

THE VALUE OF PRE-ENGINEERING TESTS IN
PREDICTING FRESHMAN SCHOLASTIC SUCCESS
IN AN ENGINEERING CURRICULUM

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A THESIS

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the Faculty of the Division of Graduate Studies
Georgia School of Technology

In Partial Fulfillment
of the Requirements for the Degree
Master of Science in Industrial Management

By

James William Sweeney

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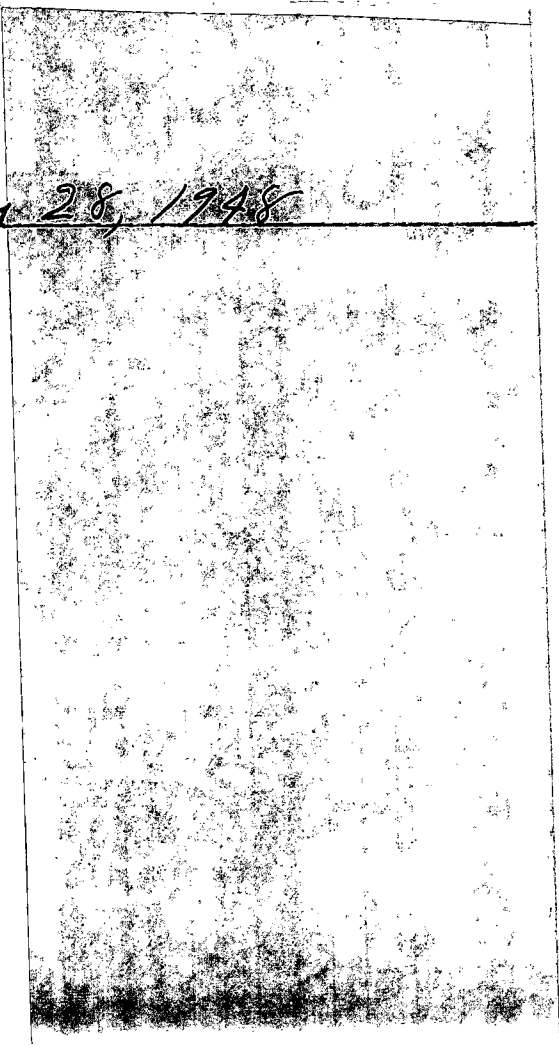
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Approved:

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Date Approved by Chairman

May 28, 1948



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THE VALUE OF PRE-ENGINEERING TESTS IN
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THE PROBLEMS, DEFINITIONS, AND STATISTICS

This study was undertaken to determine the relationship or lack of relationship between the scores attained on the psychological tests administered to the freshman class of September 1947 prior to admittance, and the scholastic success of this group during their first quarter of freshman work in the engineering curriculum at the Georgia School of Technology. Such relationship as was found, was examined to determine whether it was of sufficient significance to justify the prediction of scholastic success from the scores attained on these psychological tests.

The battery of psychological tests which were administered to this group of students under study consisted of:

- (1) The American Council on Education Psychological Examination.
- (2) The Pre-Engineering Inventory.
- (3) The Silent Reading Comprehension Test. (Van Wageningen-Part I.)
- (4) The English Placement Test. (Georgia Tech's own.)
- (5) The Study Habits Inventory. (Wrenn.)

The American Council on Education Psychological Examination and the Pre-Engineering Inventory were selected from this battery of five tests for investigation. These tests were selected because the limitations of this study would not allow the investigation of all the tests administered, and of the five, the A.C.E. and the P.E.I. were thought to be the most important and comprehensive.

The American Council on Education Psychological Examination is

composed of the following six sections:

- (1) Arithmetic
- (2) Linguistic Completion
- (3) Figure Analogy
- (4) Same and Opposite Word Comparison
- (5) Number Series
- (6) Verbal Analogy

In contrast to the Pre-Engineering Inventory Tests, which was designed to measure specific aptitudes and achievement, The American Council on Education Psychological Examination is primarily an instrument to measure the general level of intelligence of the individual.

The Pre-Engineering Inventory is a series of tests developed jointly by the Engineers Council for Professional Development of the American Society for Engineering Education, and The Carnegie Foundation for the Advancement of Teaching. This series of tests was primarily designed to measure aptitudes and achievement and to aid in the selection and guidance of engineering students.

As outlined in the prospectus of the Pre-Engineering Inventory, issued by The Carnegie Foundation for the Advancement of Teaching, the Pre-Engineering Inventory Tests are thus described:

These tests measure important components of your general scholastic ability; your knowledge of word meanings; your ability to read scientific materials accurately and carefully; your comprehension of what you have read; your ability to interpret graphs, charts, tables, and figures; your ability to relate what you read to your previous training in science and mathematics; your ability to deal with quantitative concepts of a practical and abstract nature; your ability to comprehend and apply physical principles and solve problems involving mechanical principles; and your ability to visualize form and detail from plan figures.

Success in college can be measured by two possible criteria. Freeman, as reported by Segel, indicated that the best criterion of

success in college was survival.¹ Segel, however, believed that there was not sufficient evidence to warrant changing the criterion of college success from scholarship in college level work to the length of time the student is able to maintain his residence. He argued that a student might develop lazy habits rather than those of scholastic diligence; that unpredictable factors not all connected with scholastic aptitude might terminate a student's residence; and thirdly, the correlation between mental tests and survival have been less than that between such tests and scholarship. Segel reports that Edgerton and Toops have found that the correlation between the Ohio Psychological Examination, using percentiles, and the point-hour-ratio of marks averages 0.45; the correlation between persistence in college and the Ohio test was only 0.19.²

Accordingly, the measures of college success in this study are the marks obtained in individual courses taken during the first quarter work of the freshman year, and the overall grade-point average achieved for all subjects taken during the same period. English and Mathematics were selected as most representative of the courses contained in the freshman curriculum.

The grading system at the Georgia School of Technology at the time this study was made, consisted of six classifications: AA-Superlative, A-Excellent, B-Good, C-Passing, D-Barely Passing, and F-Failing. For purposes of determining the grade-point average for the entire number of courses taken the above letter grades are assigned the

¹Segel, David, Prediction of Success in College, (U.S. Dept. of the Interior, Office of Education, Bulletin 1935, No. 15). pp. 7-8.

²Ibid, p. 7.

following values: AA-5, A-4, B-3, C-2, D-1, and F-0.³ The numerical grade-point average is determined by multiplying the numerical equivalent of the letter grade attained in a course by the number of credit hours which that course contributes towards a degree; and dividing the sum of these products for all courses taken by the total number of credit hours taken. Thus, the possible range of the grade-point is from .00 to 5.00.

The population under consideration in this study consisted of 979 students in the first quarter freshman year of the Engineering curriculum at the Georgia School of Technology. Of this number 51 percent were registered as Georgia residents and 49 percent were registered as Out-of-State students. Approximately 70 percent of the population were non-veterans, and approximately 30 percent were veterans. Of the 979 students which comprised the population a maximum of 4.5 percent of the scores were rejected as incomplete and were not included in the calculations. Thus, the minimum population in any of the distribution⁵, except where the population was divided into in-state and out-state students, contained 935 subjects. The distribution of the in-state group contained 484 students, and the out-state group contained 471 students.

In order to achieve a measure of uniformity, and lessen the chance of confusion, the symbols and formulae as outlined by Garrett have been

³For the purpose of this study the letter grades were assigned the following numerical values: AA-6, A-5, B-4, C-3, D-2, F-1. Thus a Mean of 2.70, where letter grades are being used, would be interpreted as a high D. (1.70.)

followed throughout.⁴

The arithmetic mean, M , is defined as the sum of the separate scores or other measures divided by their numbers.⁵ The mean in these calculations was determined for grouped data by the formula:

$$M = AM + ci$$

AM is the mid-point of the class interval in which the mean is assumed to be. The score correction, ci , is equal to the algebraic sum of the deviations of the class intervals from the assumed mean, divided by the number of the population; and this fraction multiplied by the size of the class interval. The standard error of the mean, σ_M , was determined by the formula:

$$\sigma_M = \frac{\sigma}{\sqrt{N-1}}$$

σ being the standard deviation of the population and N the number of scores in the population. The calculated mean, plus or minus two standard errors of the mean, should contain the true mean of the population 98 times out of a 100.⁶

The standard deviation is defined as the root-mean-square of the deviation from the arithmetic mean.⁷ It is determined for grouped data by the formula:

$$\sigma = \sqrt{\frac{\sum fd^2}{N} - c^2} \quad l$$

⁴Garrett, Henry E., Statistics in Psychology and Education. (Longmans, Green and Co., N. Y., 3rd Ed., 1947).

⁵Garrett, Henry E., *Ibid.*, p. 32.

⁶All results of equations used in this study are stated plus or minus two standard errors; thus taking in 98 probable cases out of a 100.

⁷Arkin, Herbert, and Colton, Raymond, An Outline of Statistical Methods, (Barnes and Noble, N. Y., 4th Ed., 1947.) p. 33.

in which $\sum fd^2$ is the sum of the product of the frequencies in the class intervals times the square of the intervals from the assumed mean. The standard deviation is less affected by sampling errors than is the mean deviation or the quartile deviation and is the measure of variability customarily employed in research.⁸ The standard error of the standard deviation for grouped data is calculated by the formula:

$$\sigma_{\sigma} = \frac{\sigma}{\sqrt{2(N-1)}}$$

thus, the true standard deviation will 98 times out of a 100 lie within the limits of the computed standard deviations plus or minus two standard errors of the standard deviation.

The relationship, or more accurately the association, between statistical series may be established and measured by means of the coefficient of correlation.⁹ When the relationship between two sets of measures is linear, the correlation may be expressed by the "product-moment" coefficient of correlation. Perfect relationship is expressed by a coefficient of 1.00 and a complete lack of relationship is indicated by a coefficient of .00. Thus, if a correlation lies within the limits of .00 to 1.00 there is implied some degree of positive association; the degree of association depending upon the size of the coefficient. When a negative, or inverse, association is perfect the coefficient is equal to (-) 1.00.

⁸ Garrett, Henry E., op. cit., p. 58.

⁹ Arkin, op. cit., p. 74.

The calculation of the coefficient of correlation by the "product-moment" method was used in the calculations of this study. The formula for determining this coefficient is:

$$r = \frac{\frac{\sum xy}{N} - \bar{x}\bar{y}}{\sigma_x \sigma_y}$$

in which the $\sum xy$ is the product deviation of the intervals from the assumed mean. The standard error of the coefficient of correlation was determined by the formula:

$$\sigma_r = \frac{\sqrt{1-r^2}}{\sqrt{N}}$$

The calculated coefficient of correlation plus or minus two times this standard error would, 98 times out of a 100, include the true coefficient of correlation.

The significance of the calculated coefficient of correlation was tested by the use of the null hypothesis. Assuming the population r to be zero, the method consists of comparing the t -value for the obtained r with the t 's to be expected by chance at the .05 and .01 limits.¹⁰ The t -value for a given r is found by the formula:

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}}$$

in which r is the calculated coefficient of correlation and N is the number of scores in the population. If the t -value for the calculated r is larger than the t -value expected by chance at the .05 level, the coefficient of correlation is said to be significant. If the t -value for the calculated r is larger than the t to be expected by chance at the .01

¹⁰ See Garrett, op. cit., p. 190, Table 29, for value of t for the degrees of freedom at various levels of probability.

limit, the coefficient of correlation is said to be highly significant. Thus, if a t-value for the calculated r exceeds the t-value to be expected by chance at the .01 level, the null hypothesis is clearly disproven, and evidence of a relationship not due to chance between the two statistical series is said to exist.¹¹

Because the formulae used in the determination of the "product-moment" coefficient of linear correlation assumes a normal distribution of the data, it is necessary to test the statistical series which are being correlated for a measure of skewness.

In the normal curve the mean, the median, and the mode all coincide and there is a perfect balance between the right and the left halves of the figure. A distribution is said to be skewed when the mean, the median, and the mode fall at different points in the distribution, and the balance is shifted to one side or the other. It is important to know whether the skewness which often occurs is a real divergence from the normal form, or whether the divergence is the result of chance fluctuations arising from chance causes and is not significant of a real discrepancy.¹²

The skewness, S_K , is determined by the formula:

$$S_K = \frac{P_{90} + P_{10}}{2} - P_{50}$$

in which P_{90} , P_{50} , and P_{10} represent the 90th, 50th, and 10th percentiles.

The percentiles are calculated by the formula:

¹¹Ibid., p. 299, Table 49, in which the levels of significance for degrees of freedom, $(N-2)$, is read directly in values of r.

¹²

Garrett, Henry E., op. cit., p. 119.

$$P_p = l + \left(\frac{pN - F}{f_p} \right) i$$

where p is the percentage of the distribution wanted, l the lower limit of the class interval upon which P_p lies, pN the part of N to be counted off in order to reach P_p , F the sum of all scores upon intervals below l , f_p the number of scores within the intervals upon which P_p falls, and i is the length of the class intervals.¹³

The standard error of the measure of skewness is determined by means of the formula:

$$\sigma_{s_k} = \frac{0.5185 D}{\sqrt{N}}$$

in which $D = P_{90} - P_{10}$. By dividing the measure of skewness by the standard error of the measure of skewness, a t -value is obtained which, when compared with the t -value that can be expected due to chance, will determine whether the distribution is significantly skewed, or the skewness present is due to chance.

The raw scores obtained by each student in the psychological tests considered in this study were recorded on a 3x5 card for each individual student. On the same card the grades obtained by the individual in the courses taken during his first quarter of freshman work were entered. His grade-point average was also entered on the card and an identifying mark was placed on the card classifying the student as either an in-state or out-state student.

¹³Ibid., p. 78.

In order to collect the data in such a manner as to facilitate the statistical calculations a scattergram of the type illustrated in Tables No. 2 through 10 was devised. In this scattergram the class intervals containing the psychological tests scores were placed on the X, or horizontal axis, and the class intervals of the measure of scholastic success were placed on the Y, or vertical axis. The scattergram also contains the frequencies of the class intervals, (f), the product of class interval frequency and the square of the class interval deviation from the assumed mean, (fd^2), and the total of the class interval product-moments about the assumed mean ($\sum xy$). The cumulative frequencies, (cf), for both the X and Y axes, are illustrated in Tables Nos. 2 and 6 in the bottom and far right columns.

From each individual card, the score obtained in the psychological tests and the degree of scholastic success attained, were entered in the proper class intervals on the scattergram. When the entire population had been entered the remaining columns of the scattergram were calculated and filled in. The totals, as contained in the boxes in the lower right-hand corner of the scattergram, were then used in the statistical formulae.

ANALYSIS OF THE DISTRIBUTIONS

Figures Nos. 1, 2, and 8 indicate that the distribution of the psychological tests scores, with the exception of the Pre-Engineering Inventory Mathematics distributions (total and out-state), adhere closely to the normal curve. The smoothed curve on Figures numbers 1, 2, 3, 5, 6, 7, 8, and 13 is the normal curve of the formula:

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

calculated and plotted around the arithmetic mean of the actual distribution.

In the following table, the t-values obtained for the calculated degree of skewness of each of the psychological test distributions is compared with the t-value that could be due to chance at the 0.5 level.

Table No. 11
Comparison of Calculated t-Values of Skewness
With t-Values Due to Chance at 0.05 Level

Psy. Test Distributions	t	t*
P.E.I.Total	1.477	1.96
P.E.I.Math (Total)	2.503**	1.96
P.E.I.Math (In-State)	0.402	1.97
P.E.I.Math (Out-State)	2.268**	1.97
A.C.E.Total	1.819	1.96
P.E.I.Scienc. Comp.	0.634	1.96

* See Garrett, op.cit., p. 190 Table 29.

** Indicates significant skewness.

The t-value for skewness obtained for the total raw score distributions of the A.C.E. tests and the P.E.I. tests were 1.819 and 1.477 respectively. This would indicate that the amount of skewness exhibited by these distributions is most probably due to chance and that the deviations from the normal are not significant. In the case of the distribu-

tion of the P.E.I. Scientific Comprehension (See Figure No. 8) raw scores the t-value of the computed skewness for the distribution was found to be 0.63. This is far below the chance t-value of 1.96 and this distribution also exhibited a high degree of normality. In the distribution of the P.E.I. Mathematics total raw scores, (See Figure No. 5) the distribution sufficiently deviated from the normal to indicate that the exhibited skewness was not due to chance. When the P.E.I. Mathematics total raw scores was broken down into two separate distributions, the one containing the raw scores of the in-state students (See Figure No. 6) and the other (See Figure No. 7) containing the raw scores of the out-state students, it becomes apparent that the significant skewness exhibited by the distribution of the total scores of the P.E.I. Mathematics is being caused by the significant skewness of the out-state distribution and lack of significant skewness of the in-state distribution. The t-value of the calculated skewness of the P.E.I. Mathematics distribution for in-state students is 0.40. This t-value, being far below the t-value of chance, indicates a high degree of normality and lack of significant skewness. The distribution of the P.E.I. Mathematics scores for out-state students has a t-value of calculated skewness of 2.27, which would indicate a significant amount of skewness.

The difference in the normality between the in-state and out-state distributions would seem to indicate that there is a selection factor or process operating against the out-state students between their high school level and their matriculation at the Georgia School of Technology. The mean for the distribution of the P.E.I. Mathematics tests scores for the out-state students is 31.674, while the mean for the distribution of the

in-state students is 28.717.¹⁴ This would seem to indicate that the screening process is eliminating from the out-state population the individuals who would ordinarily be in the lower score intervals. The high degree of normality exhibited by the in-state students indicate that there is probably no selection factor operating to eliminate or screen out the lower level students between the high school and college level.

Concerning the measures of scholastic success used in this study, only the grade-point average distribution exhibited sufficient normality to give a reliable coefficient of correlation. It can be observed from Figure No. 3 that the distribution of the grade-point averages compares exceptionally well with a normal curve fitted about the mean of the distribution. When the frequencies of the class intervals are plotted as percentages of the total population (N) on a logarithmic-probability graph, as illustrated in Figure No. 4, it can be seen that the distribution of the grade-point averages is very nearly normal. On this type of chart the plotted frequency percentages will form a straight line if the distribution is normal, and as the distribution deviates from the normal, the plotted percentages will tend to arrange themselves in the form of an "S" curve.

The distribution of the Mathematics 101 grades total, as shown on Figure No. 9, indicates by inspection a high degree of deviation from the normal. In the case of the in-state students, Figure No. 10, the distri-

¹⁴If the difference between the means of the samples is more than 3 times the standard errors of the mean, the difference is said to be statistically significant. In this case the difference between the means was 4.79 times the standard error.

bution of the grades can in no way be reconciled with a normal curve. The distribution of the Mathematics 101 grades for the out-state students, Figure No. 11, seems to exhibit a lesser degree of deviation from the normal distribution, but the deviation in these cases is sufficient to warrant a lack of confidence in the calculated correlation coefficients between these distribution and those of the psychological tests. The distribution of the English 101 grades, in comparison to the Mathematics 101 grades, exhibit more normal characteristics, but there is sufficient deviation from a normal distribution to again warrant a lack of confidence in the significance of the obtained coefficient of correlation.

PREDICTION

The prediction of success in a college curriculum has been attempted in previous studies using many different measurements as predictors. Porter, investigating 638 students admitted to the freshman class in the College of Engineering at The Carnegie Institute of Technology, found the best predictor of scholastic success throughout the entire college curriculum to be scholarship during the first quarter of the freshman year. He also found, that high school scholarship correlated higher with scholarship while in attendance at C.I.T. than performance on tests of general scholastic aptitude or achievement tests administered upon admission.¹⁵

Pierson found, at the University of Utah, that the best single predictor of scholastic success in a college engineering curriculum was the high school grade-point average.¹⁶ He stated, however, that although he found the high school grade-point ratio to be the best indicator of probable success in college courses in Engineering at the University of Utah, it was not comprehensive enough to be used as the only selective criterion. He further stated, that this index of general scholarship should be supported by scores made on a battery of achievement and intelligence tests, such as the Pre-Engineering Inventory,¹⁷ and further by some measure of a student's patterns of interest.

¹⁵ Porter, James M. Jr. "The Prediction of College Success in an Engineering Curriculum," The American Psychologist, Vol. 1, No. 7, (July 1946) p. 278.

¹⁶ Pierson, George A., "School Marks and Engineering", Educational and Psychological Measurement, Vol. VII No. 3, (Autumn 1947), p. 616.

¹⁷ The Pre-Engineering Inventory referred to by Pierson, Ibid., p.617, is the same battery of psychological tests used in this study.

It is necessary, before attempting to determine what instrument should be used in prediction, to determine the purpose for which the prediction is to be used. A prediction of the probable scholastic success of a student should be determined for one of two purposes. The first, to screen out students who will not be able to successfully complete the requirements set by the institution for a degree; or secondly, if all students are to be admitted, to determine that portion of the applicants which will probably encounter the most difficulty and to prepare such students for work on the college level by extra attention or remedial courses.

If the policy of a college is to allow entrance to a large number of students with the expectation that a fair number of them will fail, the predictive instrument need not be so highly predictive. However, if the aim of the college is to pick out only successful candidates to start with, the finest predictive instrument for measuring aptitude available would probably not be entirely adequate.¹⁸

It has not, nor will it probably be in the near future, the policy of the Georgia School of Technology to attempt to pick out only those students for admission who will be, almost to a certainty, successful in the engineering curriculum. In fact, the entrance requirements at the Georgia School of Technology, at present, requires that a student must be graduated from a properly accredited high school with a record high enough to indicate that he is prepared for college work and to have taken subjects in high school sufficient to satisfy the required units.¹⁹

¹⁸Segel, David, op. cit., p. 25.

¹⁹Bulletin of The Georgia School of Technology, (1947-48), p. 46.

The vast difference in the quality of the high schools within the state of Georgia is probably great enough to cast serious doubt upon the use of high school references as a predictive instrument. The difference in high school teaching methods and marking methods would, in itself, make the possible error in an attempt to predict college scholastic success so large that the attempt would likely be more or less futile.

At this point it is interesting to note that Pierson found the first quarter college total grade-point average was much more efficient in predicting future success in Engineering than the marks earned in individual subjects.²⁰ Porter also found that the scholarship shown during the first semester of the freshman year at the Carnegie Institute of Technology to be the best single index of achievement during the student's period of attendance.²¹ It would, therefore, be of great value if the population of this study was followed through the entire period of residence at the Georgia School of Technology to determine if the scholarship shown during the first quarter of the freshman year at ^{the} Georgia School of Technology is, as indicated by the other studies, the best single predictive instrument.

This study has been limited to the determination of which of the two psychological tests, the A.C.E. and the P.E.I., best measures the probability of success during the first quarter at the Georgia School of Technology. The Pre-Engineering Inventory battery was broken into separate tests scores and the predictive value of the mathematics and the scientific comprehension parts was separately determined.

²⁰ Pierson, George A., op. cit., pp. 612-617.

²¹ Porter, James M. Jr., op. cit., p. 378.

The method used for determining scholastic success from a score attained on a psychological test was a regression equation of a linear form. The methods for determining the linear regression equation, as outlined by Garrett,²² were followed. The score-form regression equation as outlined by Garrett is:

$$Y = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$

In this equation, Y is the dependent variable which is to be predicted from an independent variable X. Applying this equation to the present problem X becomes the raw score obtained on the psychological tests and Y the probable success of the student within the limits of the standard error of estimate.

The coefficient of correlation, r, in the above equation is that measure of relationship found to exist between the psychological test scores and the measurement of scholastic success of the group under study. The σ_y is the standard deviation of the measure of scholastic success, and σ_x is the standard deviation of the distribution of the psychological test scores. M_x is the arithmetic mean of the scores made on the psychological tests and M_y is the arithmetic mean of the measure of scholastic success.

The standard error of estimate is determined by the equation:

$$\sigma_{est y} = \sigma_y \sqrt{1 - r^2}$$

In this formula, σ_y , is again the standard deviation of the distribution of the measures of scholastic success.

²²Garrett, Henry E., op. cit., p. 310.

The standard error of estimate is calculated in order to indicate the accuracy with which we are able to predict a dependent Y from an independent X. Y, plus or minus one standard error of estimate, indicates that in 84 chances out of 100 the dependent variable will fall within these limits. With Y, plus or minus two standard errors of estimate, the chances are 98 times out of a 100 that the dependent variable will actually be within these limits, and if three standard errors of estimate are used the dependent variable will fall within the limits,²³ for practical uses, to a certainty. On Figures Nos. 13 and 14, the lines of regression have been drawn in and the limits of one, two, and three standard errors of estimate have been added as indicated by broken lines.

It will be noted from the formula²⁴ for the standard error of estimate, that as r approaches zero the standard error of estimate increases so markedly that predictions from the regression equation range all the way from almost a certainty to what is virtually a guess. The significance of an r with respect to predictive value may be accurately gauged by the extent to which r improves our prediction over a mere guess. Thus, when $r = .00$ our estimate of a person's Y score is not aided at all by a knowledge of his X score. When $r = 1.00$ the standard error of estimate is zero and the prediction of Y from X becomes almost a certainty.²⁵

Assuming the measure of success to be predicted as being the grade-point average to be expected during the first quarter of freshman college

²³ The chances are 99.99 out of a 100 at three standard error of estimates.

²⁴ cf. ante, p. 18.

²⁵ Garrett, Henry E., op. cit., p. 321.

work, the regression equation for predicting the dependent variable from the total raw score made on the A.C.E. Psychological Examinations was found to be:

$$Y = 0.020 X - 0.247$$

The standard error of estimate, when $r = 0.456$, and the standard deviation equals 0.973, was found to be 0.865. This equation is illustrated in Figure No. 14. It will be noted from this figure that the slope of the regression line and the large standard error of estimate creates a serious doubt concerning the predictive value of the A.C.E. total raw scores in determining a student's probable point average. As an example; if a slightly above average student were to attain a score of 112 on the A.C.E. tests it could be expected 98 times out of a 100 that he would make a grade-point average of between 0.263 and 3.723.

If the problem of general prediction is considered the lower limit would, for all practical purposes, indicate no chance of success while the upper limit would indicate that it is possible that this student would be in the upper ten percent of his class. It also is impossible to predict a probable grade-point average above 2.95.

The regression equation for predicting scholastic success, as indicated by the grade-point averages, from the raw scores attained on the P.E.I. tests was determined and illustrated as shown in Figure No. 13. In this case the dependent variable X can be predicted from the equation:

$$Y = 0.015 X + 0.377$$

The standard error of estimate was found to be 0.740, and r is 0.646. Figure No. 13 clearly indicates the superior predictive quality of this

equation over the equation illustrated in Figure No. 14. The standard error of estimate is smaller and the slope of the regression line is more within the range of the grade-point average ordinate.

Three examples of students scoring in the lower, middle, and upper range of the P.E.I. Tests are to be discussed and their positions illustrated.

As an example, let us assume that a student falling in the lower fourth of the test range (See Figure No. 14) scored 75 on the P.E.I. test. This student will most probably earn a grade-point average of 1.50. This represents the best guess on the basis of the average performance of the group of students in this study. It can also be said that his grade-point average will not, 84 times out of a 100 exceed 2.24 nor be less than 0.76. It is, for practical purposes, a certainty that his grade-point average will not exceed 3.72.

The student who makes a middle range score of 150²⁶ on the P.E.I. test will most probably complete his first quarter with a grade-point average of 2.80. The chances are 84 times out of a 100 that his grade-point average will not be less than 2.06 nor greater than 3.54. It is certain that this student will not make a grade-point average of less than 0.58.

If a student earns a total raw score of 225, placing him in the high range of the P.E.I. test, he will most probably make a first-quarter grade-point average of 4.10, and the chances are 84 times out of a 100

²⁶The average score on the P.E.I. is 106.15.

that he will not make less than 3.36 nor more than 4.84. It is certain that he will not make a grade-point average of less than 1.14.

The remaining regression equations, as illustrated in Table No. 1, were not further investigated because of the size of their standard error of estimates.

CONCLUSIONS

The results of this study would seem to indicate that the Pre-Engineering Inventory total raw scores furnish the best tool, of those investigated, in predicting scholastic success in the first quarter of freshman work of the Georgia School of Technology. The American Council on Education Psychological Examination scores would seem to be a second best predictor of scholastic success.

The A.C.E. test, due to a relatively low coefficient of correlation and a consequently large standard error of estimate, is less useful than the P.E.I. test for the purpose of this study.

The evidence presented by this study would seem to indicate that the Pre-Engineering Inventory test is the best single predictor of probable scholastic success in terms of grade-point averages, of those investigated. The line of regression (Figure No. 14) extends throughout the entire range of possible grade-point averages. Thus, all of the predicted probable grade-point averages will be within the artificial limits, .00 to 5.00, of the grade-point system.

The standard error of estimate of the P.E.I. test in predicting grade-point averages is the smallest, 0.740, of all of the combinations investigated. The amount of expected deviation of the actual grade-point average from the predicted, is therefore less and the chances of accuracy increased.

It is obvious that neither of the psychological tests investigated in this study will predict, with any reasonable certainty, absolute scholastic success. However, on the basis of the evidence presented by

this study it is felt that the Pre-Engineering Inventory raw scores, could be used to determine that portion of the entering freshman whose lack of either aptitude or preparation would warrant giving such students special attention. If it were decided, for instance, that all students who attain a raw score of less than 75 on the Pre-Engineering Inventory, should be given non-credit remedial courses, it is possible that the chance of these students failing out of school might be considerably reduced.

The Pre-Engineering Inventory Tests measures both aptitude and achievement. It is possible that the large standard error of estimate of prediction is due to a significant difference between the pre-college training of the individual students. If a portion of the students have had an intensive four year technical high school training it is possible that they would make a relatively high score on the Pre-Engineering Inventory Tests, due to their achievement, and not necessarily due to a high natural aptitude or rate of learning. These students with a high achievement but a low aptitude would probably show up well in the Pre-Engineering Inventory scores, but could do poorly in the actual college level work. Conversely, a student with a general high school education, and possibly only a three year period of high school training, might show up very poorly in the Pre-Engineering Inventory scores due to a low achievement, and yet, due to a high natural aptitude be successful in the college level work.

Therefore, if the population under study were to be broken down into independent homogenous groups on the basis of pre-college training, it is probable that a predictive value for the Pre-Engineering Inventory test would be of much greater significance. This refinement, however,

was beyond the scope of this study.

In summary, this study offers evidence that:

- (1) There is a statistically reliable difference between the in-state and out-state student scores on the Pre-Engineering Mathematics test; the out-state students earning the higher mean score.
- (2) Of the measures used, the Pre-Engineering Inventory total raw scores appears to be the best single indicator of probable scholastic success in the first quarter of the freshman year.
- (3) The Pre-Engineering Inventory total raw scores are not sufficiently reliable to be used as a single method of prediction for the purpose of screening applicants.
- (4) These tests may be used as standands for singling out the following groups of students:
 - (a) Those who may require extra attention or remedial non-credit courses to improve their scholastic average.
 - (b) Those who could most probably profit from enriched courses taught at a higher level.
- (5) It appears from the normality of the overall grade-point average, that this measure might prove to be the best predictor of future success in subsequent quarters.

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Table No. 1

	M_x	M_y	σ_x	σ_y	r	Zr	Regression Equation	$\sigma_{est y}$
1.	106.150 ± 2.72	1.950 ± 0.062	42.252 ± 1.924	0.969 ± 0.044	0.646 ± 0.038	0.77	$Y = 0.015X + 0.377$	0.740
2.	28.717 ± 1.264	2.469 ± 0.124	13.880 ± 0.894	1.359 ± 0.088	0.617 ± 0.028	0.72	$Y = 0.060X + 0.734$	1.070
3.	31.674 ± 1.200	2.628 ± 0.126	13.070 ± 0.852	1.367 ± 0.090	0.517 ± 0.068	0.57	$Y = 0.054X + 0.915$	1.170
4.	30.175 ± 0.878	2.548 ± 0.088	13.570 ± 0.622	1.766 ± 0.062	0.571 ± 0.044	0.65	$Y = 0.057X + 0.814$	1.121
5.	$108.854 \pm 1.428^*$	2.565 ± 0.088	22.0 ± 1.010	1.370 ± 0.062	0.337 ± 0.058	0.35	$Y = 0.021X + 0.499$	1.290
6.	$109.256 \pm 1.434^*$	2.974 ± 0.078	21.925 ± 1.014	1.208 ± 0.056	0.412 ± 0.054	0.44	$Y = 0.023X + 0.494$	1.101
7.	$109.004 \pm 1.428^*$	1.943 ± 0.062	22.082 ± 1.010	0.973 ± 0.044	0.456 ± 0.052	0.49	$Y = 0.020X - 0.247$	0.865
8.	38.795 ± 1.108	2.873 ± 0.072	16.962 ± 0.778	1.105 ± 0.050	0.511 ± 0.048	0.57	$Y = 0.033X + 1.582$	0.950
9.	38.558 ± 1.108	2.545 ± 0.088	17.016 ± 0.784	1.353 ± 0.062	0.420 ± 0.054	0.45	$Y = 0.033X + 1.258$	1.228

1. P.E.I. Total Against Grade-Point Averages
2. P.E.I. Math Against Math 101 Grades (In-State)
3. P.E.I. Math Against Math 101 Grades (Out-State)
4. P.E.I. Math Against Math 101 Grades (Total)
5. A.C.E. Total Against Math 101 Grades
6. A.C.E. Total Against English 101 Grades
7. A.C.E. Total Against Grade-Point Averages
8. P.E.I. Scientific Comprehension Against English 101 Grades
9. P.E.I. Scientific Comprehension Against Math 101 Grades

* The Mean for this population, as calculated by the University of Chicago (3/31/48), was 108.88; the mean for a population of 34,658 on the same test was 105.24 and the standard deviation (σ_x) was 25.15 .

Scattergram Table No. 2

	20-31	32-43	44-55	56-67	68-79	80-91	92-103	104-115	116-127	128-139	140-151	152-163	164-175	176-187	188-199	200-211	212-223	224-235	236-	f_y	d_y	fd_y	fd_y^2	Σxy	$c f_y$
45-50	0	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	0	0	1	4	4	16	64	108	966
40-44	0	0	0	0	0	0	0	1	1	0	2	1	3	5	3	2	1	0	0	19	3	57	171	306	962
36-39	0	0	0	0	1	2	1	0	3	5	4	5	12	4	6	3	0	0	0	46	2	92	184	374	943
30-34	0	0	1	1	2	1	3	3	12	18	12	8	7	5	2	0	1	2	0	18	1	78	78	204	897
25-29	0	0	0	3	8	14	15	22	20	11	21	14	11	6	1	1	1	0	0	148	0	0	0	0	819
20-24	1	3	3	7	10	20	22	18	24	29	19	7	6	5	1	1	0	0	0	176	-1	-176	176	-91	671
15-19	1	4	11	11	26	24	21	22	24	12	11	3	3	0	1	1	0	0	0	175	-2	-350	700	307	495
10-14	5	12	19	27	23	21	22	15	9	7	2	4	2	0	0	0	0	0	0	168	-3	-504	1512	1164	320
05-09	12	9	15	13	12	11	11	7	5	4	0	0	0	0	0	0	0	0	0	99	-4	-396	1584	1284	152
0-0.4	4	8	15	7	6	4	3	3	1	1	1	0	0	0	0	0	0	0	0	53	-5	-265	1325	1010	53
f_x	23	36	64	69	88	97	98	91	100	87	72	42	44	25	15	9	3	2	1	966					
d_x	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10	11						
fd_x	-161	-216	-320	-276	-264	-194	-98	0	100	174	216	168	220	150	105	72	27	20	11	-266					
fd_x^2	1127	1296	1600	1104	792	388	98	0	100	348	648	672	1100	900	735	576	243	200	121	12048					
Σxy	602	738	1080	784	615	380	183	0	-99	-134	-78	-16	110	138	168	104	27	20	44	4666					
$c f_x$	23	59	123	192	280	377	475	566	666	753	825	867	911	936	951	960	963	965	966						

Total Pre-Engineering Raw Scores Against Point Averages

Scattergram Table No. 3

	60-65	66-71	72-77	78-83	84-89	90-95	96-101	102-107	108-113	114-119	120-125	126-131	132-137	138-143	144-149	150	f_y	d_y	$f_y d_y$	$f_y d_y^2$	$\Sigma X Y$
AA	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	1	3	3	9	-3
A	0	0	0	0	0	2	1	1	7	2	9	8	8	5	4	5	52	2	208	416	624
B	1	1	1	5	4	2	21	9	24	22	23	33	20	23	18	12	219	1	219	219	1092
C	5	5	3	11	13	32	30	37	48	45	41	29	12	10	12	10	343	0	0	0	0
D	2	8	19	10	22	22	29	17	15	17	13	8	2	1	1	0	186	-1	-186	186	-179
F	15	13	16	10	17	11	11	12	9	9	7	2	0	1	1	0	134	-2	-268	536	100
f_x	23	27	39	36	57	69	92	76	103	95	98 80	42	40	36	27	935		-24	1366	1634	
d_x	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10					
$f_x d_x$	-115	-108	-117	-72	-57	0	92	152	309	380	465	480	294	320	324	270	2619				
$f_x d_x^2$	575	432	351	144	57	0	92	304	927	1520	2325	2880	2058	2560	2896	2700	19821				
$\Sigma X Y$	155	132	150	50	49	0	-28	-60	15	-36 70	222	238	250	207	220	1634					

Total A.C.E. Raw Scores Against English 101 Grades

Scattergram

Table No. 4

	60-65	66-71	72-77	78-83	84-89	90-95	96-101	102-107	108-113	114-119	120-125	126-131	132-137	138-143	144-149	150-	f_y	d_y	$f_y d_y$	$f_y d_y^2$	$\Sigma X Y$
AA	1	1	1	0	0	2	0	0	1	1	1	5	3	2	5	6	29	3	87	261	516
A	0	0	1	2	1	1	5	2	10	7	8	7	2	6	6	5	63	2	126	252	614
B	2	3	3	2	4	1	9	13	17	15	18	19	12	7	5	4	140	1	140	140	536
C	2	5	6	8	13	7	26	17	34	17	26	19	11	10	9	6	224	0	0	0	0
D	2	7	6	8	20	15	26	16	18	29	22	12	9	11	5	4	222	-1	-222	222	-596
F	18	11	25	19	21	24	27	29	26	25	19	12	5	5	6	0	272	-2	-544	1088	-592
f_x	25	27	42	39	59	69	93	77	106	94	94	81	42	41	36	25	950		-413	1963	478
d_x	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8	9	10					
$f_x d_x$	-125	-108	-126	-78	-59	0	93	154	318	376	470	486	294	328	324	250	2597				
$f_x d_x^2$	625	432	378	156	59	0	93	308	954	1504	2350	2916	2058	2624	2916	2500	19873				
$\Sigma X Y$	165	92	144	80	56	0	-61	-114	-90	-188	-115	30	42	22	135	280	478				

Total A.C.E. Raw Score Against Mathematics 101 Grades

Scattergram

Table No. 5

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-	f_y	d_y	$f_y d_y$	$f_y d_y^2$	$\Sigma X Y$	$c f_y$
AA	0	0	0	1	1	0	1	5	2	3	5	5	4	0	1	28	3	84	252	186	955
A	0	0	0	1	3	3	3	10	14	9	5	4	7	2	0	61	2	122	244	176	927
B	0	1	2	4	5	17	25	25	25	15	9	7	2	0	3	140	1	140	140	35	866
C	0	2	11	11	23	37	49	38	27	11	8	8	4	0	0	229	0	0	0	0	726
D	1	4	9	29	43	46	29	31	10	7	5	1	1	0	0	216	-1	-216	216	394	497
F	13	27	46	56	46	43	10	23	7	6	2	1	1	0	0	281	-2	-562	1124	1814	281
f_x	14	34	68	102	121	146	117	132	85	51	34	26	19	2	4	455		-432	1976	2605	
d_x	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7						
$f_x d_x$	-98	-204	-340	-408	-363	-292	-117	0	85	102	102	104	95	12	28	-1294					
$f_x d_x^2$	686	1224	1700	1632	1089	584	117	0	85	204	306	416	475	72	196	8786					
$\Sigma X Y$	189	342	495	528	363	218	15	0	35	46	75	108	125	24	42	2605					
$c f_x$	14	48	116	218	339	485	602	734	819	870	904	930	949	951	955						

Total P.E.I. Mathematics Against Mathematics 101 Grades

Scattergram

Table No. 6

	60-65	66-71	72-77	78-83	84-89	90-95	96-101	102-107	108-113	114-119	120-125	126-131	132-137	138-143	144-149	150-	f_y	d_y	$f_y d_y$	$f_y d_y^2$	$\Sigma X Y$
4.5-5.0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	1	4	4	16	64	84
4.0-4.4	0	0	1	0	0	1	0	0	2	2	2	6	1	0	1	3	19	3	57	171	195
3.5-3.9	0	1	1	2	0	0	0	0	4	5	9	7	3	5	6	3	46	2	92	184	322
3.0-3.4	1	1	0	1	0	4	6	6	9	6	12	8	7	5	5	6	77	1	77	77	206
2.5-2.9	0	3	2	1	5	4	11	11	24	13	17	17	8	13	10	5	144	0	0	0	0
2.0-2.4	2	4	5	3	8	14	17	13	19	20	19	13	12	10	7	8	174	-1	-174	174	-257
1.5-1.9	4	2	6	3	13	13	19	24	20	23	15	17	6	4	2	2	173	-2	-346	692	-194
1.0-1.4	3	7	9	13	16	20	22	18	14	15	17	10	2	4	2	0	166	-3	-498	1494	261
0.5-0.9	7	4	10	11	13	9	12	9	9	8	5	1	2	0	1	0	101	-4	-404	1616	700
0-0.4	9	5	8	4	3	4	8	3	4	3	1	0	1	0	1	0	54	-5	-270	1350	710
f_x	26	27	42	38	58	69	95	78	106	95	97	79	43	41	36	28	958		-1450	5822	2077
d_x	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8					
$f_x d_x$	-182	-162	-210	-152	-174	-138	-95	0	106	190	291	316	215	246	252	224	+727				
$f_x d_x^2$	1274	972	1050	608	522	276	95	0	106	380	873	1264	1075	1476	1764	1792	13527				
$\Sigma X Y$	602	402	595	428	447	298	203	0	-130	-272	-267	-164	-115	-90	-14	104	2027				
$c f_x$	26	53	95	133	191	260	355	433	539	634	731	810	853	894	930	958					

Total A.C.E. Raw Scores Against Point Averages

Scattergram Table No. 7

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-	f_y	d_y	$f_y d_y$	$f_y d_y^2$	$\sum xy$	cf_y
AA	0	0	0	1	1	0	0	3	0	1	4	2	2	0	0	14	3	42	126	117	471
A	0	0	0	1	1	2	2	8	6	6	3	2	3	0	0	34	2	68	136	142	457
B	0	0	0	1	3	9	14	13	9	8	6	5	2	0	1	71	1	71	71	106	423
C	0	0	7	5	13	19	22	21	16	8	5	6	2	0	0	124	0	0	0	0	352
D	0	2	4	17	19	19	9	14	6	5	4	0	1	0	0	100	-1	-100	100	71	228
F	2	7	16	25	28	21	6	13	5	3	1	1	0	0	0	128	-2	-256	512	444	128
f_x	2	9	27	50	65	70	53	72	42	31	23	16	10	0	1	471		-175	945	880	
d_x	-8	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8						
$f_x d_x$	-12	-45	-108	-150	-130	-70	0	72	84	93	92	80	60	0	8	-26					
$f_x d_x^2$	72	225	432	450	260	70	0	72	168	279	368	400	360	0	64	3220					
$\sum xy$	24	80	144	183	134	48	0	-2	10	36	72	65	78	0	8	880					
cf_x	2	11	38	88	153	223	276	348	390	421	444	460	470	470	471						

Out of State Students
P.E.I Mathematics Score Against Mathematics 101 Grades

Scattergram Table No. 8

	0-5	6-11	12-17	18-23	24-29	30-35	36-41	42-47	48-53	54-59	60-65	66-71	72-77	78-83	84--	t_y	d_y	$f_y d_y$	$f_y d_y^2$	Σxy	cf_y
AA	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	3	3	9	-15	
A	0	0	0	0	1	0	4	7	7	7	9	11	2	4	2	54	2	108	216	266	
B	1	2	3	5	17	25	24	33	38	30	24	12	6	2	0	222	1	222	222	81	
C	1	2	14	24	45	48	51	58	44	23	12	8	9	4	0	343	0	0	0	0	
D	6	14	13	25	30	31	32	13	12	8	1	2	0	1	0	188	-1	-188	188	430	
F	6	13	26	26	18	13	6	12	4	3	0	0	0	0	0	132	-2	-264	528	850	
f_x	14	31	57	80	111	117	117	123	110	71	46	33	17	11	2	940		-119	1163	1612	
d_x	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7						
$f_x d_x$	-98	-186	-285	-320	-333	-234	-117	0	110	142	138	132	86	66	14	-886					
$f_x d_x^2$	686	1116	1425	1280	999	468	117	0	110	284	414	528	425	396	98	8346					
Σxy	119	228	295	288	141	64	12	0	22	60	123	128	50	54	28	1612					
cf_x	14	45	102	182	293	410	527	650	760	831	877	910	928	938	940						

P.E.I. Scientific Comprehension Against English 101 Grades

Scattergram Table No. 9

	0-5	6-11	12-17	18-23	24-29	30-35	36-41	42-47	48-53	54-59	60-65	66-71	72-77	78-83	84-	f_y	d_y	$f_y d_y$	$f_y d_y^2$	Σxy	
AA	0	2	0	0	1	0	3	2	1	2	5	6	1	3	1	27	3	81	243	168	
A	0	1	0	0	3	5	5	7	11	5	12	6	1	1	1	58	2	116	232	138	
B	2	2	4	4	12	16	11	24	25	17	14	5	4	3	0	143	1	143	143	18	
C	0	3	6	24	23	23	33	32	26	23	9	8	7	3	0	220	0	0	0	0	
D	3	4	20	14	32	42	34	28	24	13	4	7	3	1	0	229	-1	-229	229	304	
F	9	21	30	41	42	29	31	33	20	11	3	0	1	0	0	271	-2	-542	1084	1324	
f_x	14	33	60	83	113	115	117	126	107	71	47	32	17	11	2	948		-431	1931	1952	
d_x	-7	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7						
$f_x d_x$	-98	-198	-300	-332	-339	-230	-117	0	107	142	141	128	85	66	14	-731					
$f_x d_x^2$	686	1188	1500	1328	1017	460	117	0	107	284	423	512	425	396	98	8541					
Σxy	133	216	380	368	285	148	66	0	-14	-4	129	112	20	78	35	1952					

P.E.I. Scientific Comprehension Against Mathematics 101 Grades

Scattergram

Table No. 10

	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-	f_y	j_y	$f_y d_y$	$f_y d_y^2$	$\sum xy$	cf_y
AA	0	0	0	0	0	0	1	2	2	2	1	3	2	0	1	14	3	42	126	153	484
A	0	0	0	0	2	1	1	2	8	3	2	2	4	2	0	27	2	54	108	156	470
B	0	1	2	3	2	8	11	12	16	7	3	2	0	0	2	69	1	69	69	69	443
C	0	2	4	6	10	18	27	17	11	3	3	2	2	0	0	105	0	0	0	0	374
D	1	2	5	12	24	27	20	17	4	2	1	1	0	0	0	116	-1	-116	116	107	269
F	11	20	30	31	18	22	4	10	2	3	1	0	1	0	0	153	-2	-306	612	808	153
f_x	12	25	41	52	56	76	64	60	43	20	11	10	9	2	3	484		-257	1031	1293	
d_x	-6	-5	-4	-3	-2	-1	0	1	2	3	4	5	6	7	8						
$f_x d_x$	-72	-125	-164	-156	-112	-76	0	60	86	60	44	50	54	14	24	-313					
$f_x d_x^2$	432	625	656	468	224	76	0	60	172	180	176	250	324	98	192	3933					
$\sum xy$	138	205	252	213	108	61	0	-15	60	33	28	70	72	28	40	1293					
cf	12	37	78	130	186	262	326	386	429	449	460	470	479	481	484						

In State Students
P.E.I. Mathematics Scores Against Mathematics 101 Grades

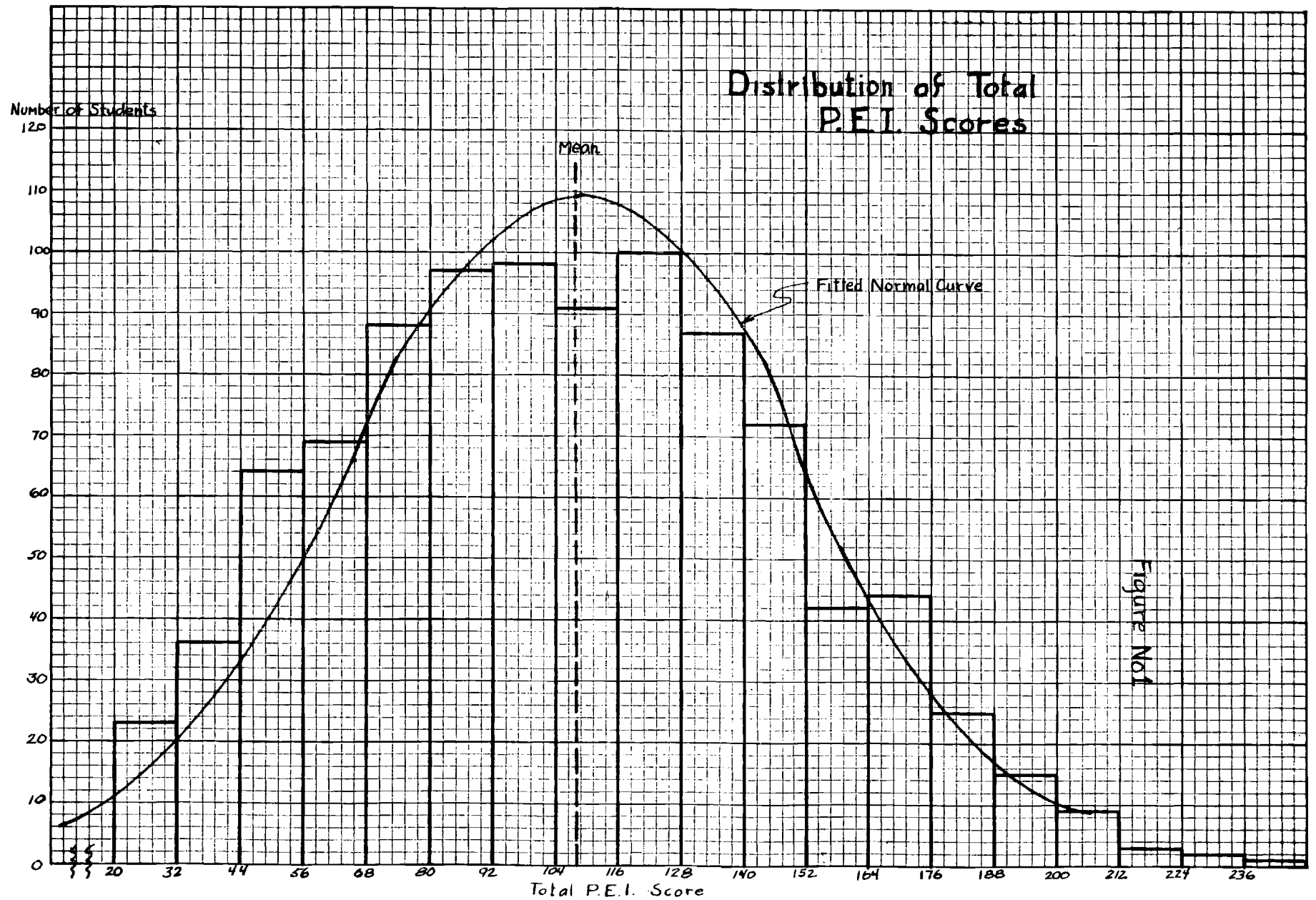


Figure No. 1

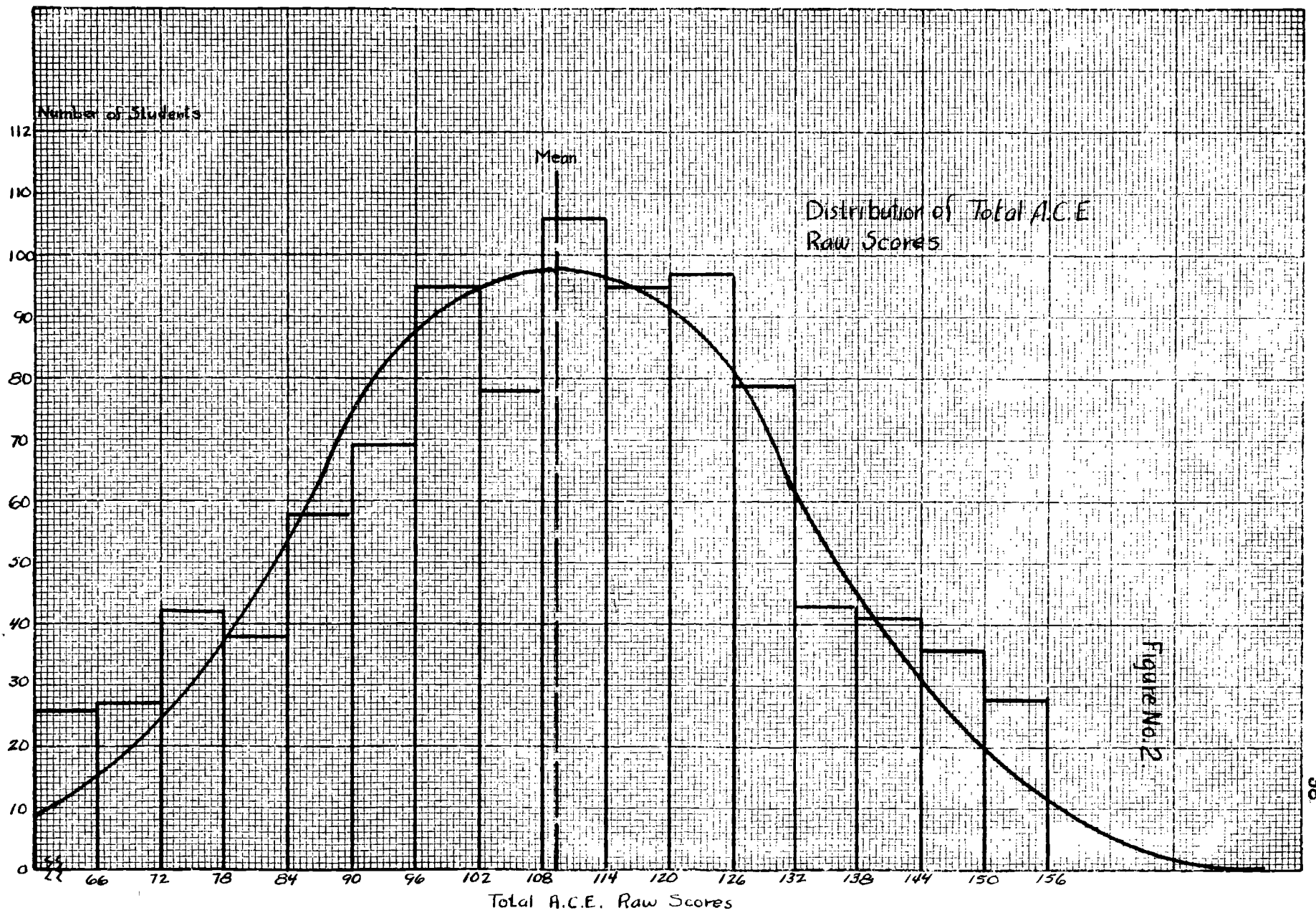


Figure No. 2.

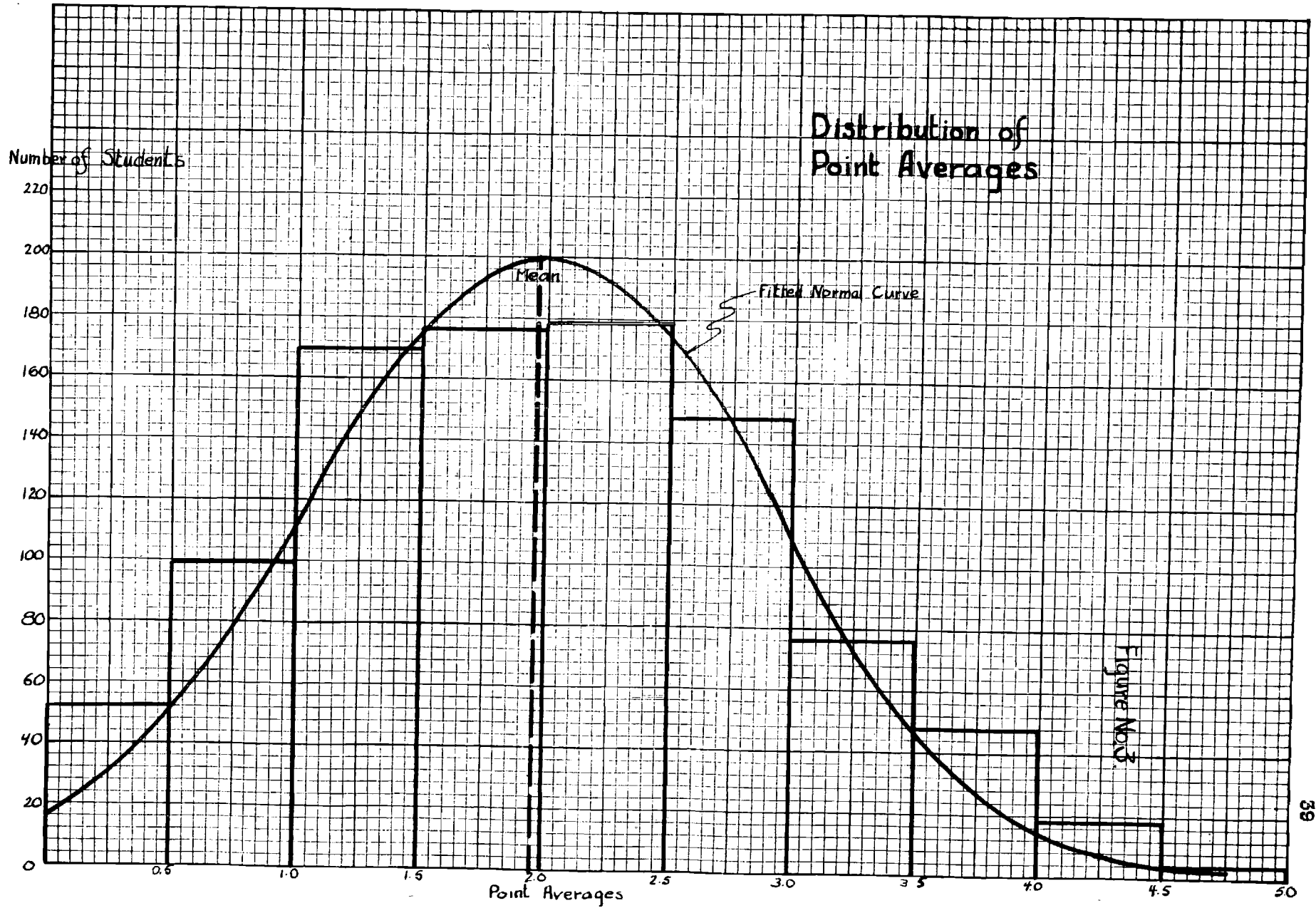
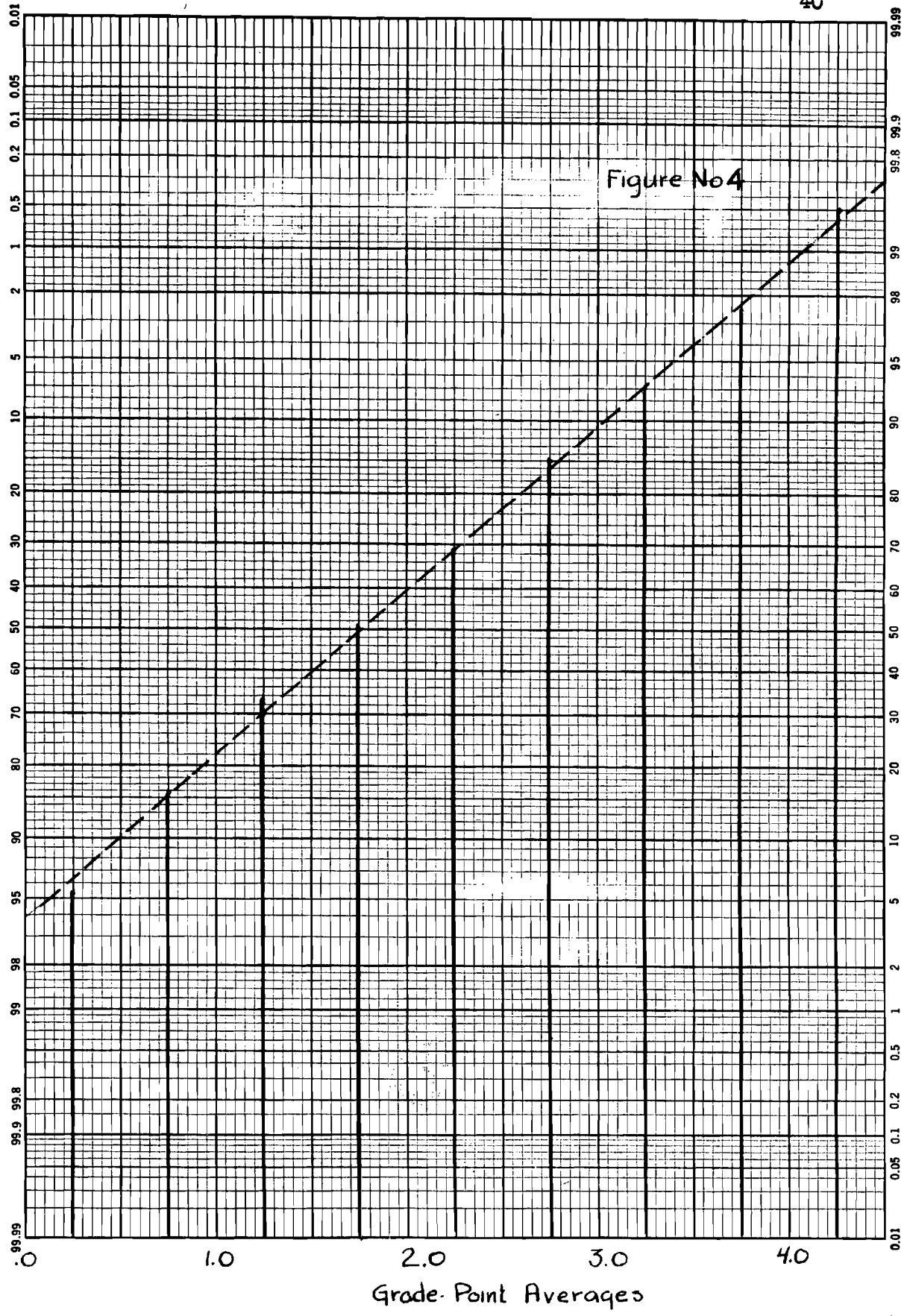


Figure No. 3



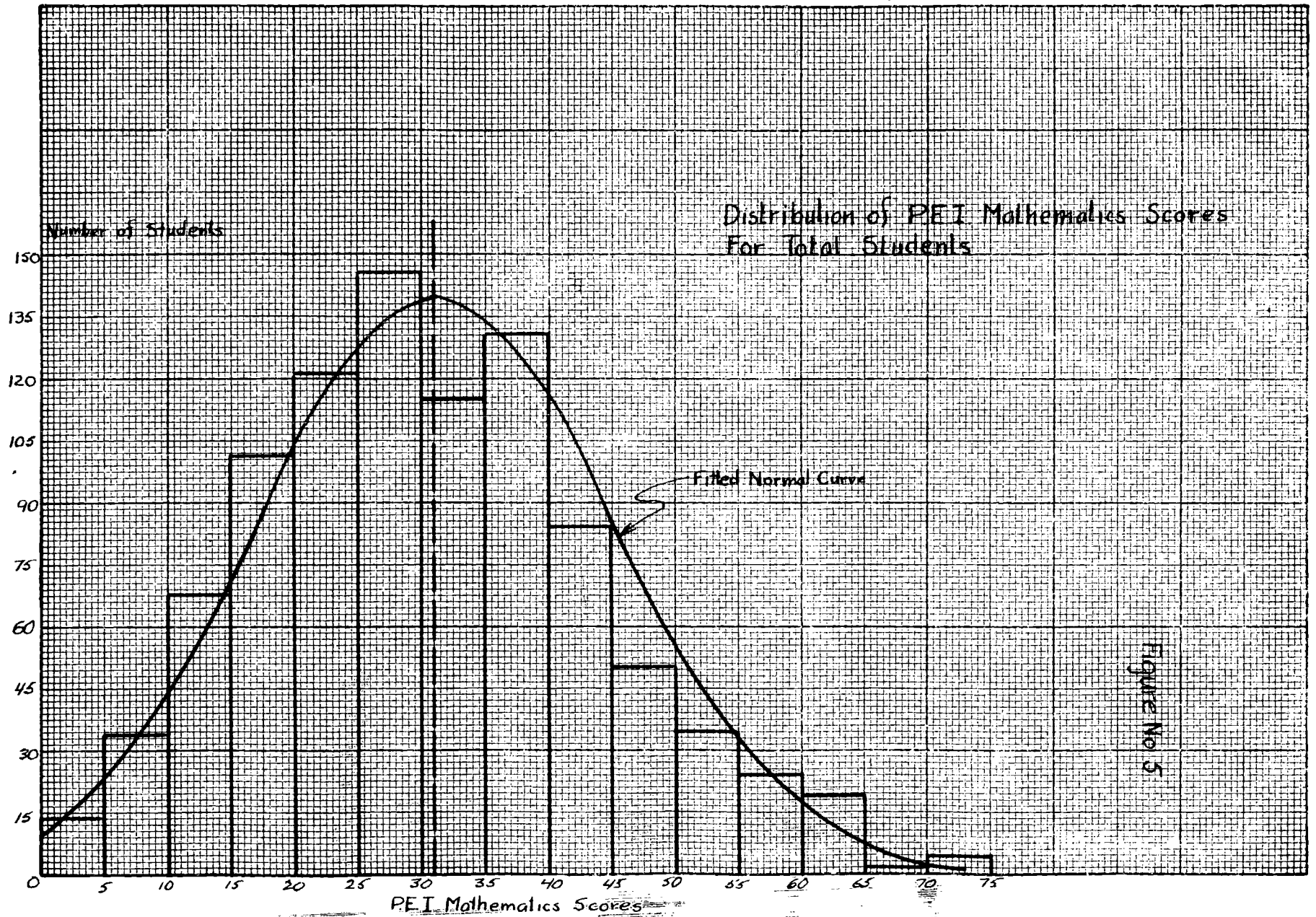


Figure No 5

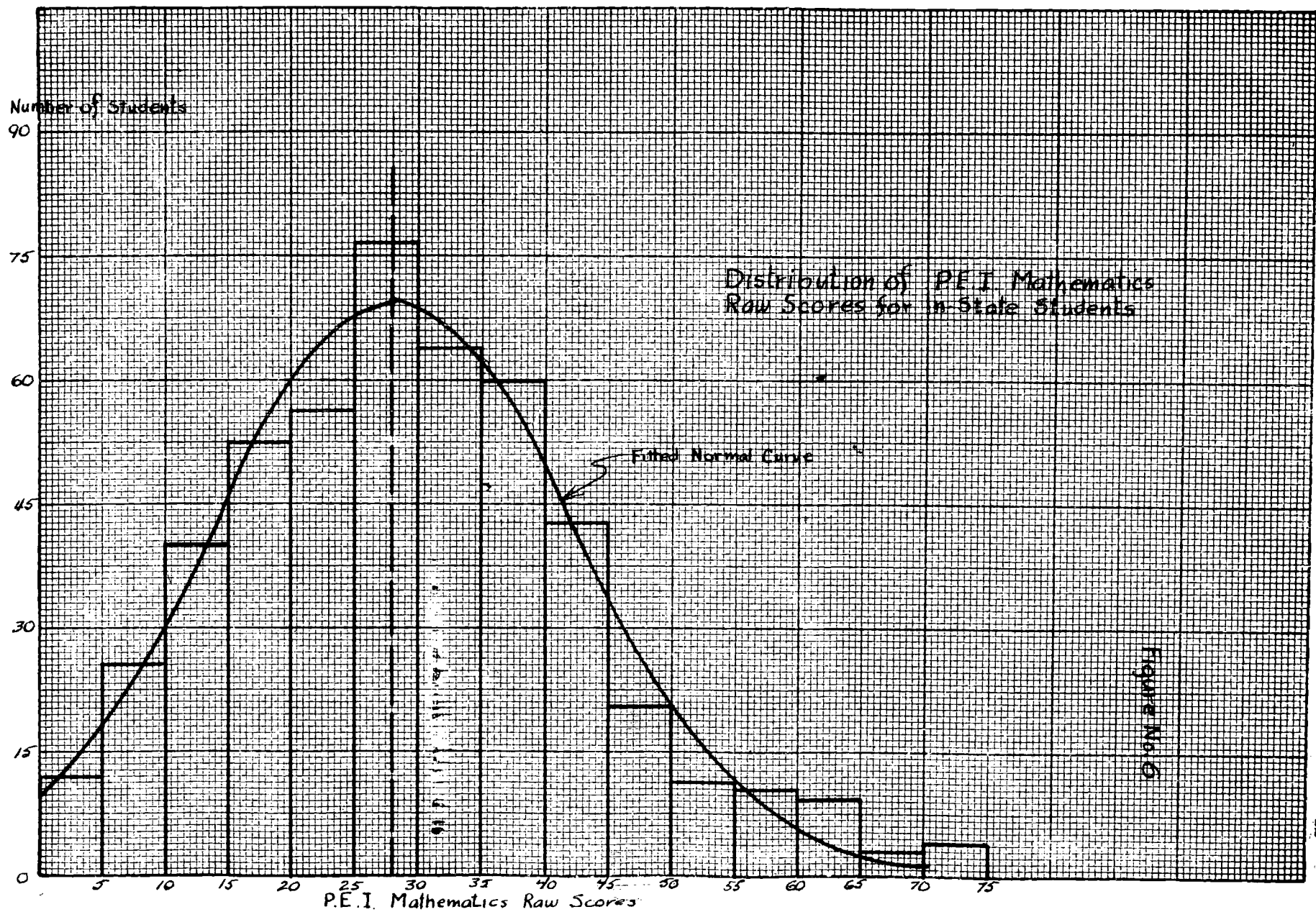


Figure No. 6

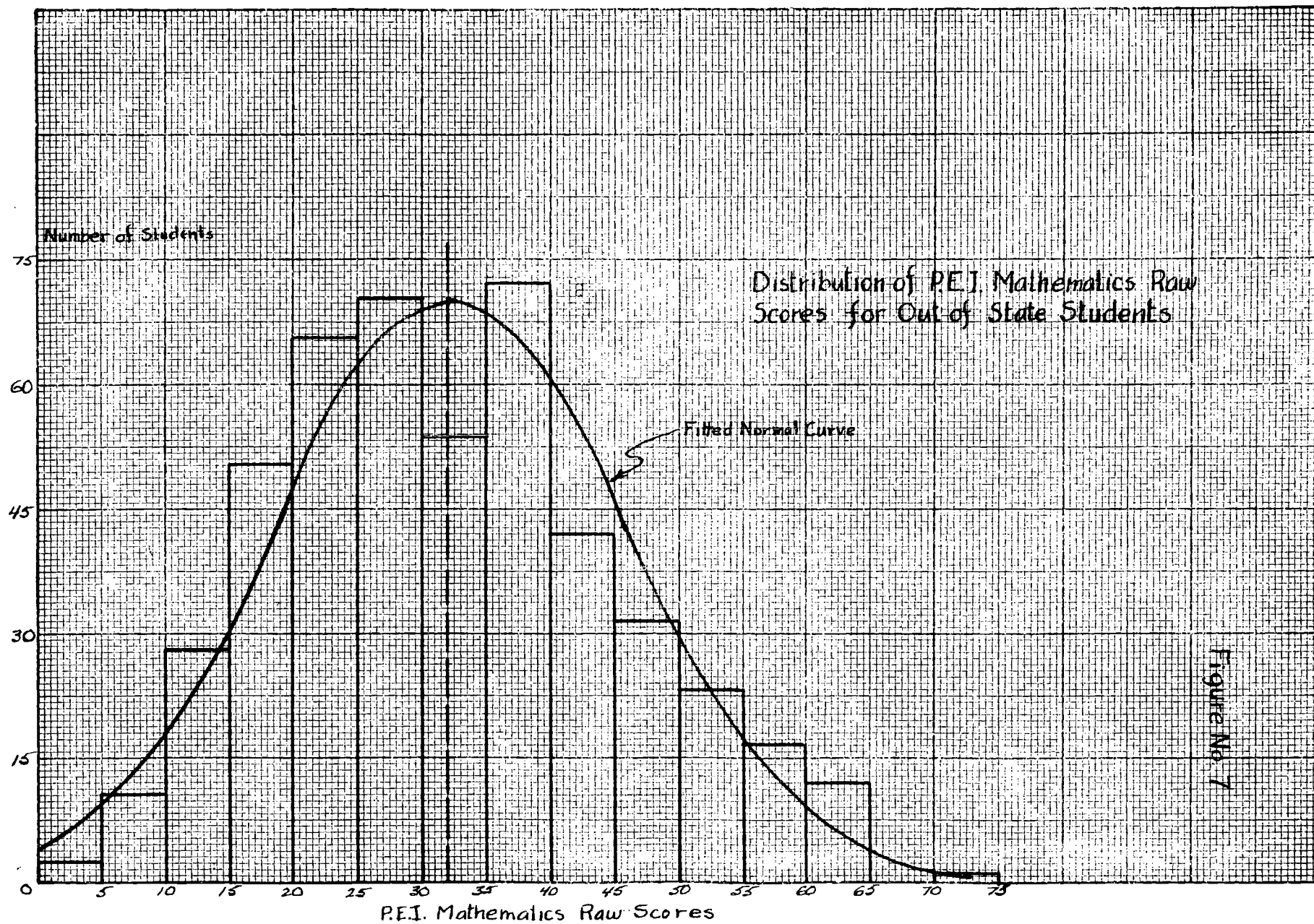
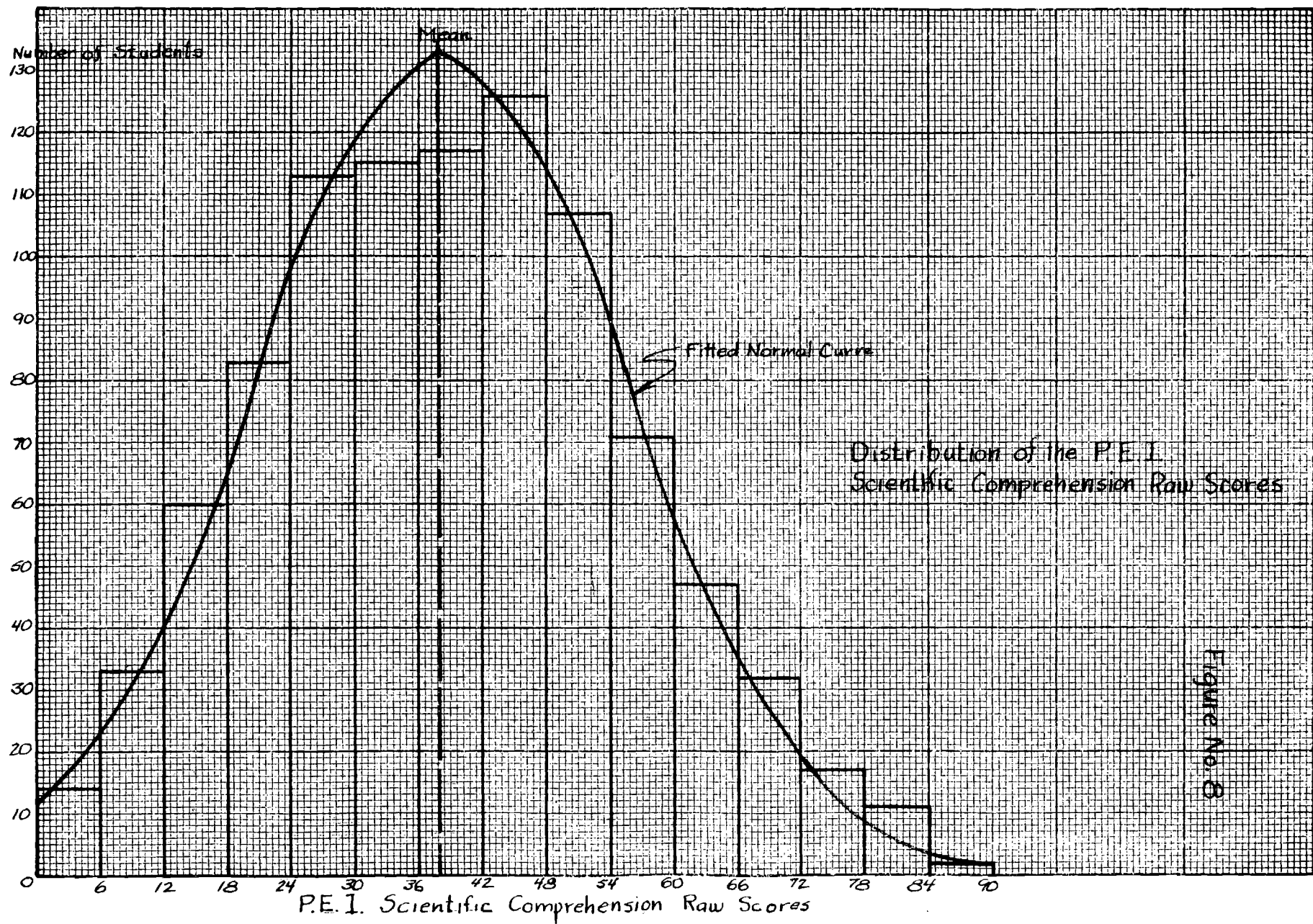


Figure No. 7



Distribution of the P.E.I. Scientific Comprehension Raw Scores

Figure No. 8

Figure No. 9

Number of Students

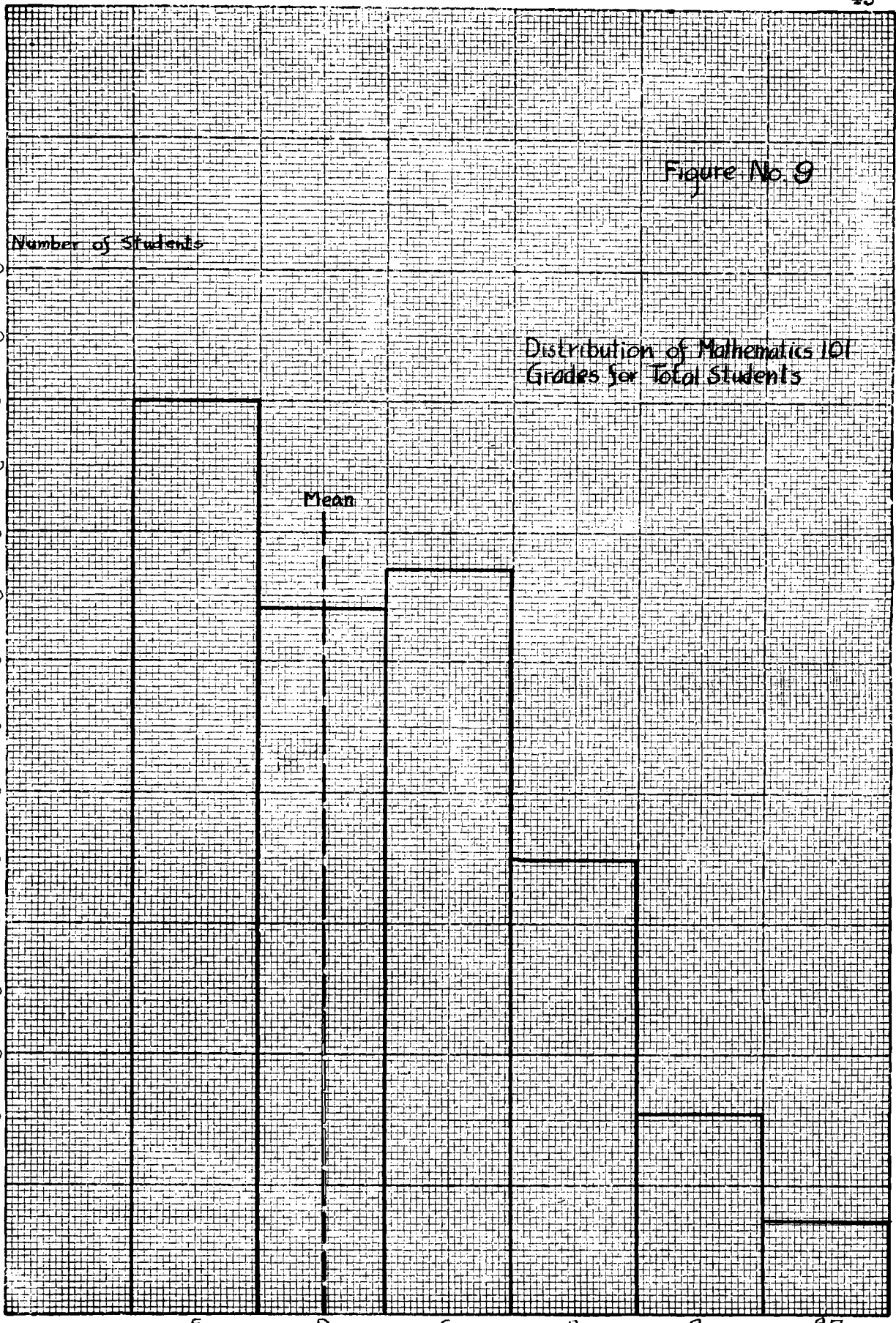
320
300
280
260
240
220
200
180
160
140
120
100
80
60
40
20
0

Distribution of Mathematics 101 Grades for Total Students

Mean

F D C B A AA

Mathematics 101 Grades



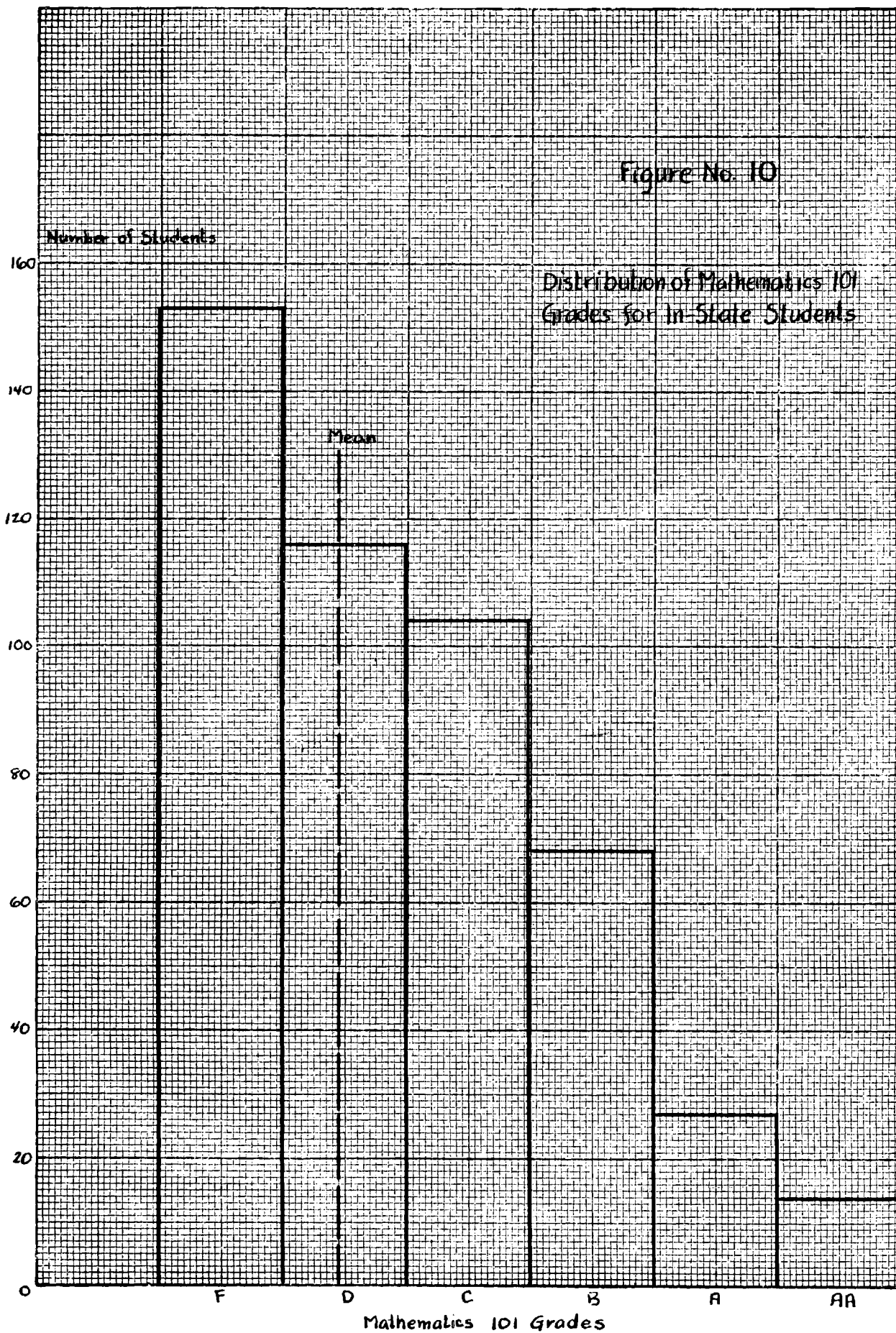


Figure No. II

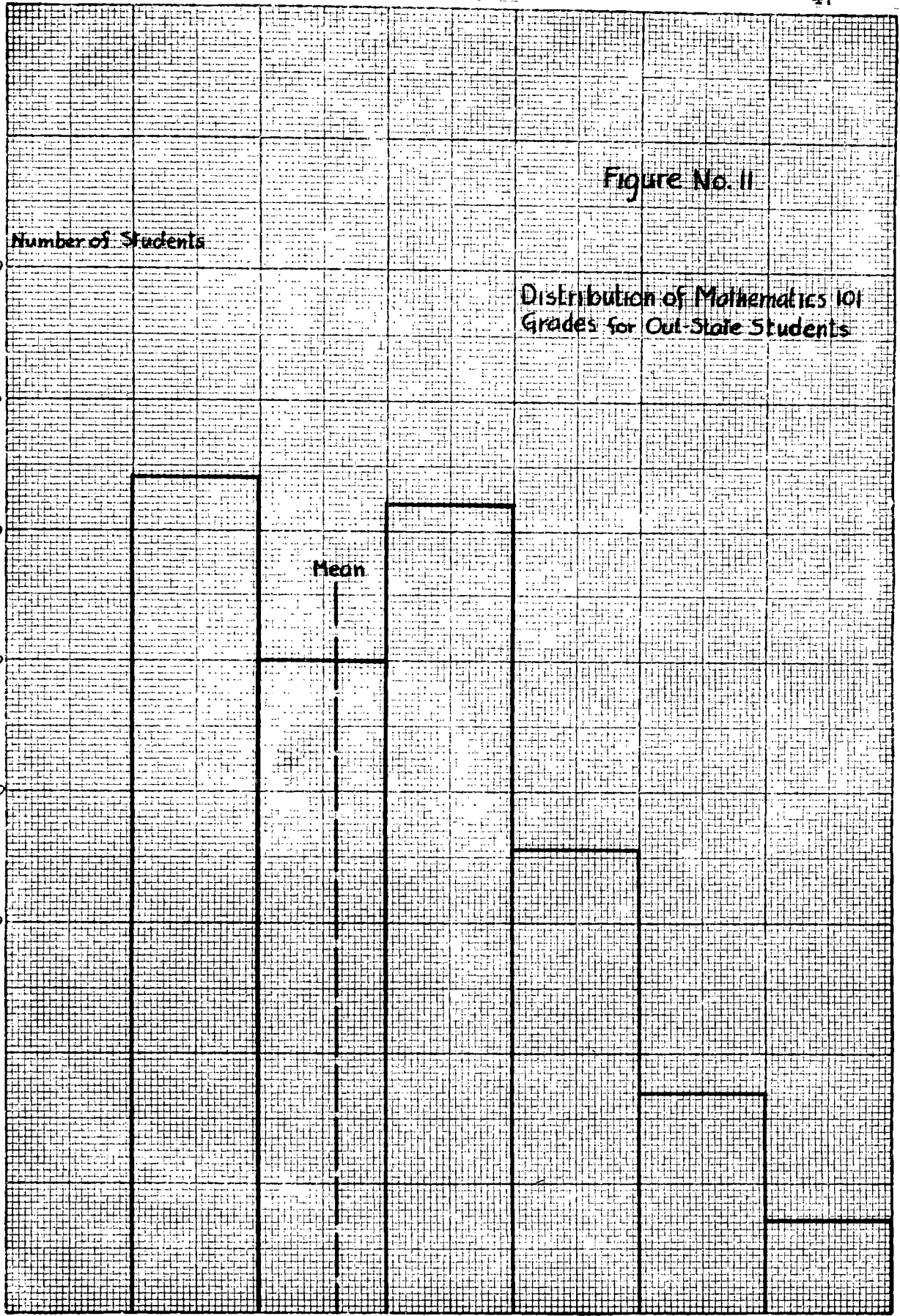
Number of Students

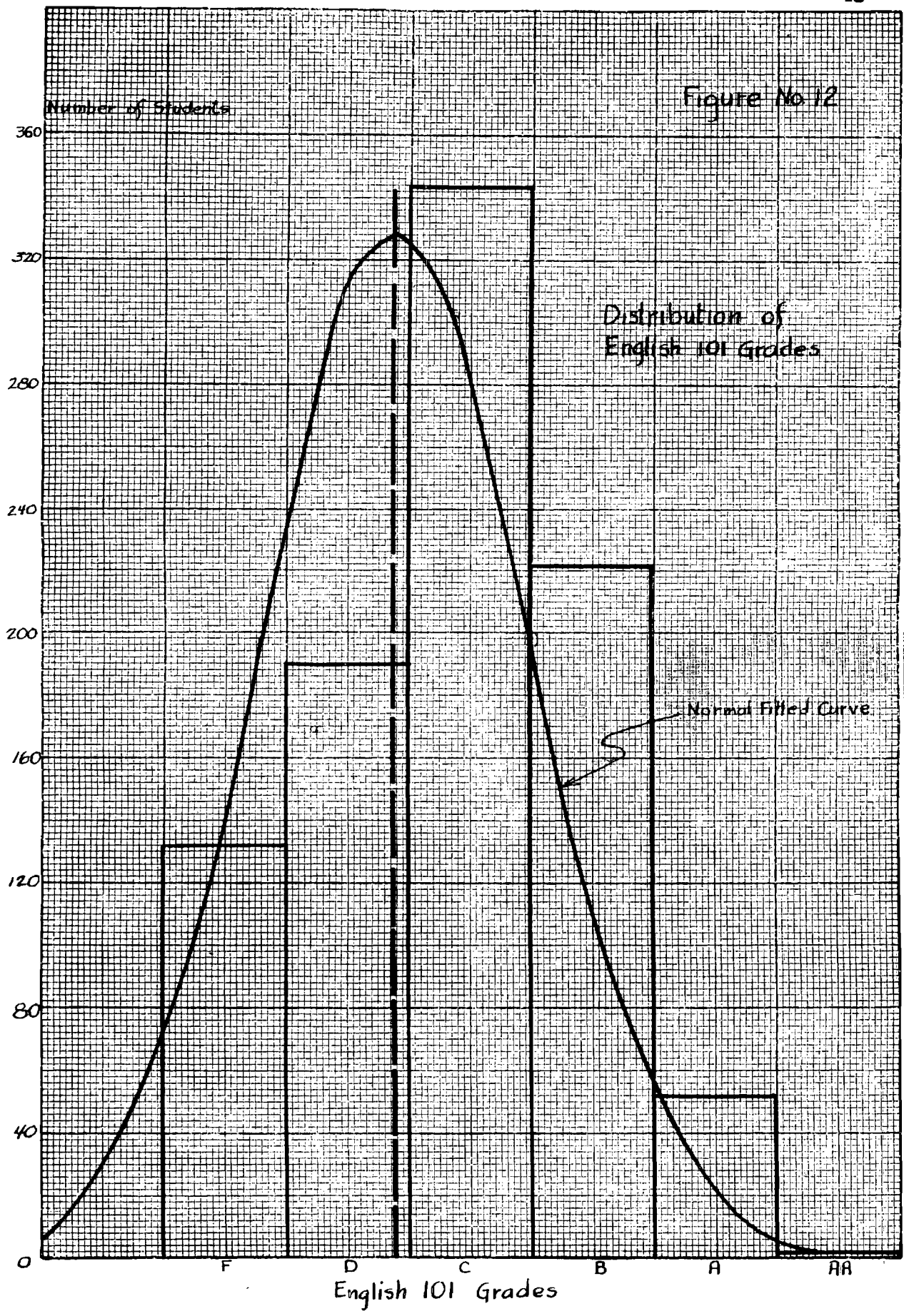
Distribution of Mathematics 101 Grades for Out-State Students

160
140
120
100
80
60
40
20
0

F D C B A AA
Mathematics 101 Grades

Mean





Number of Students

Figure No 12

Distribution of English 101 Grades

Normal Fitted Curve

English 101 Grades

Equation For Predicting Point Averages
From Pre-Engineering Raw Scores

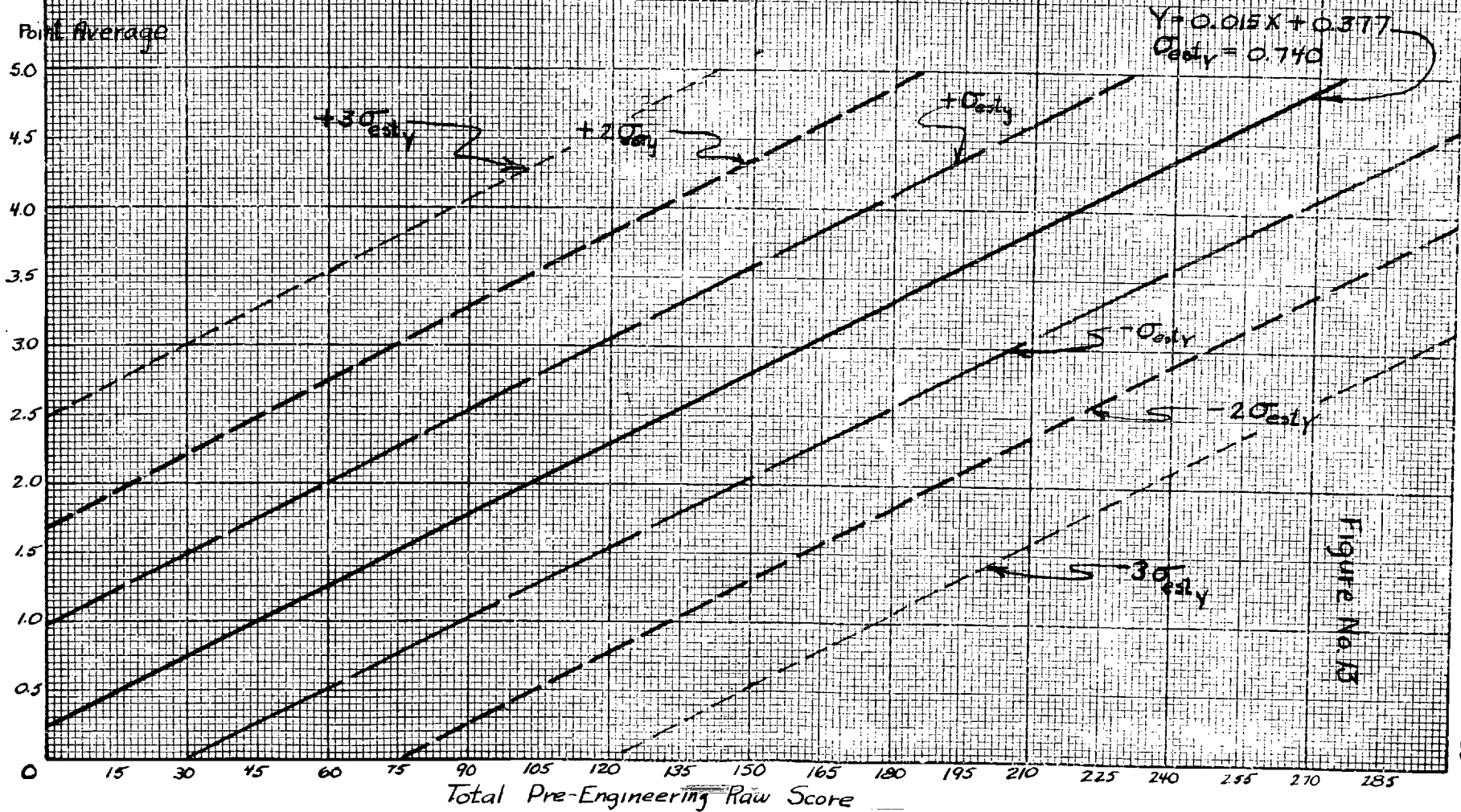


Figure No. 13

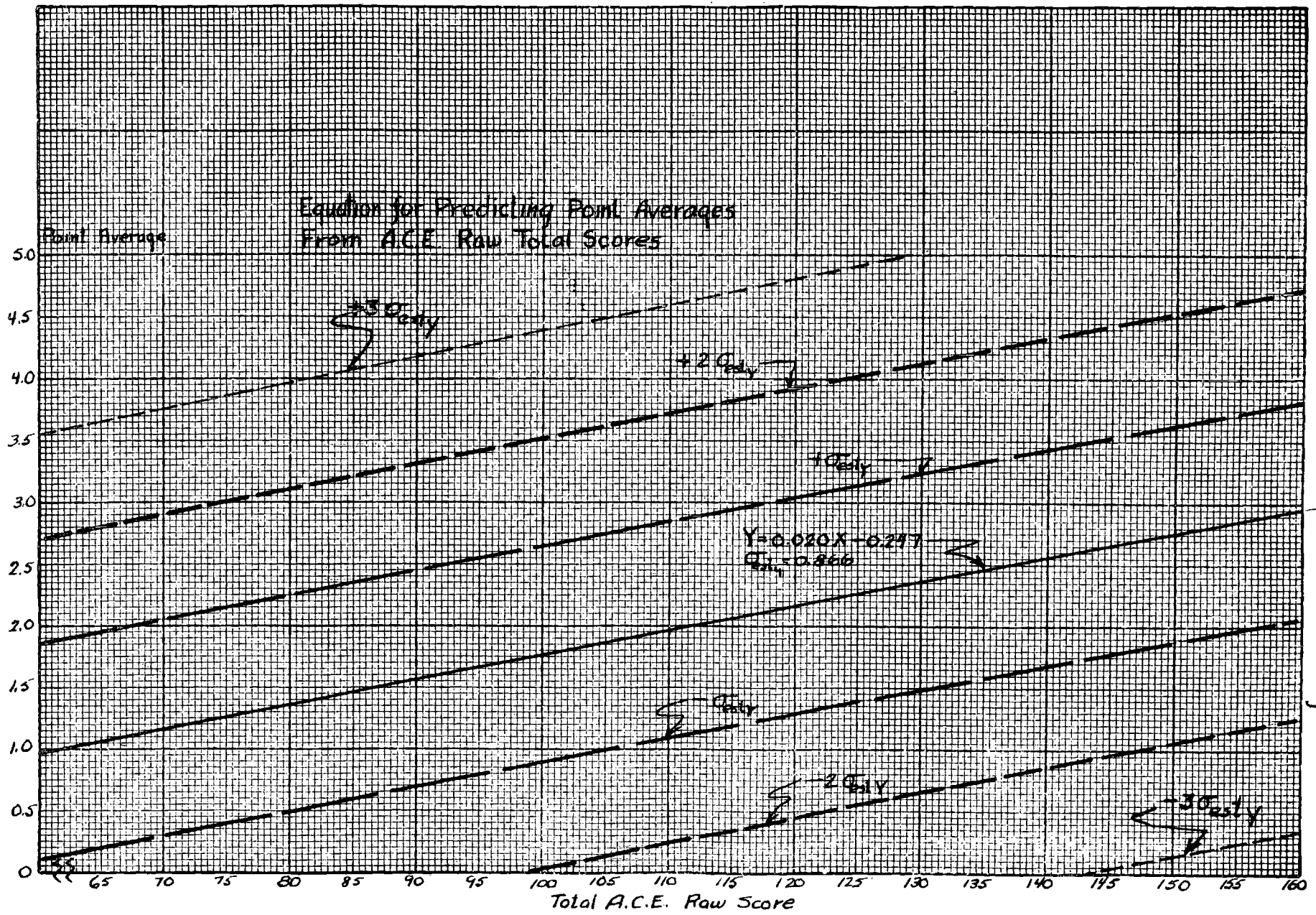


Figure No. 14
50

Distribution of Total Pre-Engineering Inventory Raw Scores

51

$$(1) P_{90} = l + \left(\frac{P(N-F)}{f_p} \right) i$$

$$P_{90} = 163.5 + \left(\frac{869.4 - 867}{44} \right) 12$$

$$P_{90} = 164.155$$

$$P_{50} = l + \left(\frac{P(N-F)}{f_p} \right) i$$

$$P_{50} = 103.5 + \left(\frac{483 - 475}{91} \right) 12$$

$$P_{50} = 104.555$$

$$P_{10} = l + \left(\frac{P(N-F)}{f_p} \right) i$$

$$P_{10} = 43.5 + \left(\frac{96.6 - 59.0}{64} \right) 12$$

$$P_{10} = 50.550$$

$$(2) S_k = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$S_k = \frac{50.550 + 164.155}{2} - 104.555$$

$$S_k = + 2.798$$

$$(3) \sigma_{sk} = \frac{0.5185 D}{\sqrt{N}}$$

$$\sigma_{sk} = \frac{(0.5185)(113.605)}{31.081}$$

$$\sigma_{sk} = 1.895$$

$$D = P_{90} - P_{10}$$

$$D = 164.155 - 50.550$$

$$D = 113.605$$

$$t = \frac{S_k}{\sigma_{sk}}$$

$$t = \frac{2.798}{1.895}$$

$$t = 1.477$$

$$(4) V = \frac{\sigma}{M} \times 100$$

$$V = \frac{42.252}{106.150} \times 100$$

$$V = 39.804\%$$

ACE Total Score Distribution (x)

(1)

$$P_{90} = l + \left(\frac{PN - F}{f_p} \right) i$$

$$P_{90} = 137.5 + \left(\frac{8622 - 8530}{41} \right) 6$$

$$P_{90} = 138.846$$

$$P_{50} = l + \left(\frac{PN - F}{f_p} \right) i$$

$$P_{50} = 107.5 + \left(\frac{479 - 433}{106} \right) 6$$

$$P_{50} = 110.103$$

$$P_{10} = l + \left(\frac{PN - F}{f_p} \right) i$$

$$P_{10} = 77.5 + \left(\frac{95.8 - 95.0}{38} \right) 6$$

$$P_{10} = 77.626$$

2)

$$Sk = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$Sk = 108.236 - 110.103$$

$$Sk = -1.867$$

$$\sigma_{Sk} = \frac{(0.5185) D}{\sqrt{N}}$$

$$\sigma_{Sk} = \frac{(0.5185)(61.220)}{30.952}$$

$$\sigma_{Sk} = 1.026$$

$$D = P_{90} - P_{10}$$

$$D = 138.846 - 77.626$$

$$D = 61.220$$

$$\sqrt{958} = 30.952$$

(3)

$$t = \frac{Sk}{\sigma_{Sk}}$$

$$t = \frac{1.867}{1.026}$$

$$t = 1.819$$

(4)

$$V_x = \frac{\sigma_x}{M_x} \times 100$$

$$V_x = \frac{22.082}{109.004} \times 100$$

$$V_x = 20.258\%$$

P.E.I. Mathematics Scores Distribution

53

$$(1) P_{90} = l + \left(\frac{P^N - F}{f_p} \right) i$$

$$P_{90} = 44.5 + \left(\frac{859.5 - 819.0}{51} \right) 5$$

$$P_{90} = 48.471$$

$$P_{50} = l + \left(\frac{P^N - F}{f_p} \right) i$$

$$P_{50} = 24.5 + \left(\frac{477.5 - 339.0}{146} \right) 5$$

$$P_{50} = 29.243$$

$$P_{10} = l + \left(\frac{P^N - F}{f_p} \right) i$$

$$P_{10} = 9.5 + \left(\frac{95.5 - 48.0}{68} \right) 5$$

$$P_{10} = 12.993$$

$$(2) S_k = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$S_k = \frac{48.471 + 12.993}{2} - 29.243$$

$$S_k = 1.489$$

$$\sigma_{SK} = \frac{0.5185 D}{\sqrt{N}}$$

$$\sigma_{SK} = \frac{(0.5185)(35.478)}{30.903}$$

$$\sigma_{SK} = 0.595$$

$$(3) t = \frac{S_k}{\sigma_{SK}}$$

$$t = \frac{1.489}{0.595}$$

$$t = 2.503$$

$$(4) V = \frac{t}{M} \times 100$$

$$V = \frac{13.570}{30.175} \times 100$$

$$V = 44.971\%$$

Distribution of PEI Mathematics Raw Scores for In-State Students

(1)

$$P_{90} = L + \left(\frac{PN - F}{f_p} \right) L$$

$$P_{90} = 44.5 + \left(\frac{435.6 - 429}{20} \right) 5$$

$$P_{90} = 46.145$$

$$P_{50} = L + \left(\frac{PN - F}{f_p} \right) L$$

$$P_{50} = 24.5 + \left(\frac{242 - 186}{76} \right) 5$$

$$P_{50} = 28.184$$

$$P_{10} = L + \left(\frac{PN - F}{f_p} \right) L$$

$$P_{10} = 9.5 + \left(\frac{48.4 - 37}{41} \right) 5$$

$$P_{10} = 10.890$$

(2)

$$SK = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$SK = \frac{46.145 + 10.890}{2} - 28.184$$

$$SK = 10.334$$

(3)

$$\sigma_{SK} = \frac{0.5185 D}{\sqrt{N}}$$

$$\sigma_{SK} = \frac{(0.5185)(35.255)}{22}$$

$$\sigma_{SK} = 0.831$$

$$D = P_{90} - P_{10}$$

$$D = 46.145 - 10.890$$

$$D = 35.255$$

$$\sqrt{N} = 22.0$$

$$t = \frac{SK}{\sigma_{SK}}$$

$$t = \frac{10.334}{0.831}$$

$$t = 12.442$$

Distribution of P.E.I. Mathematics Raw Scores for Out of State Students

$$(1) P_{90} = L + \left(\frac{FN - F}{f_p} \right) L$$

$$P_{90} = 49.5 + \left(\frac{423.9 - 421.0}{92} \right) 5$$

$$P_{90} = 49.658$$

$$P_{50} = L + \left(\frac{FN - F}{f_p} \right) L$$

$$P_{50} = 29.5 + \left(\frac{235.5 - 223.0}{53} \right) 5$$

$$P_{50} = 30.679$$

$$P_{10} = L + \left(\frac{FN - F}{f_p} \right) L$$

$$P_{10} = 14.5 + \left(\frac{471 - 38.0}{50} \right) 5$$

$$P_{10} = 15.410$$

(2)

$$S_k = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$S_k = \frac{49.658 + 15.410}{2} - 30.679$$

$$S_k = +1.855$$

(3)

$$\sigma_{SK} = \frac{0.5185 D}{\sqrt{N}}$$

$$D = P_{90} - P_{10}$$

$$D = 49.658 - 15.410$$

$$D = 34.248$$

$$\sigma_{SK} = \frac{(0.5185)(34.248)}{21703}$$

$$\sigma_{SK} = 0.818$$

$$4) V = \frac{\sigma}{M} \times 100$$

$$V = \frac{13.070}{31.674} \times 100$$

$$V = 41.264 \%$$

$$Z = \frac{SK}{\sigma_{SK}}$$

$$Z = \frac{1.855}{0.818}$$

$$Z = 2.268$$

Distribution of P.E.T. Scientific Comprehension Raw Scores

56

$$(1) P_{90} = L + \left(\frac{Q_N - F}{f_p} \right) i$$

$$P_{90} = 59.5 + \left(\frac{846 - 831}{40} \right) 6$$

$$P_{90} = 61.456$$

$$P_{50} = L + \left(\frac{Q_N - F}{f_p} \right) i$$

$$P_{50} = 35.5 + \left(\frac{470 - 410}{117} \right) 6$$

$$P_{50} = 38.577$$

$$P_{10} = L + \left(\frac{Q_N - F}{f_p} \right) i$$

$$P_{10} = 11.5 + \left(\frac{94 - 45}{57} \right) 6$$

$$P_{10} = 16.658$$

$$(2) S_K = \frac{P_{90} + P_{10}}{2} - P_{50}$$

$$S_K = \frac{61.456 + 16.658}{2} - 38.577$$

$$S_K = +0.480$$

$$(3) \sigma_{SK} = \frac{0.5185 D}{\sqrt{N}}$$

$$\sigma_{SK} = \frac{(0.5185)(44.798)}{30.659}$$

$$\sigma_{SK} = 0.757$$

$$D = P_{90} - P_{10}$$

$$D = 61.456 - 16.658$$

$$D = 44.798$$

$$t = \frac{S_K}{\sigma_{SK}}$$

$$t = \frac{0.480}{0.757}$$

$$t = 0.634$$

Calculations

Total P.E.I. Raw Scores Against Point Averages

$$(1) M_x = AM_x + c_x L_x$$

$$c_x = \frac{fd_x}{N}$$

$$L_x = 12$$

$$M_x = 109.45 - 3.300$$

$$c_x = \frac{-266}{966}$$

$$c_x L_x = -3.300$$

$$M_x = 106.150$$

$$c_x = -0.275$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{42.252}{31.064}$$

$$\sigma_{M_x} = 1.360$$

$$M_x = 106.150 \pm 2.720$$

$$(2) M_y = AM_y + c_y L_y$$

$$c_y = \frac{fd_y}{N}$$

$$L_y = 0.5$$

$$c_y L_y = -0.750$$

$$M_y = 2.700 - 0.750$$

$$c_y = -\frac{1448}{966}$$

$$M_y = 1.950$$

$$c_y = -1.499$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{0.969}{31.064}$$

$$\sigma_{M_y} = 0.031$$

$$M_y = 1.950 \pm 0.062$$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - C_x^2} \cdot L$$

$$\sigma_x = \sqrt{\frac{12,048}{966} - 0.076} \cdot L$$

$$\sigma_x = \sqrt{12.396} \cdot L$$

$$\sigma_x = 3.521 \cdot 12$$

$$\sigma_x = 42.252$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{42.252}{43.932}$$

$$\sigma_{\sigma_x} = 0.962$$

$$\sigma_x = 42.252 \pm 1.924$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - C_y^2} \cdot L$$

$$\sigma_y = \sqrt{\frac{5794}{966} - 2.247} \cdot L$$

$$\sigma_y = \sqrt{3.752} \cdot L$$

$$\sigma_y = 1.937 \cdot 0.5$$

$$\sigma_y = 0.969$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{0.969}{43.932}$$

$$\sigma_{\sigma_y} = 0.022$$

$$\sigma_y = 0.969 \pm 0.044$$

$$(5) r = \frac{\sum xy}{N} - C_x C_y$$

$$r = \frac{4666}{966} - 0.422$$

$$(1.937)(3.521)$$

$$r = 0.646 \pm 0.038$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.583}{31.081}$$

$$\sigma_r = 0.019$$

$$(6) t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.646)(31.048)}{0.764}$$

$$t = 26.260$$

$$(8) \sigma_{est y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est y} = 0.969(0.764)$$

$$\sigma_{est y} = 0.740$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (x - M_x) + M_y$$

$$Y = (0.646) \frac{0.969}{42.252} (x - 126.150) + 1.950$$

$$Y = 0.015x + 0.377$$

Calculations
for

A.C.E. Total Scores Against Point Averages

59

(1)

$$M_x = AM_x + C_x l_x$$

$$M_x = 104.45 + 4.554$$

$$M_x = 109.004$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{22.082}{30.935}$$

$$\sigma_{M_x} = 0.714$$

$$M_x = 109.004 \pm 1.428$$

$$C_x = \frac{fd_x}{N}$$

$$C_x = + \frac{727}{958}$$

$$C_x = +0.759$$

$$AM_x = 104.45$$

$$C_x^2 = 0.576$$

$$N = 958$$

$$l_x = 6$$

$$C_x l_x = +4.554$$

$$\sqrt{957} = 30.935$$

$$\sigma_x = 22.082$$

(2)

$$M_y = AM_y + C_y l_y$$

$$M_y = 2.700 - 0.757$$

$$M_y = 1.943$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{0.973}{30.935}$$

$$\sigma_{M_y} = 0.031$$

$$M_y = 1.943 \pm 0.062$$

$$C_y = \frac{fd_y}{N}$$

$$C_y = - \frac{1450}{958}$$

$$C_y = -1.514$$

$$AM_y = 2.700$$

$$C_y^2 = 2.292$$

$$N = 958$$

$$l_y = 0.5$$

$$C_y l_y = -0.757$$

$$\sqrt{957} = 30.935$$

$$\sigma_y = 0.973$$

$$(3) \quad \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - C_x^2} \cdot L_x$$

$$\sigma_x = \sqrt{\frac{13.527}{958} - 0.576} \cdot L_x$$

$$\sigma_x = \sqrt{13.544} \cdot L_x$$

$$\sigma_x = 3.68026 \cdot 6$$

$$\sigma_x = 22.082$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{22.082}{43.7495}$$

$$\sigma_{\sigma_x} = 0.505$$

$$\sigma_x = 22.082 \pm 1.010$$

$$(4) \quad \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - C_y^2} \cdot L_y$$

$$\sigma_y = \sqrt{\frac{5822}{958} - 2.292} \cdot L_y$$

$$\sigma_y = \sqrt{3.785} \cdot L_y$$

$$\sigma_y = 1.9455 \cdot 0.5$$

$$\sigma_y = 0.973$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{0.973}{43.7495}$$

$$\sigma_{\sigma_y} = 0.022$$

$$\sigma_y = 0.973 \pm 0.044$$

60

$$(5) \quad r = \frac{\frac{\sum xy}{N} - C_x C_y}{\sigma_x \sigma_y}$$

$$r = \frac{\frac{2027}{958} - 1.149}{(3.680)(1.946)}$$

$$r = 0.456 \pm 0.052$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.792}{30.952}$$

$$\sigma_r = 0.026$$

(6)

$$t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.456)(30.919)}{0.890}$$

$$t = 15.842$$

(7)

$$Y = r \frac{\sigma_y}{\sigma_x} (x - M_x) + M_y$$

$$Y = (0.456) \frac{0.973}{22.082} (x - 109.004) + 1.943$$

$$Y = 0.020x - 0.247$$

$$(8) \quad \sigma_{est y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est y} = (0.973)(0.890)$$

$$\sigma_{est y} = 0.865$$

Calculations

ACE Total Raw Scores Against Mathematics 101 Grades ⁵⁰⁷ 61

$$(1) M_x = AM_x + C_x L_x$$

$$C_x = \frac{fd_x}{N} \quad L_x = 6$$

$$M_x = 92.45 + 16.404$$

$$C_x = \frac{2597}{950} \quad C_x L_x = 16.404$$

$$M_x = 108.854$$

$$C_x = 2.734$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{22.0}{30.806}$$

$$\sigma_{M_x} = 0.714$$

$$M_x = 108.854 \pm 1.428$$

$$(2) M_y = AM_y + C_y L_y$$

$$C_y = \frac{fd_y}{N} \quad L_y = 1.0$$

$$M_y = 3.006 - 0.435$$

$$C_y = \frac{-413}{950} \quad C_y L_y = -0.435$$

$$M_y = 2.565$$

$$C_y = -0.435$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{1.370}{30.806}$$

$$\sigma_{M_y} = 0.044$$

$$M_y = 2.565 \pm 0.088$$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - C_x^2} \cdot L_x$$

$$\sigma_x = \sqrt{\frac{19873}{950} - 7.474^2} \cdot L_x$$

$$\sigma_x = \sqrt{13.445} \cdot L_x$$

$$\sigma_x = 3.667 \cdot L_x$$

$$\sigma_x = 22.0$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{22.0}{43.566}$$

$$\sigma_{\sigma_x} = 0.505$$

$$\sigma_x = 22.0 \pm 1.010$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - C_y^2} \cdot L_y$$

$$\sigma_y = \sqrt{\frac{1963}{950} - 0.189^2} \cdot L_y$$

$$\sigma_y = \sqrt{1.877} \cdot L_y$$

$$\sigma_y = 1.370 \cdot 1.0$$

$$\sigma_y = 1.370$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.370}{43.566}$$

$$\sigma_{\sigma_y} = 0.031$$

$$\sigma_y = 1.370 \pm 0.062$$

$$(5) r = \frac{\sum xy - C_x C_y}{\sigma_x \sigma_y}$$

$$r = \frac{478}{950} + 1189}{(3.667)(1.370)}$$

$$r = 0.337 \pm 0.058$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.886}{30.882}$$

$$\sigma_r = 0.029$$

$$(6) t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.337)(30.792)}{0.942}$$

$$t = 11.022$$

$$(8) \sigma_{est_y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est_y} = (1.370)(0.942)$$

$$\sigma_{est_y} = 1.290$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$

$$Y = (0.337) \frac{1.370}{22.0} (X - 108.854) + 2.783$$

$$Y = 0.021 X + 0.499$$

Calculations

A.C.E. Total Raw Scores Against English 101 Grades

63

$$(1) \quad M_x = AM_x + C_x L_x$$

$$C_x = \frac{fd_x}{N} \quad L_x = 6$$

$$M_x = 92.45 + 16.806$$

$$C_x = \frac{2619}{935} \quad C_x L_x = 16.806$$

$$M_x = 109.256$$

$$C_x = 2.801$$

$$C_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{21.925}{30.561}$$

$$\sigma_{M_x} = 0.717$$

$$M_x = 109.256 \pm 1.434$$

$$(2) \quad M_y = AM_y + C_y L_y$$

$$C_y = \frac{fd_y}{N} \quad L_y = 10$$

$$M_y = 3.000 - 0.026$$

$$C_y = \frac{-24}{935} \quad C_y L_y = -0.026$$

$$M_y = 2.974$$

$$C_y = -0.026$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{1.208}{30.561}$$

$$\sigma_{M_y} = 0.039$$

$$M_y = 2.974 \pm 0.078$$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - c_x^2} \cdot L_x$$

$$C_x = \sqrt{\frac{19521}{935} - 7840} \cdot L_x$$

$$C_x = \sqrt{13.353} \cdot L_x$$

$$\bar{\sigma}_x = 3.654 \cdot 6$$

$$\sigma_x = 21.925$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{21.925}{43.220}$$

$$\sigma_{\sigma_x} = 0.507$$

$$\sigma_x = 21.925 \pm 1.014$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - c_y^2} \cdot L_y$$

$$\sigma_y = \sqrt{\frac{1366}{935} - 0.001} \cdot L_y$$

$$\sigma_y = \sqrt{1.460} \cdot L_y$$

$$\sigma_y = 1.208 \cdot 1.0$$

$$\sigma_y = 1.208$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.208}{43.220}$$

$$\sigma_{\sigma_y} = 0.028$$

$$\sigma_y = 1.208 \pm 0.056$$

$$(5) r = \frac{\frac{\sum xy}{N} - c_x c_y}{\sigma_x \sigma_y}$$

$$r = \frac{\frac{1034}{935} - 0.072}{(3.654)(1.208)}$$

$$r = 0.412 \pm 0.054$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.830}{30.578}$$

$$\sigma_r = 0.027$$

$$(6) t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.412)(30.545)}{0.911}$$

$$t = 13.814$$

$$(8) \sigma_{est_y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est_y} = (1.208)(0.911)$$

$$\sigma_{est_y} = 1.101$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$

$$Y = (0.412) \frac{1.208}{21.925} (X - 109.256) + 2974$$

$$Y = 0.023X + 0.494$$

Calculations

for

P.E.I. Mathematics Scores Against Mathematics 101 Grades

65

(1)

$$M_x = AM_x + c_x l_x$$

$$M_x = 36.95 - 6.775$$

$$M_x = 30.175$$

$$c_x = \frac{fd_x}{N}$$

$$l_x = 5$$

$$c_x = -\frac{1294}{955}$$

$$c_x l_x = -6.775$$

$$c_x = -1.355$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{13.570}{30.887}$$

$$\sigma_{M_x} = 0.439$$

$$M_x = 30.175 \pm 0.878$$

(2)

$$M_y = AM_y + c_y l_y$$

$$M_y = 3.000 - 0.452$$

$$M_y = 2.548$$

$$c_y = \frac{fd_y}{N}$$

$$l_y = 1.000$$

$$c_y = -\frac{432}{955}$$

$$c_y l_y = 0.452$$

$$c_y = -0.452$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{1.366}{30.887}$$

$$\sigma_{M_y} = 0.044$$

$$M_y = 2.548 \pm 0.088$$

$$(3) \quad \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - c_x^2} \cdot L$$

$$\sigma_x = \sqrt{\frac{8786}{955} - 1.836} \cdot L$$

$$\sigma_x = \sqrt{7.364} \cdot L$$

$$\sigma_x = 2.714 \cdot 5$$

$$\sigma_x = 13.570$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{13.570}{43.681}$$

$$\sigma_{\sigma_x} = 0.311$$

$$\bar{\sigma}_x = 13.570 \pm 0.622$$

$$(4) \quad \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - c_y^2} \cdot L$$

$$\sigma_y = \sqrt{\frac{1976}{955} - 0.204} \cdot L$$

$$\sigma_y = \sqrt{1.865} \cdot L$$

$$\sigma_y = 1.366$$

(L=1)

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.366}{43.681}$$

$$\sigma_{\sigma_y} = 0.031$$

$$\bar{\sigma}_y = 1.366 \pm 0.062$$

(5)

$$r = \frac{\frac{\sum xy}{N} - c_x c_y}{\sigma_x \sigma_y}$$

$$r = \frac{\frac{2605}{955} - 0.612}{(2.714)(1.366)}$$

$$r = 0.571 \pm 0.044$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.674}{30.903}$$

$$\sigma_r = 0.022$$

(6)

$$t = \frac{r\sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.571)(30.871)}{0.821}$$

$$t = 21.471$$

(7)

$$Y = r \frac{\sigma_y}{\sigma_x} (x - M_x) + M_y$$

$$Y = (0.571) \frac{1.366}{13.570} (x - 30.175) + 2.548$$

$$Y = 0.057x + 0.814$$

$$(8) \quad \sigma_{est_y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est_y} = (1.366)(0.821)$$

$$\sigma_{est_y} = 1.121$$

Calculations

S.D.

P.E.I. Mathematics Raw Scores Against Mathematics 101 Grades In-State Students

67

(1) $M_x = AM_x + C_x L_x$

$M_x = 31.950 - 3.233$

$M_x = 28.717$

$C_x = \frac{fdx}{N} \quad L_x = 5$

$C_x = -\frac{313}{484} \quad C_x L_x = -3.233$

$C_x = -0.647$

$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$

$\sigma_{M_x} = \frac{13.880}{21.977}$

$\sigma_{M_x} = 0.632$

$M_x = 28.717 \pm 1.264$

(2) $M_y = AM_y + C_y L_y$

$M_y = 3.000 - 0.531$

$M_y = 2.469$

$C_y = \frac{fdy}{N} \quad L_y = 1.0$

$C_y = -\frac{257}{484} \quad C_y L_y = -0.531$

$C_y = -0.531$

(3) $\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$

$\sigma_{M_y} = \frac{1.359}{21.977}$

$\sigma_{M_y} = 0.062$

$M_y = 2.469 \pm 0.124$

(4) $V = \frac{\sigma}{M} \times 100$

$V = \frac{13.880}{28.717} \times 100$

$V = 48.334 \%$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - c_x^2} \quad L$$

$$\sigma_x = \sqrt{\frac{3433}{484} - 0.414} \quad L$$

$$\sigma_x = \sqrt{7.707} \quad L$$

$$\sigma_x = 2.776 \cdot 5$$

$$\sigma_x = 13.880$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{13.880}{31.081}$$

$$\sigma_{\sigma_x} = 0.447$$

$$\sigma_x = 13.880 \pm 0.894$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - c_y^2} \quad L$$

$$\sigma_y = \sqrt{\frac{1031}{484} - 0.282} \quad L$$

$$\sigma_y = \sqrt{1.848} \quad L$$

$$\sigma_y = 1.359 \cdot 1$$

$$\sigma_y = 1.359$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.359}{31.081}$$

$$\sigma_{\sigma_y} = 0.044$$

$$\sigma_y = 1.359 \pm 0.088$$

$$(5) r = \frac{\sum xy}{N} - c_x c_y$$

$$r = \frac{1293}{484} - 0.344$$

$$r = \frac{(2.776)(1.359)}{(2.776)(1.359)}$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.619}{22.0}$$

$$\sigma_r = 0.028$$

$$(6) t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.617)(21.954)}{0.787}$$

$$t = 17.212$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$

$$Y = (0.617) \frac{1.359}{13.880} (X - 28.717) + 2.469$$

$$Y = 0.060 X + 0.734$$

$$(8) \sigma_{estY} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{estY} = (1.359)(0.787)$$

$$\sigma_{estY} = 1.070$$

Calculations

Sol

P.E.I. Mathematics Raw Scores Against Mathematics 101 Grades Out-State 69

$$(1) M_x = AM_x + C_x L_x$$

$$C_x = \frac{fd_x}{N}$$

$$L_x = 5$$

$$M_x = 31.95 - 0.276$$

$$C_x = -\frac{26}{471}$$

$$C_x L_x = -0.276$$

$$M_x = 31.674$$

$$C_x = -0.055$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{n-1}}$$

$$\sigma_{M_x} = \frac{13.070}{21.679}$$

$$\sigma_{M_x} = 0.603$$

$$M_x = 31.674 \pm 1.206$$

$$(2) M_y = AM_y + C_y L_y$$

$$C_y = \frac{fd_y}{N}$$

$$L_y = 1.00$$

$$M_y = 3.000 - 0.372$$

$$C_y = -\frac{175}{471}$$

$$C_y L_y = -0.372$$

$$M_y = 2.628$$

$$C_y = -0.372$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{n-1}}$$

$$\sigma_{M_y} = \frac{1.367}{21.679}$$

$$\sigma_{M_y} = 0.063$$

$$M_y = 2.628 \pm 0.126$$

(3) $\sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - c_x^2} \cdot L_x$
 $\sigma_x = \sqrt{\frac{3226}{471} - 0.003} \cdot L_x$
 $\sigma_x = \sqrt{6.834} \cdot L_x$
 $\sigma_x = 2.614 \cdot 5$
 $\sigma_x = 13.070$

(4) $\sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - c_y^2} \cdot L_y$
 $\sigma_y = \sqrt{\frac{945}{471} - 0.138} \cdot L_y$
 $\sigma_y = \sqrt{1.868} \cdot L_y$
 $\sigma_y = 1.367 \cdot 1.0$
 $\sigma_y = 1.367$

$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$
 $\sigma_{\sigma_x} = \frac{13.070}{30.659}$
 $\sigma_{\sigma_x} = 0.426$

$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$
 $\sigma_{\sigma_y} = \frac{1.367}{30.659}$
 $\sigma_{\sigma_y} = 0.045$

$\sigma_x = 13.070 \pm 0.852$

$\sigma_y = 1.367 \pm 0.090$

(4) $r = \frac{\frac{\sum xy}{N} - c_x c_y}{\sigma_x \sigma_y}$
 $r = \frac{\frac{880}{471} - 0.026}{(2.614)(1.367)}$
 $r = 0.517 \pm 0.068$

$\sigma_r = \frac{1-r^2}{\sqrt{N}}$
 $\sigma_r = \frac{0.733}{21.703}$
 $\sigma_r = 0.034$

(5) $Z = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$
 $t = \frac{(0.517)(21.652)}{0.856}$
 $t = 13.078$

(7) $\sigma_{est_y} = \sigma_y \sqrt{1-r^2}$
 $\sigma_{est_y} = (1.367)(0.856)$
 $\sigma_{est_y} = 1.170$

(6) $Y = r \frac{\sigma_y}{\sigma_x} (x - M_x) + M_y$
 $Y = (0.517) \frac{1.367}{13.070} (x - 31.674) + 2.628$
 $Y = 0.054x + 0.915$

Calculations for

P.E.I. Scientific Comprehension Scores Against English 101 Grades 71

$$(1) M_x = AM_x + C_x L_x$$

$$M_x = 44.45 - 5.655$$

$$M_x = 38.795$$

$$C_x = \frac{fd_x}{N}$$

$$L_x = 6$$

$$C_x = \frac{-886}{940}$$

$$C_x L_x = -5.655$$

$$C_x = -0.943$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{16.962}{30.643}$$

$$\sigma_{M_x} = 0.554$$

$$M_x = 38.795 \pm 1.108$$

$$(2) M_y = AM_y + C_y L_y$$

$$M_y = 3.000 - 0.127$$

$$M_y = 2.873$$

$$C_y = \frac{fd_y}{N}$$

$$L_y = 1.0$$

$$C_y = \frac{-119}{940}$$

$$C_y L_y = -0.127$$

$$C_y = -0.127$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{1.105}{30.643}$$

$$\sigma_{M_y} = 0.036$$

$$M_y = 2.873 \pm 0.072$$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - C_x^2} \cdot L_x$$

$$\sigma_x = \sqrt{\frac{8346}{940} - 0.888^2} \cdot L_x$$

$$\sigma_x = \sqrt{7.990} \cdot L_x$$

$$\sigma_x = 2.827 \cdot 6$$

$$\bar{C}_x = 16.962$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{16.962}{43.520}$$

$$\sigma_{\sigma_x} = 0.389$$

$$\sigma_x = 16.962 \pm 0.778$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - C_y^2} \cdot L_y$$

$$\sigma_y = \sqrt{\frac{1263}{940} - 0.016^2} \cdot L_y$$

$$\sigma_y = \sqrt{1.221} \cdot L_y$$

$$\sigma_y = 1.105 \cdot 1.0$$

$$\sigma_y = 1.105$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.105}{43.520}$$

$$\sigma_{\sigma_y} = 0.025$$

$$\sigma_y = 1.105 \pm 0.050$$

$$(5) r = \frac{\sum xy - C_x C_y}{C_x \sigma_y}$$

$$r = \frac{1612}{940} - 0.119$$
$$(2.827)(1.105)$$

$$r = 0.511 \pm 0.048$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.739}{30.659}$$

$$\sigma_r = 0.024$$

$$(6) t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.511)(30.627)}{0.860}$$

$$t = 18.207$$

$$(8) \sigma_{est_y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est_y} = (1.105)(0.860)$$

$$\sigma_{est_y} = 0.950$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (X - M_x) + M_y$$

$$Y = (0.511) \frac{1.105}{16.962} (X - 38.795) + 2.873$$

$$Y = 0.033X + 1.582$$

Calculations

for

PEI Scientific Comprehension Scores Against Mathematics 101 Grades 73

$$(1) \quad M_x = AM_x + c_x L_x$$

$$c_x = \frac{fdy}{N}$$

$$L_x = 6$$

$$c_x = \frac{-931}{948}$$

$$c_x L_x = -5.892$$

$$M_x = 44.45 - 5.892$$

$$M_x = 38.558$$

$$c_x = -0.982$$

$$\sigma_{M_x} = \frac{\sigma_x}{\sqrt{N-1}}$$

$$\sigma_{M_x} = \frac{17.016}{30.773}$$

$$\sigma_{M_x} = 0.554$$

$$M_x = 38.558 \pm 1.108$$

(2)

$$M_y = AM_y + c_y L_y$$

$$c_y = \frac{fdy}{N}$$

$$L_y = 1.0$$

$$M_y = 3.000 - 0.455$$

$$c_y = \frac{-431}{948}$$

$$c_y L_y = -0.455$$

$$M_y = 2.545$$

$$c_y = -0.455$$

$$\sigma_{M_y} = \frac{\sigma_y}{\sqrt{N-1}}$$

$$\sigma_{M_y} = \frac{1.353}{30.773}$$

$$\sigma_{M_y} = 0.044$$

$$M_y = 2.545 \pm 0.088$$

$$(3) \sigma_x = \sqrt{\frac{\sum fd_x^2}{N} - C_x^2} \cdot L_x$$

$$\sigma_x = \sqrt{\frac{8541}{948} - 0.964^2} \cdot L_x$$

$$\sigma_x = \sqrt{8045} \cdot L_x$$

$$\sigma_x = 2.836 \cdot 6$$

$$\sigma_x = 17.016$$

$$\sigma_{\sigma_x} = \frac{\sigma_x}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_x} = \frac{17.016}{43.520}$$

$$\sigma_{\sigma_x} = 0.392$$

$$\sigma_x = 17.016 \pm 0.784$$

$$(4) \sigma_y = \sqrt{\frac{\sum fd_y^2}{N} - C_y^2} \cdot L_y$$

$$\sigma_y = \sqrt{\frac{1931}{948} - 0.207^2} \cdot L_y$$

$$\sigma_y = \sqrt{1.830} \cdot L_y$$

$$\sigma_y = 1.353 \cdot 1.0$$

$$\sigma_y = 1.353$$

$$\sigma_{\sigma_y} = \frac{\sigma_y}{\sqrt{2(N-1)}}$$

$$\sigma_{\sigma_y} = \frac{1.353}{43.520}$$

$$\sigma_{\sigma_y} = 0.031$$

$$\sigma_y = 1.353 \pm 0.062$$

$$(5) r = \frac{\sum xy}{N} - C_x C_y$$

$$r = \frac{1952}{948} - 0.447$$

$$r = 0.420 \pm 0.054$$

$$\sigma_r = \frac{1-r^2}{\sqrt{N}}$$

$$\sigma_r = \frac{0.824}{30.790}$$

$$\sigma_r = 0.027$$

$$(6) t = \frac{r \sqrt{N-2}}{\sqrt{1-r^2}}$$

$$t = \frac{(0.420)(30.757)}{0.908}$$

$$t = 14.224$$

$$(8) \sigma_{est y} = \sigma_y \sqrt{1-r^2}$$

$$\sigma_{est y} = (1.353)(0.908)$$

$$\sigma_{est y} = 1.228$$

$$(7) Y = r \frac{\sigma_y}{\sigma_x} (x - M_x) + M_y$$

$$Y = (0.420) \frac{1.353}{17.016} (x - 38.558) + 2.545$$

$$Y = 0.033x + 1.258$$