implications

The following implications were drawn from the conclusions of this study:

1. The pupils who are working significantly above or below their ability bear further analysis.

2. The pupils who are working significantly below their ability need extra help from either the regular grade teacher or from the helping class teacher.

3. Other studies have proved that more pupils with low IQ's work above their ability and that more pupils with high IQ's work below their ability.

4. Language Arts need special attention.

5. Arithmetic Problems are either taught better than other subjects, are enjoyed more by the pupils or are easier for the pupils to comprehend.

6. Testing in the lower grades is less reliable than in the upper grades.

Limitations of the Study

1. Not all the pupils were present at the time of testing.

2. Correlations between the Kuhlmann-Anderson Intelligence Test and the Metropolitan Achievement subtests were low in many instances.

3. Validation of the technique used in this study must await its application to a number of other similar studies in different communities.

Suggestions for Further Study

1. A study to determine causes underlying the large percentage of low achievers found in this study.

2. A study[1] by Maxin reveals that emotional maladjustment coexists with educational retardation. This might be one causal factor to explore.

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1. D. L. Maxin, Study of the Relation Between the Achievement and Some Personality Factors, Unpublished Master's Thesis, Boston University, 1948, p.51.

3. A study giving methods used in trying to help these low achievers to become average achievers.

4. A further analysis of the high achievers found in this study.

5. A study of the attitudes of the high and low achievers. Travers[1] states that one of the difficulties of predicting achievement is that the assumption that "....the individual's own characteristics are entirely responsible for his success or failure and that the person who has the right attitudes will inevitably succeed." This idealistic viewpoint hardly seems tenable in our type of society where unplanned events are likely to influence a person's entire career. The extent to which such factors influence achievement has not been determined, but it is reasonable to hypothesize that their effort is considerable.

6. A study employing the Metropolitan Achievement Test as the achievement measure and an intelligence test other than the Kuhlmann-Anderson Test as the capacity measure, using the same technique as the one used in this study.

7. A study employing the Kuhlmann-Anderson Intelligence Test as the capacity measure and an achievement test other than the Metropolitan Achievement Test, using the same technique as the one used in this study.

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1. R. M. W. Travers, School and Society, 70:293 N5 L949.

APPENDIX

1. Enter the appropriate information in the spaces provided in the upper right-hand corner of the chart, above the heavy black line. Determine the width of the intervals which are to be used in grouping the X and Y scores, and record these values after "i_X" and "i_Y" respectively. After "X_o" and "Y_o" write the midpoints of the lowest intervals of the X and Y distributions. (Step 1)

2. In the uppermost row, marked "X," enter the upper and lower limits of the successive intervals of the distribution of the X scores, starting with the lowest interval at the left-hand corner. Similarly, in the column at the left-hand side of the chart enter the limits of the intervals of the Y distribution, starting with the lowest interval in the box immediately above the one marked "Y." (Step 2)

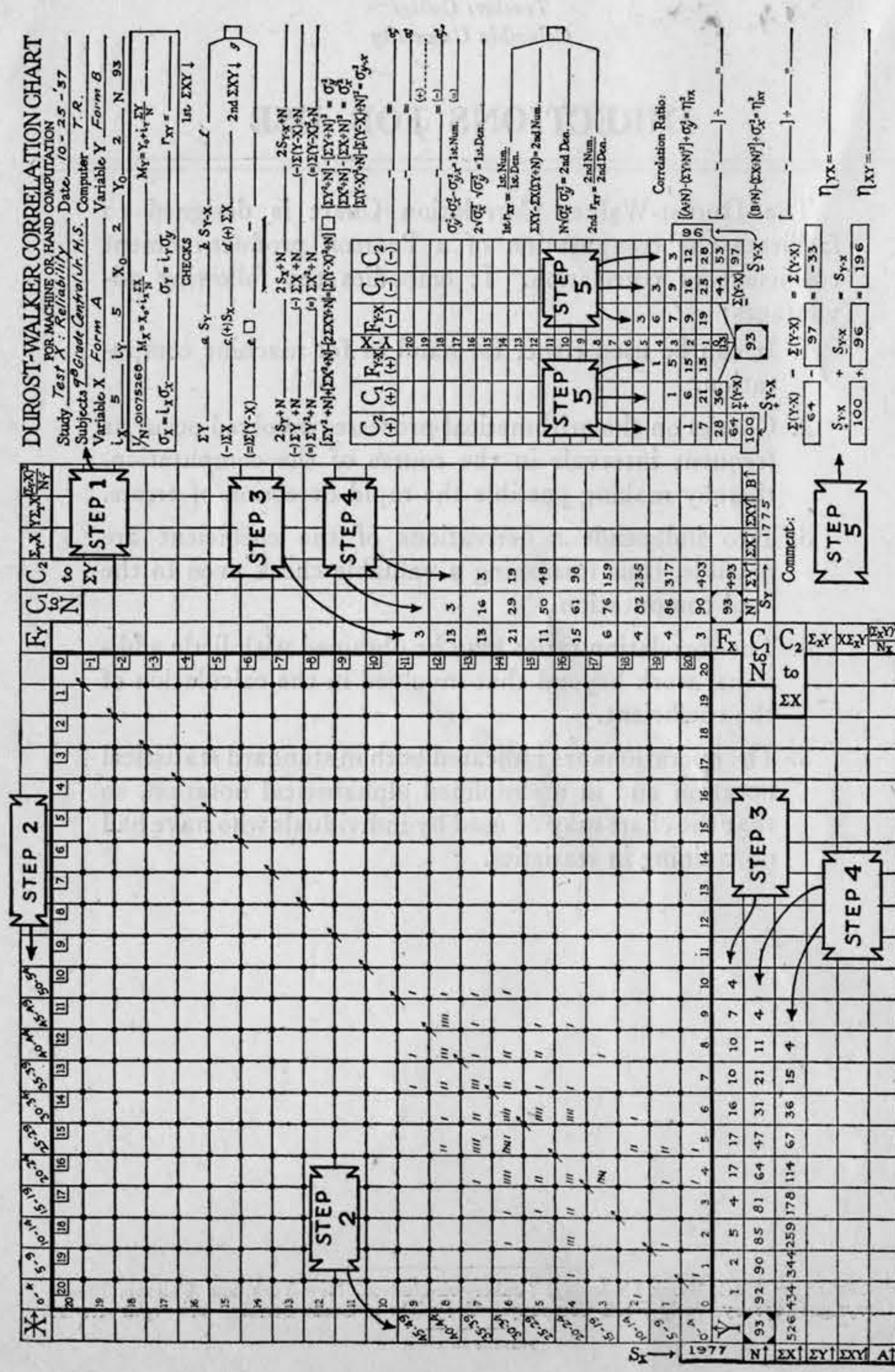

Fig. I. Correlation Chart, showing operations complete through Step 5.

3. Record a small tally mark in the appropriate cell in the scatter diagram for each pair of scores. After the tabulating is complete, the computer may, if he desires, place a numeral in each cell to indicate the number of tallies there; e.g., . Some computers find it easier to work from these numerals than directly from the tallies. These numerals should be encircled so as to be readily distinguishable from other numbers which will be entered in the cells. This step has not been shown in the illustrations in order to avoid overcrowding the diagrams.

Add the tally marks or numerals in each row, and record their sums in the column headed "F_Y." Add the tallies or numerals in each column, and record their sums in the "F_X" row. (Step 3)

4. Cumulate the values in the "F_Y" column from top to bottom, and record the cumulated values in the "C_1 to N" column, entering the first value one box below the highest interval in which any tallies occur, as shown in Figure I. Continue the cumulation to the bottom of the column, even though there be several intervals in which no frequencies occur. The final value, recorded in the box *immediately above* "N," equals the number of cases. Then, in the "C_2 to ΣY" column, cumulate the values in the "C_1 to N" column, again starting one box below the highest one in which there is any entry in the "C_1 to N" column, as in Figure I. Continue the cumulation to the end of the column. The final entry in this column is ΣY. Find the *sum* of the values in this column and record it as S_Y. (Step 4)

Similarly, cumulate the values in the "F_X" row, from ***right* to *left***, entering these values in the "C_1 to N" row, the last value again equaling N. Re-cumulate in the "C_2 to ΣX" row, in each case starting one box to the left of the highest interval in which any entry occurs in the previous row, as shown in Figure I. Continue the cumulation to the end of the row, even if there be several intervals in which no frequencies occur. The final value in the "C_2 to ΣX" row is ΣX, and the *sum* of the values in this row is recorded as S_X. (Step 4)

5. Add the tally marks in the cells along the central diagonal, lower left to upper right, and record their sum in the "0" cell of the "Y–X" column. Add the tallies in each diagonal *above* the central one, find the corresponding Y–X value at the left of the scatter diagram, and record their sums in the "$F_{Y-X(+)}$" column. Similarly add the tallies in each diagonal *below* the central one, find the corresponding Y–X value at the right of the scatter diagram, and record the sums in the "$F_{Y-X(-)}$" column. The sum of the entries in the "F_{Y-X}" columns, including the entry in the "0" cell, must equal N. Cumulate and re-cumulate the values in the "F_{Y-X}" columns, recording the cumulated values in the "$C_{1(+)}$" and "$C_{2(+)}$" and "$C_{1(-)}$" and "$C_{2(-)}$" columns, proceeding as in the previous cumulations and recording the values as shown in Figure I. NOTE: The entry in the "$\underline{S}_{Y-X}$" box is the sum of the values in the "$C_{2(-)}$" column, ***exclusive of the entry in the lowest, or "$\underline{\Sigma}$Y–X," box.***

In the spaces immediately below, fill in the indicated values, solving for Σ(Y–X) and S_{Y-X}. (Step 5)

6. To obtain 1st ΣXY, cumulate the tallies within each *column* in the scatter diagram, as shown in Figure II, always starting one box below the highest one in which any tallies appear, and recording the cumulated values in red or some other distinctive color, in the lower

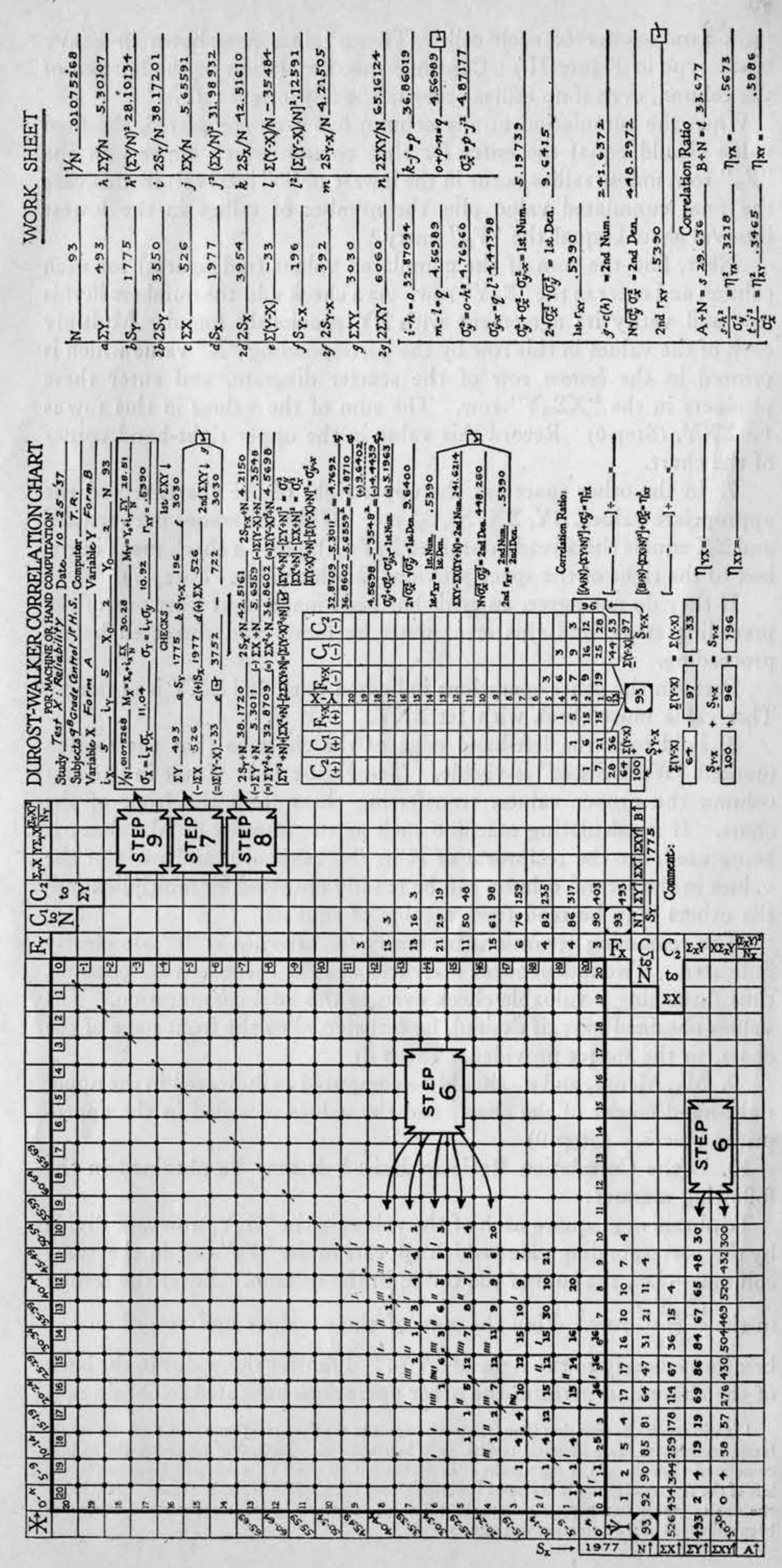

Fig. II. Correlation Chart, showing operations complete through Step 9, and completed Work Sheet.

right-hand corner of each cell. (These values are shown in heavy black type in Figure II.) Continue the cumulation to the bottom of the column, even if no tallies occur in the few lowest cells.

When the cumulation in any column has been completed, the final value should equal the entry for that column which appears in the "F_X" row, unless tallies occur in the lowest or "0" interval; in this case the final cumulated value plus the number of tallies in the lowest interval should equal the "F_X" entry.[1]

Next, find the sum of the cumulated values (red figures) for each column and enter in the "$\Sigma_X Y$" row. As a check add the numbers in this row and verify its agreement with ΣY previously found. Multiply each of the values in this row by the corresponding "X" value which is printed in the *bottom* row of the scatter diagram, and enter these products in the "$X\Sigma_X Y$" row. The sum of the values in this row is 1st ΣXY (Step 6) Record this value in the upper right-hand corner of the chart.

7 In the other spaces at the upper right of the chart, record the appropriate values, ΣY, ΣX, S_Y, S_X, etc. If the difference between ΣY and ΣX equals the already obtained $\Sigma(Y-X)$, place a check mark in the box to the right of the space provided for this value. (Step 7)

If they do not agree, an error has been made in at least one of the preceding steps, and this error must be found and corrected before proceeding.

Perform the other operations indicated until 2nd ΣXY is obtained. This value must check with 1st ΣXY

8. Fold over the left-hand edge of the chart so that the section marked "Work Sheet" is visible. (See Figure II.) Enter in the first column the proper values, transferring them from the front of the chart. If a calculating machine such as the Monroe or Marchant is being used, set the reciprocal of N in the keyboard, and most of the values in the second column can be readily obtained by multiplication; the others may be read from a table of squares.

The remaining operations necessary for arriving at "r" are clearly indicated. Two independent derivations of the coefficient are possible, thus furnishing a valuable check even to the final computation. The values obtained may, if desired, be transferred to the front page of the chart, to the spaces provided. (Step 8)

9. M_X, M_Y, σ_X, and σ_Y should be computed as indicated in the upper right-hand corner of the chart, and the values recorded in the appropriate places. (Step 9)

10. If the Correlation Ratio is desired, it may be obtained in the following manner:

To obtain η_{YX}, square each of the values in the "$\Sigma_X Y$" row and divide by the corresponding value which appears in the "F_X" row in the same column i.e., the sum of the tallies in the column. Enter the results in the $\frac{(\Sigma_X Y)^2}{N_X}$ row. Find the sum of these values and record in the box immediately to the right of "A ↑ " Transfer this value to the back of the chart, and perform the other operations indicated to obtain η_{YX}.

[1] It will readily be seen that if no frequencies occur in the few lowest intervals, a shorter cumulating method, yielding identical results, may be employed. Instead of repeating the highest cumulated value in each of the vacant cells, multiply it by the "Y" value which appears at the left of the scatter diagram in the same row, and record the product in the box immediately below the one in which this highest cumulated value first appears. This is the method which has been employed in the accompanying figures.

In order to find η_{XY}, it is necessary to make an additional cumulation of the tallies in each row in the scatter diagram similar to the one already made for each column. Cumulate from right to left, as shown in Figure III, and record the sums for each row in the proper box in the "$\Sigma_Y X$" column. Square each of the entries in this column, and divide by the corresponding entry in the "F_Y" column, recording the results in the $\frac{(\Sigma_Y X)^2}{N_Y}$ column. Find the sum of these values and record immediately above "B ↑ " Transfer this value to the Work Sheet, and solve as indicated for η_{XY}. (Step 10)

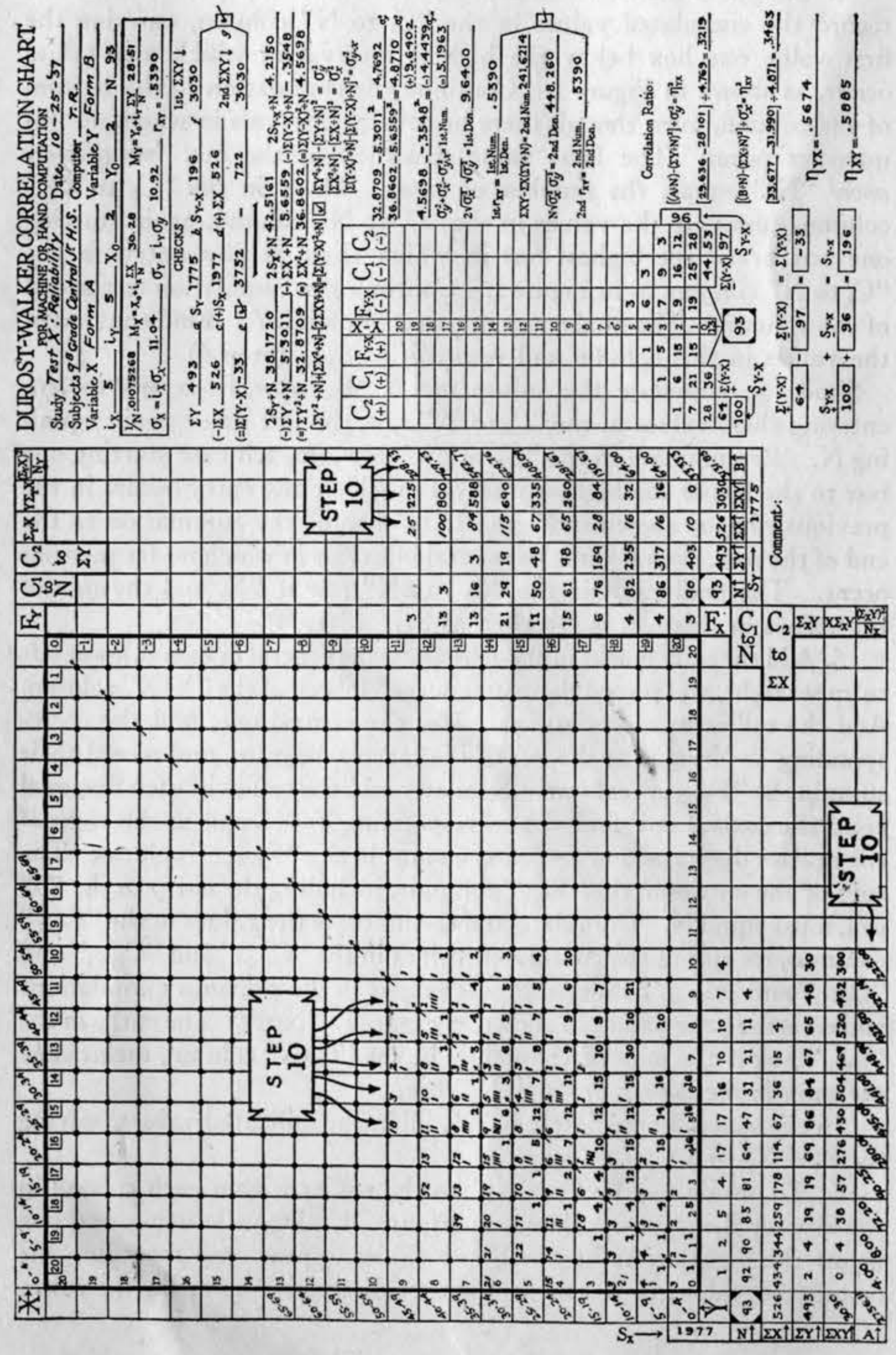

Fig. III. Correlation Chart, showing operations complete through Step 10.

DUROST-WALKER CORRELATION CHART

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DIRECTIONS FOR USE

The Durost-Walker Correlation Chart is designed to facilitate the computation of a Pearson product-moment coefficient of correlation. It embodies the following advantages:

1. It can be used either for hand or for machine computation.
2. Checks on the arithmetical processes involved occur at frequent intervals in the course of the computation, thereby making possible the rapid detection of errors.
3. Two independent derivations of the coefficient are possible, thus furnishing a valuable check even to the final computation.
4. The correlation ratios may be obtained with little additional work beyond that involved in the calculation of the coefficient.
5. The operations are indicated both in standard statistical notation and in a simplified alphabetical notation, so that the chart may be used by individuals who have had no training in statistics.

Published by World Book Company, Yonkers-on-Hudson, New York, and Chicago, Illinois

PRINTED IN U.S.A.

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