CHAPTER IX

STATISTICAL ANALYSIS OF THE DATA

A test has meaning only if it is a standardised one. The process of standardisation of a test includes, in general, the following steps.

(1) The statistical analysis of the test data. This again includes the computation of mean, median, SD etc. of the whole sample and the graphical presentation and statistical discussions of the nature of the distribution of the test-scores.

(2) Establishing the test norms.

(3) The estimation of the test reliability.

(4) The estimation of the test validity.

(5) The construction of the prediction equation.

(6) The factor-analysis of the test data.

In this chapter, we shall treat the first item, i.e. "statistical analysis of the data".

THE CLASSIFICATION OF TEST-SCORES

Data collected from test have little meaning until they have been classified in a systematic way. The first task that confronts us, then, is the organisation of our material and this leads naturally to a grouping of the scores into classes.

For standardising the test, we are concerned primarily no doubt, with the total test-scores, but just to know how each sub-test works, we decided to analyse statistically the sub-test-scores also. Not only this, but the total sample is composed of six groups of trainees, tested at six different centres also. So to find out the correspondence among all the group samples, the statistical analyses of group samples also were carried out.

In this way, forty-two different kinds of data were obtained. They are shown in the following table.

TABLE NO. 17

SHOWING DIFFERENT TYPES OF TEST DATA

Test	No.of data for total sample	No.of data for group samples	Total no. of data
Whole test	1	6	7
Sub-test I	1	6	7
Sub-test II	1	6	7
Sub-test III	1	6	7
Sub-test IV	1	6	7
Sub-test V	1	6	7
Total	6	36	42

In all, 42 data had to be classified. The statistical analysis of each datum was carried out.

We shall now discuss how the statistical analyses of different data were done. The detailed computational steps are given only for the analyses of data obtained from total samples - for each of the sub-tests and the total test. For the remaining data, tables are given in the following pages of this chapter, to show the results of their analyses.

STATISTICAL ANALYSIS OF TOTAL-TEST-SCORE DATA OBTAINED FROM WHOLE SAMPLE

The maximum score that a testee can obtain on this test is 132; and the lowest score that can be obtained is, naturally zero. The highest score that is obtained on the test is 102, while the lowest score is 53. The range between the highest and the lowest scores is, therefore, (102 - 53) + 1 = 50. This range within which the scores are distributed is divided into eleven class intervals, each interval being of five units. The distribution of the score is given in table on the next page.

TABLE NO. 18

DATA GROUPED FOR THE CALCULATION OF MEAN, MEDIAN AND STANDARD DEVIATION OF THE APTITUDE SCORES OF 530 TRAINEES

Scores	Mid.pts.	f	Cum.f.	X'	fx'	fx'^{2}
100-104	102.0	5	530	+5	25	125
95- 99	97.0	16	525	+4	64	256
90- 94	92.0	45	509	+3	135	405
85- 89	87.0	80	464	+2	160	320
80- 84	82.0	126	384	+1	126	126
75- 79	77.0	102	258	0	000	000
70- 74	72.0	74	156	-1	- 74	74
65- 69	67.0	44	82	-2	- 88	176
60- 64	62.0	28	38	-3	- 84	252
55- 59	57.0	8	10	-4	- 32	128
50- 54	52.0	2	2	-5	- 10	50
		N = 530			Σ fx' = +222	Σ fx'^{2} = 1912

CALCULATION OF THE MEAN BY THE "ASSUMED MEAN" METHOD[1]

$$C = \frac{\Sigma fx'}{N} = \frac{+222}{530} = +0.4171$$

$$\therefore \; C^2 = 0.1739$$

1 Garrett, H. E., "Statistics in Psychology and Education", Longmans, Green and Co., New York, 1958, p. 35.

$\therefore$ Ci = .4171 x 5

= 2.0855

= 2.09

Mean Score = Assumed Mean + Ci

= 77.00 + 2.09

= 79.09

Calculation of the median:[1]

$$\text{Mdn.} = \ell + \left(\frac{\frac{N}{2} - F}{fm} \right) \times i$$

$$= 79.5 + \left(\frac{265 - 258}{126} \right) \times 5$$

$$= 79.5 + .278$$

$$= \underline{79.778}$$

Calculation of the SD by the "Short Method":[2]

$$\text{Standard Deviation (SD)} = i \times \sqrt{\frac{\Sigma fx'^2}{N} - c^2}$$

$$= 5 \times \sqrt{\frac{1912}{530} - .1739}$$

$$= 5 \times 1.853$$

$$= 9.265$$

$$= 9.27$$

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1 Garrett, H.E., Op.Cit., p. 32.

2 Ibid., p. 51.

RELIABILITY OF MEAN, MEDIAN AND STANDARD DEVIATION

The above are the statistics obtained from the random sampling. These may deviate from the population parameters. We have tried to arrive at statistics that would approximate the corresponding parameters very closely, by selecting an adequate random sample. But no guarantee can be given for the reliability of these statistics. It is necessary to test the reliability of these statistics. The use of standard errors and other sampling statistics can be made to estimate how far our obtained statistics may have deviated from their corresponding parameters. We have tested the reliability of each of the above statistics by calculating its standard error.

(1) Standard error (SE) of the mean:[1]

$$SE_M \text{ or } \sigma_M = \frac{\sigma}{\sqrt{N}}$$, Where σ = the standard deviation of the distribution.

N = the number of cases in the sample.

$$= \frac{9.27}{\sqrt{530}}$$

$$= \frac{9.27}{23.022}$$

$$= 0.4027$$

$$= 0.403$$

∴ The 'true' mean lies between 79.09 $\pm$ 0.403 x 2.58, at 0.01 level; i.e. between 78.05 and 80.13. Thus, the obtained mean is highly reliable as the 'true' mean lies within much narrow range.

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1 Garrett, H. E., Op. Cit., p. 185.

(2) Standard error (SE) of the median:[1]

$$SE_{Mdn} = \frac{1.253\ \sigma}{\sqrt{N}}$$

$$= \frac{1.253 \times 9.27}{\sqrt{530}}$$

$$= \frac{1.253 \times 9.27}{23.022}$$

$$= 0.505$$

∴ The 'true' median lies between 79.778 ± 0.505 x 2.58, at 0.01 level; i.e. between 78.475 and 81.081. The median obtained is also highly reliable.

(3) Standard error (SE) of the standard deviation:[2]

$$SE_{SD} = \frac{0.71\ \sigma}{\sqrt{N}}$$

$$= \frac{0.71 \times 9.27}{\sqrt{530}}$$

$$= \frac{0.71 \times 9.27}{23.022}$$

$$= 0.286$$

∴ The 'true' standard deviation lies between 9.27 ± 0.286 x 2.58, at 0.01 level; i.e. between 8.532 and 10.008. The SD, obtained, is, therefore, highly reliable.

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1 Garrett, H. E., Op.Cit., p. 195.

2 Ibid., p. 196.

It can be concluded from these results that all the 'parameters' lie within narrow ranges and hence all the statistics obtained are highly reliable.

Such statistics for all the 42 types of data were calculated. The table No. 25 shows the results.

The classification tables of the scores on each of the five sub-tests obtained by the total sample, but not computational details even for these data, are given below.

TABLE NO. 19

SHOWING SCORES ACHIEVED BY 530 TRAINEES ON 'ATTITUDE TOWARDS CHILDREN', SUB-TEST I

Scores	Mid.pts.	f	cum. f.
28 - 30	29.0	8	530
25 - 27	26.0	111	522
22 - 24	23.0	259	411
19 - 21	20.0	137	152
16 - 18	17.0	13	15
13 - 15	14.0	1	2
10 - 12	11.0	1	1
		N = 530	

Class-interval = 3

TABLE NO. 20

SHOWING SCORES ACHIEVED BY 530 TRAINEES
ON 'MENTAL ABILITY' - SUB-TEST II

Scores	Mid.pts.	f.	Cum. f.
25 - 29	27.0	26	530
20 - 24	22.0	244	504
15 - 19	17.0	188	260
10 - 14	12.0	58	72
5 - 9	7.0	13	14
0 - 4	2.0	1	1
-	-	N = 530	-

Class-interval = 5

TABLE NO. 21

SHOWING SCORES ACHIEVED BY 530 TRAINEES
ON 'INTEREST IN PROFESSION - SUB-TEST III

Scores	Mid.Pts.	f	Cum.f.
20 - 24	22.0	11	530
15 - 19	17.0	297	519
10 - 14	12.0	192	222
5 - 9	7.0	29	30
0 - 4	2.0	1	1
-	-	-	-
-	-	N = 530	-

Class-interval = 5

TABLE NO. 22

SHOWING SCORES ACHIEVED BY 530 TRAINEES ON 'ADAPTABILITY' - SUB-TEST IV

Scores	Mid.Pts.	f	Cum.f.
15 - 19	17.0	16	530
10 - 14	12.0	331	514
5 - 9	7.0	177	183
0 - 4	2.0	6	6
-	-	N = 530	-

Class-interval = 5

TABLE NO. 23

SHOWING SCORES ACHIEVED BY 530 TRAINEES ON 'PROFESSIONAL INFORMATION' - SUB-TEST V

Scores	Mid.Pts.	f	Cum.f
20 - 24	22.0	8	530
15 - 19	17.0	100	522
10 - 14	12.0	315	422
5 - 9	7.0	106	107
0 - 4	2.0	1	1
-	-	N = 530	-

Class-interval = 5

Henceforth, in this chapter and in the following chapters in this treatise, all the six sub-group samples will be designated as follows, just to avoid the repetition of writing lengthy names of the institutions where the testing programme was carried out.

TABLE NO. 24

SHOWING HOW EACH TESTING CENTRE (SUB-GROUP SAMPLE) IS DESIGNATED

Sr. No.	Name of the sub-group sample (Testing centre)	Designated as
1	Faculty of Education & Psychology, Baroda	Unit A
2	A.G.Teachers' College, Ahmedabad	Unit B
3	R.G.Teachers' College, Porbandar	Unit C
4	Secondary Teachers' Training College, Bombay	Unit D
5	St.Xavier's Institute of Education, Bombay	Unit E
6	Tilak College of Education, Poona	Unit F

The statistics obtained above, for the whole sample, are tabulated on the pages to follow, along with the statistics obtained for each of the unit samples.

In table No. 25, statistics for the whole-test-score for all the samples are given, while in table Nos. 26, 27, 28, 29 and 30, statistics obtained from each sub-test-score for all samples are given.

TABLE NO. 25

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE 'APTITUDE TEST SCORE' - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' mean falls	Median	SE of median	Range within which 'true' median falls	SD	SE of SD	Range within which 'true' SD falls
1	Total sample (N = 530)	79.09	0.403	78.05 and 80.13	79.778	0.505	78.475 and 81.081	9.27	0.286	8.532 and 10.008
2	Unit A (N = 100)	81.60	0.830	79.46 and 83.74	82.4	1.04	79.72 and 85.02	8.3	0.589	5.78 and 9.82
3	Unit B (N = 74)	79.80	0.889	77.51 and 82.09	79.74	1.11	76.88 and 82.60	7.65	0.632	6.02 and 9.28
4	Unit C (N = 66)	82.22	0.985	79.68 and 84.76	81.75	1.23	78.58 and 84.92	8.0	0.699	6.2 and 9.8
5	Unit D (N = 94)	80.20	0.908	77.86 and 82.54	80.60	1.14	77.66 and 83.54	8.8	0.645	7.14 and 10.46
6	Unit E (N = 78)	77.07	1.143	74.12 and 80.02	78.07	1.43	74.38 and 81.76	10.1	0.812	8.01 and 12.19
7	Unit F (N = 118)	75.20	0.875	72.94 and 77.46	73.83	1.10	70.99 and 76.67	9.5	0.621	7.9 and 11.1

TABLE NO. 26

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE SCORES ON 'ATTITUDE TOWARDS CHILDREN' - SUB-TEST I - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB-GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' Mean falls	Median	SE of Median	Range between which 'true' Median falls	SD	SE of SD	Range between which 'true' SD falls
1	Total sample (N = 530)	22.76	0.106	22.49 and 23.03	22.81	0.133	22.47 and 23.15	2.45	0.076	2.25 and 2.65
2	Unit A (N = 100)	22.65	0.270	21.95 and 23.35	22.50	0.338	21.63 and 23.37	2.70	0.192	2.21 and 3.19
3	Unit B (N = 74)	23.15	0.326	22.31 and 23.99	22.90	0.408	21.85 and 23.95	2.80	0.231	2.20 and 3.39
4	Unit C (N = 66)	23.82	0.314	23.01 and 24.63	23.50	0.393	22.49 and 24.51	2.55	0.223	1.98 and 3.12
5	Unit D (N = 94)	23.10	0.252	22.45 and 23.75	22.78	0.315	21.97 and 23.59	2.44	0.179	1.98 and 2.90
6	Unit E (N = 78)	22.70	0.311	21.90 and 23.50	22.52	0.390	21.51 and 23.53	2.75	0.221	2.18 and 3.32
7	Unit F (N = 118)	21.96	0.212	21.41 and 22.51	21.97	0.265	21.29 and 22.65	2.30	0.150	1.91 and 2.69

TABLE NO. 27

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE SCORES ON 'MENTAL ABILITY' SUB-TEST III - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB-GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' mean falls	Median	SE of Median	Range between which 'true' median falls	SD	SE of SD	Range between which 'true' SD falls
1	Total sample (N = 530)	19.00	0.185	18.52 and 19.48	19.60	0.231	19.00 and 20.20	4.25	0.131	3.91 and 4.59
2	Unit A (N = 100)	20.30	0.420	19.22 amd 21.38	20.84	0.526	19.49 and 22.19	4.20	0.298	3.43 and 4.97
3	Unit B (N = 74)	19.40	0.401	18.37 and 20.43	19.43	0.502	18.13 and 20.73	3.45	0.285	2.72 and 4.18
4	Unit C (N = 66)	19.65	0.492	18.38 and 20.92	20.36	0.617	18.77 and 21.95	4.00	0.350	3.10 and 4.90
5	Unit D (N = 94)	19.34	0.426	18.24 and 20.44	20.27	0.534	18.89 and 21.65	4.13	0.302	3.35 and 4.91
6	Unit E (N = 78)	18.60	0.475	17.38 and 19.82	19.13	0.596	17.59 and 20.67	4.20	0.337	3.33 and 5.07
7	Unit F (N = 118)	17.43	0.410	16.37 and 18.49	17.60	0.513	16.28 and 18.92	4.45	0.291	3.70 and 5.20

TABLE NO. 28

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE SCORES ON 'INTEREST IN PROFESSION' - SUB-TEST III - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB-GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' Mean falls	Median	SE of Median	Range between which 'true' Median falls	SD	SE of SD	Range between which 'True' SD falls
1	Total sample (N = 530)	14.70	0.139	14.34 and 15.06	15.22	0.174	14.77 and 15.67	3.20	0.099	2.95 and 3.46
2	Unit A (N = 100)	15.25	0.310	14.45 and 16.05	15.56	0.388	14.56 and 16.56	3.1	0.220	2.53 and 3.67
3	Unit B (N = 74)	14.90	0.343	14.02 and 15.78	15.56	0.430	14.45 and 16.67	2.95	0.243	2.32 and 3.58
4	Unit C (N = 66)	16.00	0.292	15.25 and 16.75	16.2	0.365	15.26 and 17.14	2.37	0.207	1.84 and 2.90
5	Unit D (N = 94)	14.86	0.336	13.99 and 15.73	14.93	0.421	13.85 and 16.01	3.26	0.239	2.64 and 3.88
6	Unit E (N = 78)	13.82	0.402	12.78 and 14.86	13.71	0.503	12.41 and 15.01	3.55	0.285	2.82 and 4.28
7	Unit F (N = 118)	14.10	0.276	13.39 and 14.81	14.23	0.346	13.34 and 15.12	3.00	0.196	2.49 and 3.50

TABLE NO. 29

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE SCORES ON 'ADAPTABILITY' - SUB-TEST IV - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB-GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' mean falls	Median	SE of Median	Range between which 'true' median falls	SD	SE of SD	Range between which 'true' SD falls
1	Total sample (N = 530)	10.37	0.11[illegible]	10.06 and 10.68	10.74	0.150	10.35 and 11.13	2.75	0.085	2.53 and 2.97
2	Unit A (N = 100)	11.10	0.270	10.40 and 11.80	11.40	0.338	10.53 and 12.27	2.70	0.192	2.21 and 3.19
3	Unit B (N = 74)	10.69	0.286	9.95 and 11.43	10.70	0.358	9.78 and 11.62	2.46	0.203	1.94 and 2.98
4	Unit C (N = 66)	11.14	0.295	10.38 and 11.90	11.14	0.370	10.19 and 12.09	2.40	0.210	1.86 and 2.94
5	Unit D (N = 94)	10.78	0.234	10.18 and 11.38	11.17	0.293	10.41 and 11.93	2.27	0.166	1.84 and 2.70
6	Unit E (N = 78)	10.10	0.304	9.32 and 10.88	10.60	0.381	9.62 and 11.58	2.69	0.216	2.13 and 3.25
7	Unit F (N = 118)	9.94	0.267	9.25 and 10.63	10.14	0.335	9.28 and 11.00	2.90	0.190	2.41 and 3.39

TABLE NO. 30

SHOWING RESULTS OF THE STATISTICAL ANALYSIS OF THE SCORES ON 'PROFESSIONAL INFORMATION' - SUB-TEST V - DATA OBTAINED FROM THE TOTAL SAMPLE AND SUB-GROUP SAMPLES

Sr. No.	Type of sample	Mean	SE of Mean	Range between which 'true' mean falls	Median	SE of Median	Range between which 'true' median falls	SD	SE of SD	Range between which 'true' SD falls
1	Total sample (N = 530)	12.08	0.148	11.70 and 12.46	12.01	0.185	11.53 and 12.49	3.40	0.105	3.13 and 3.67
2	Unit A (N = 100)	12.65	0.372	11.69 and 13.61	12.40	0.466	11.20 and 13.60	3.72	0.264	3.04 and 4.40
3	Unit B (N = 74)	11.86	0.395	10.84 and 12.88	11.83	0.495	10.55 and 13.11	3.40	0.281	2.68 and 4.12
4	Unit C (N = 66)	11.40	0.321	10.57 and 12.23	11.93	0.402	10.89 and 12.97	2.61	0.228	2.02 and 3.20
5	Unit D (N = 94)	12.16	0.296	11.40 and 12.92	12.10	0.371	11.14 and 13.06	2.87	0.210	2.33 and 3.41
6	Unit E (N = 78)	11.75	0.434	10.63 and 12.87	11.70	0.543	10.30 and 13.10	3.83	0.308	3.04 and 4.62
7	Unit F (N = 118)	12.30	0.283	11.57 and 13.03	12.24	0.354	11.33 and 13.15	3.07	0.201	2.55 and 3.59

The calculation of all these statistics for all the 42 data, has helped us in revealing the following points.:

(1) The values of mean, median and standard deviation obtained for aptitude test score for the total sample show that the distribution of the scores seems to be fairly normal.

(2) The values of means, medians and standard deviations obtained for scores on different sub-tests for the total sample show that the distributions of the scores on these sub-tests do not seem to be normal.

(3) The statistics obtained for unit samples do not compare so closely as to enable one to conclude that all the unit samples are cent percent similar. But one can assert that the divergence is not so much as to deteriorate or reduce the representativeness of the total sample.

(4) The unit samples can, therefore, be taken to be fairly similar and separately representative of the total population to much extent. The total sample, which is composed of all these unit samples is, therefore, highly representative of the total population. The statistics obtained from the data collected from the total sample are, thus, very much closer to the 'parameters' -

obtainable from the total population.

Test results can be statistically interpreted by using "parametric methods", only if the distribution of the test scores is normal. It is, therefore, highly necessary to test the normality of the distribution of the test scores by standard methods and come to the conclusion as to whether the distribution is normal.

DECIDING THE NATURE OF THE
DISTRIBUTION OF TEST SCORES

If the test scores are distributed normally, we can say that the tool is satisfactory. While any significant deviation of the distribution to either side, suggests any of the following:

(1) The sample may not be fully representative of the population, i.e. it may be biased.

(2) The sample selected may not be large enough to represent the population.

(3) Wrong procedures for selecting test-items might have been followed.

(4) Any other error, likely to affect the distribution adversely, might have been committed in test-construction.

The following three procedures were used to study the distribution of the aptitude test scores as well as those of the total scores on each of the five sub-tests.

(1) Calculations of 'skewness' and 'kurtosis'.

(2) Chi-square test of the Hypothesis of Normal Distribution.

(3) Graphical representation of the test-scores and their interpretation.

<u>Calculation of skewness of the distribution:</u> (Aptitude test score-data from total sample): There are two different formulas for the calculation of skewness. Skewness is calculat-ed by using both these formulae. The formulae are as given below.[1]

(1) $$Sk = \frac{3\,(\text{mean} - \text{median})}{\sigma} \quad \ldots\ldots\ldots\ldots\ldots\ldots(A)$$

and (2) $$Sk = \frac{(P_{90} + P_{10})}{2} - P_{50} \quad \ldots\ldots\ldots\ldots(B)$$

Calculation of Sk by formula, 'A':

Mean = 79.090
Median = 79.778 (from table No. 25)
SD = 9.27

$$\therefore Sk = \frac{3\,(79.090 - 79.778)}{9.27}$$

$$= \frac{-2.064}{9.27}$$

$$= -0.223$$

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1 Garrett, H. E., Op.Cit., p.100.

Calculation of Sk by formula, 'B'

$P_{90} = 90.941$
$P_{10} = 66.205$ (from table No. 89)
$P_{50} = 79.778$

$$\therefore Sk = \frac{90.941 + 66.205}{2} - 79.778$$

$$= \frac{157.146}{2} - 79.778$$

$$= 78.573 - 79.778$$

$$= -1.205$$

The value of skewness obtained indicates a little negative skewness.

The results obtained by these two formulae are, thus, numerically different. Garrett[1] explains why it is so. According to him, the two measures of skewness are computed from different reference values in the distribution, and hence are not directly comparable.

SIGNIFICANCE OF SKEWNESS

For concluding whether the obtained skewness is significant, the standard error of skewness should be known. According to Garrett,[2] standard errors for formulae (A & B) used here, are not very satisfactory. He asserts, "The measures of skewness, as they stand, are often sufficient for many

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1 Garrett,H. E., Op.Cit., p.101.

2 Garrett,H.E., Op.Cit., p.101.

problems in psychology and education." Accordingly, the test-constructor would have been justified in not computing standard error of skewness at all. But he has calculated the standard error of skewness obtained by using formula, B, and from this SE of Sk, concluded that the skewness is not at all significant.

The formula[1] used for the calculation of SE of Sk is given below.

$$\sigma_{Sk} = \frac{.5185D}{\sqrt{N}}, \quad \text{Where } D = P_{90} - P_{10}$$

$$= \frac{.5185}{23.022} \times (90.941 - 66.205)$$

$$= \frac{12.83}{23.022}$$

$$= \underline{0.557}$$

The deviation of our measure of skewness from 0 skewness is - 1.205.

$$\therefore \text{ CR} = \frac{-1.205}{0.557}$$

$$= \underline{-2.16}$$

Our Sk, therefore, deviates - 2.16 σ_k from 0. The CR (-2.16) falls well within the $\pm$ 2.58 limits, which determine the 0.01 level of significance. Hence it is clear that

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1 Garrett, H. E., "Statistics in Psychology and Education", Longmans, Green and Co., New York, 1953, p. 241.

-1.205 represents no real deviation of this frequency distribution from normality.

CALCULATION OF KURTOSIS OF THE DISTRIBUTION

The following formula[1] was used for the calculation of kurtosis.:

$$Ku = \frac{Q}{(P_{90} - P_{10})}, \quad \text{Where } Q = \frac{P_{75} - P_{25}}{2}$$

$$= \frac{\frac{85.344 - 72.912}{2}}{90.941 - 66.205}$$

$$= \frac{6.216}{24.736}$$

$$= \underline{0.251}$$

The kurtosis of the frequency distribution is, thus, 0.251. The Ku value deviates - 0.012 from 0.263, the Ku value of the normal distribution. The negative direction of the deviation indicates that the distribution tends slightly toward leptokurtosis.

SIGNIFICANCE OF KURTOSIS

To estimate the significance of the deviation of Ku thus obtained from the Ku of the normal curve, the SE of Ku is calculated by the following formula.[2]

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1 Garrett, H.E., Op.Cit., (1953 edition), p.100.

2 Ibid., p. 242.

$$\sigma_{Ku} = \frac{0.28}{\sqrt{N}}$$

$$= \frac{0.28}{23.022}$$

$$= 0.0121$$

and the CR $= \frac{D}{\sigma_{Ku}}$ Where D = deviation of Ku of the obtained distribution from Ku (0.263) of normal distribution.

$$= \frac{-0.012}{0.0121}$$

$$= -0.992$$

This CR (-0.992) falls well within the ± 1.96 limits, which determine the 0.05 level of significance. Hence it is clear that 0.251 represents no real deviation of this frequency distribution from normality.

All the statistics that were calculated for the aptitude score distribution, were calculated for each sub-test score distribution to test whether the score distribution for each sub-test is normal. The previous ones and these statistics were calculated from data obtained from the total sample only as no useful inference was likely to be obtained from such statistics calculated from data obtained from unit samples.

All the statistics obtained are shown in table No. 31 on page No. 263. Even a cursory glance at this table will show that the distribution of the aptitude scores is very nearly normal. The aptitude score distribution

TABLE NO. 31

SHOWING THE VALUES OBTAINED OF SKEWNESS, KURTOSIS ETC. OF SCORE-DISTRIBUTION ON APTITUDE TEST (WHOLE TEST) AND ON EACH SUB-TEST - DATA OBTAINED FROM TOTAL SAMPLE

Sr. No.	Test	N	Sk by formula 'A'	Sk by formula 'B'	Type of Sk	SE_{Sk} (Sk from 'B')	CR	* Whether signifi-cant	Ku	Type of Ku	SE_{Ku}	CR	* Whether signifi-cant
1	Total test	530	-0.223	-1.205	Negative	0.557	-2.16	N.S.at 0.01 level	0.251	Lepto-kurtic	0.0121	-0.992	N.S.at both levels
2	Sub-Test I	530	-0.061	-0.005	Negative	0.157	-0.032	N.S.at both levels	0.235	Lepto-kurtic	0.0121	-2.31	N.S.at 0.01 level
3	Sub-Test II	530	-0.423	-1.190	Negative	0.250	-4.76	S at both levels	0.280	Platy-kurtic	0.0121	+1.44	N.S.at both levels
4	Sub-Test III	530	-0.488	-0.775	Negative	0.196	-3.95	S at both levels	0.304	Platy-kurtic	0.0121	+3.39	S at both levels
5	Sub-Test IV	530	-0.404	-0.855	Negative	0.183	-4.67	S at both levels	0.288	Platy-kurtic	0.0121	+2.07	N.S.at 0.01 level
6	Sub-Test V	530	+0.062	+0.090	Positive	0.232	+0.388	N.S.at both levels	0.162	Lepto-kurtic	0.0121	-8.34	S at both levels

* S = Significant

NS = Not significant

can, therefore, be assumed normal for applying "parametric methods" to interpret test results.

As regards the sub-tests, the distribution of the scores on sub-test I, seems to be fairly normal. While the score-distributions of remaining four sub-tests deviate much significantly from the normality.

These results should not be taken for granted. They must be confirmed. The chi-square test of testing Normal-Distribution-Hypothesis was applied to judge the normality of the test score distribution.

We now proceed to discuss how this technique was applied and what results were obtained and how these results compared with those obtained previously.

CHI-SQUARE TEST OF THE HYPOTHESIS
OF NORMAL DISTRIBUTION

One most important use of chi-square is in testing some hypothesis.

A chi-square is the sum of ratios. Each ratio is that between a squared discrepancy or difference and an expected frequency. The discrepancy is between an obtained frequency and a frequency expected on the basis of the hypothesis we are testing.

The hypothesis to be tested here is:

(1) The distribution of the scores on the (aptitude) test follows the normal curve;

(2) if there is any discrepancy between the observed and the expected frequencies, it is insignificant and is due to chance factor/factors only.

The computational details for finding chi-square value are shown in table No. 32 .

The procedure, discussed in Biometrika[1] tables for Statisticians, was followed thoroughly for calculating chi-square values here.

The number of df to use is the number of class-intervals minus 3. One degree of freedom has been lost in computing the mean; a second in computing the standard deviation; and a third for N, the size of sample.

Along with the statistics for total test-score, the statistics for scores on each sub-test also have been calculated with a view to studying the nature and role of each sub-test in the whole aptitude-test battery. The importance of this detailed knowledge of each sub-test is discussed later on at an appropriate place in this treatise.

It should, therefore, be tested whether the sub-test

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1 Pearson, E. S. & Heartley, H. O. (Editors), "Biometrika Tables for Statisticians," Published for the Biometrika Trustees at the University Press, Cambridge, 1956, Vol. I, p. 2.

scores, separately are also distributed normally.

The chi-square values for each sub-test score distribution are also calculated. These are shown in table Nos. 33 , 34 , 35 , 36 , and 37 . For calculating chi-square values here, the same procedure, as was used for calculating chi-square value of total test-score distribution, was followed.

TABLE NO. 32

A CHI-SQUARE TEST OF THE NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF APTITUDE TEST SCORES

Scores	Scores	Frequency f_o	x - M	$\frac{x - M}{\sigma}$	Area P(x)	$\Delta P(x)$	fe = N X $\Delta P(x)$	|fo-fe|	$(fo-fe)^2$	$\frac{(fo-fe)^2}{fe}$
100-104	99.5 - 104.5	5	20.405	2.20	0.9860966	0.0139034	7	2	4	0.5714
95- 99	94.5 - 99.5	16	15.405	1.66	0.9515428	0.0345538	18	2	4	0.2222
90- 94	89.5 - 94.5	45	10.405	1.12	0.8686431	0.0828997	44	1	1	0.0227
85- 89	84.5 - 89.5	80	5.405	0.58	0.7190427	0.1496004	79	1	1	0.0127
80- 84	79.5 - 84.5	126	0.405	0.04	0.5159534	0.2030893	108	18	324	3.0000
75- 79	74.5 - 79.5	102	-4.595	-0.50	0.3085375	0.2074159	110	8	64	0.5818
70- 74	69.5 - 74.5	74	-9.595	-1.04	0.1491700	0.1593675	84	10	100	1.1905
65- 69	64.5 - 69.5	44	-14.595	-1.58	0.0570534	0.0921166	49	5	25	0.5102
60- 64	59.5 - 64.5	28	-19.595	-2.12	0.0170030	0.0400504	21	7	49	2.3333
55- 59	54.5 - 59.5	8 *	-24.595	-2.66	0.0039070	0.0130960	7 *	1	1	0.1111
50- 54	49.5 - 54.5	2	-29.595	-3.20	-	0.0039070	2	0	0	-
		530					529			X^2 = 8.5559

* The bracketed intervals are combined.

Mean = M = 79.095 (79.09)

SD = σ = 9.27

df = 7

From the X^2 - table:

At 0.01 level, X^2 = 18.475

At 0.05 level, X^2 = 14.067

∴ X^2, obtained, is <u>not significant</u> at both levels.

TABLE NO. 33

A CHI-SQUARE TEST OF THE NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF SUB-TEST I, - TEST SCORES

Scores	Scores	Frequency f_o	x - M	$\frac{x - M}{\sigma}$	Area P(x)	$\Delta P(x)$	fe = NXΔP(x)	|fo-fe|	$(fc-fe)^2$	$\frac{(fo-fe)^2}{fe}$
28 - 30	27.5 - 30.5	8	4.74	1.93	0.9731966	0.0268034	14	6	36	2.571
25 - 27	24.5 - 27.5	111	1.74	0.71	0.7611479	0.2120487	112	1	1	0.009
22 - 24	21.5 - 24.5	259	-1.26	-0.51	0.3050257	0.4561222	242	17	289	1.194
19 - 21	18.5 - 21.5	137	-4.26	-1.74	0.0409295	0.2640962	140	3	9	0.064
16 - 18	15.5 - 18.5	13]*	-7.26	-2.96	0.0015382	0.0393913	21]*	7	49	2.227
13 - 15	12.5 - 15.5	1]	-10.26	-4.19	0.0000139	0.0015243	1]	-	-	-
10 - 14	9.5 - 12.5	1]	-13.26	-5.41	-	0.0000139	0]	-	-	-
		530					530			X^2 = 6.065

* The bracketed intervals are combined

Mean = M = 22.76

SD = σ = 2.45

df = 2

From the X^2 - table:

At 0.01 level, X^2 = 9.210

At 0.05 level, X^2 = 5.991

$\therefore$ X^2, obtained, is a little significant at 0.05 level but not significant at 0.01 level.

TABLE NO. 34

A CHI-SQUARE TEST OF THE NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF SUB-TEST, II, - TEST SCORES

Scores	Scores	Frequency f_o	x - M	$\frac{x - M}{\sigma}$	Area P(x)	$\Delta P(x)$	$f_e = N X \Delta P(x)$	$\lvert f_o - f_e \rvert$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
25 - 29	24.5 - 29.5	26	5.53	1.30	0.9031995	0.0968005	52	26	676	13.000
20 - 24	19.5 - 24.5	244	0.53	0.12	0.3960802	0.5071193	269	25	625	2.323
15 - 19	14.5 - 19.5	188	-4.47	-1.05	0.1468591	0.2492211	132	56	3136	23.758
10 - 14	9.5 - 14.5	58	-9.47	-2.22	0.0132094	0.1336497	71	13	169	2.380
5 - 9	4.5 - 9.5	13]*	-14.47	-3.40	0.0003369	0.0128725	7]*	7]*	49	7.000
0 - 4	-0.5 - 4.5	1]	-19.47	-4.57	-	0.0003369	0]	0]	-	-
		530					531			$X^2 = 48.461$

* The bracketed intervals are combined.

Mean = M = 18.97 (19.00)

SD = σ = 4.25

df = 2

From X^2 - table:

At 0.01 level, X^2 = 9.210

At 0.05 level, X^2 = 5.991

∴ X^2, obtained, is highly significant at both levels.

TABLE NO. 35

A CHI-SQUARE TEST OF NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF SUB-TEST, III, TEST SCORES

Scores	Scores	Frequency f_o	x - M	$\frac{x - M}{\sigma}$	Area P(x)	$\Delta P(x)$	$f_e = N X \Delta P(x)$	$\lvert f_o - f_e \rvert$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
20 - 24	19.5 - 24.5	11	4.80	1.50	0.9331928	0.0668072	35	24	576	16.457
15 - 19	14.5 - 19.5	297	-0.20	-0.063	0.4760778	0.4571150	242	55	3025	12.500
10 - 14	9.5 - 14.5	192	-5.20	-1.63	0.0515507	0.4245271	225	33	1089	4.840
5 - 9	4.5 - 9.5	29 *	-10.20	-3.19	0.0007114	0.0508393	27 *	3	9	0.333
0 - 4	-0.5 - 4.5	1	-15.20	-4.75	-	0.0007114	0	-	-	-
		530					529			$X^2 = 34.130$

* The bracketed intervals are combined

Mean = M = 14.70

SD = σ = 3.20

df = 1

From X^2 - table:

At 0.01 level, X^2 = 6.635

At 0.05 level, X^2 = 3.841

∴ X^2, obtained, is highly significant at both levels.

TABLE NO. 36

A CHI-SQUARE TEST OF THE NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF SUB-TEST, IV, TEST SCORES

Scores	Scores	Frequency f_o	$x - M$	$\frac{x - M}{\sigma}$	Area P(x)	$\Delta P(x)$	$f_e = N X \Delta P(x)$	$\lvert f_o - f_e \rvert$	$(f_o - f_e)^2$	$\frac{(f_o - f_e)^2}{f_e}$
15 - 19	14.5 - 19.5	16	4.13	1.50	0.9331928	0.0363072	35	19	331	10.314
10 - 14	9.5 - 14.5	331	-0.87	-0.32	0.3744342	0.5587086	296	35	1225	4.139
5 - 9	4.5 - 9.5	177	-5.87	-2.13	0.0165858	0.3578984	190	13	169	0.889
0 - 4	-0.5 - 4.5	6	-10.87	-3.95	-	0.0165858	9	3	9	1.000
		530					530		X^2 =	16.342

Mean = M = 10.37

SD = σ = 2.75

df = 1

From X^2 - table:

At 0.01 level, X^2 = 6.635

At 0.05 level, X^2 = 3.841

∴ X^2, obtained, is highly significant at both levels.

TABLE NO. 37

A CHI-SQUARE TEST OF THE NORMAL-DISTRIBUTION HYPOTHESIS APPLIED TO A FREQUENCY DISTRIBUTION OF SUB-TEST, V, - TEST SCORES

Scores	Scores	frequency f_o	x - M	$\frac{x - M}{\sigma}$	Area P(x)	ΔP (x)	fe= N X ΔP(x)	$\lvert f_o - f_e \rvert$	$(f_o-f_e)^2$	$\frac{(f_o-f_e)^2}{f_e}$
20 - 24	19.5 - 24.5	8	7.42	2.18	0.9853713	0.0146287	8	0	0	0.000
15 - 19	14.5 - 19.5	100	2.42	0.71	0.7611479	0.2242234	119	19	361	3.034
10 - 14	9.5 - 14.5	315	-2.58	-0.76	0.2236273	0.5375206	285	30	900	3.158
5 - 9	4.5 - 9.5	106]*	-7.58	-2.23	0.0128737	0.2107536	112]*	12	144	1.210
0 - 4	-0.5 - 4.5	1]	-12.58	-3.70	-	0.0128737	7]	-	-	-
		530					531			X^2 = 7.402

* The bracketed intervals are combined

Mean = M = 12.08

SD = σ = 3.40

df = 1

From X^2 - table:

At 0.01 level, X^2 = 6.635

At 0.05 level, X^2 = 3.841

$\therefore$ X^2, obtained, is fairly significant at both levels.

Thus the chi-square test proves the 'Normal distribution (of the test-scores) hypothesis' for the whole test as well as for the sub-test I. It disproves the hypothesis for the remaining four sub-tests.

These results are exactly similar to the previous ones. Thus the conclusion, that the whole-test scores and sub-test I scores are distributed normally and the score-distributions for the remaining four sub-tests are asymmetric, is confirmed cent per cent by chi-square test.

These results were subjected to graphical representation for further confirmation of the conclusions reached earlier.

GRAPHICAL REPRESENTATION OF THE TEST SCORES

It is often advisable and convenient also, to compare the obtained distribution "by eye" with that normal curve which "best fits" the data. Such a comparison is profitably made even if no measures of divergence from normality are computed. Garrett[1] says,

> The direction and extent of asymmetry often strike us more convincingly when seen in a graph than when expressed by measures of skewness and kurtosis.

Garrett's statement is, thus, more than enough to stress the importance of graphical representation of the score distribution.

1 Garrett, H. E., Op.Cit., p. 102.

Different methods of representing a distribution of scores, graphically, are listed below.

(1) The frequency polygon or the "smoothed frequency polygon."

(2) The histogram,

and (3) The best-fitting normal-distribution curve for the test data.

For the whole test data, the following graphs are drawn.

(1) The frequency polygon: The data used are given in table No. 38 on page No. 276.

The method given by Garrett[1] in his book for the construction of the frequency polygon was followed.

The frequency polygon is shown on page No. 275.

(2) The 'smoothed' frequency polygon:

In order to smoothen the chance irregularities, the frequencies for the different class-intervals were smoothed. The smoothing of the frequencies was done by the method suggested by Garrett.[2] The smoothed frequencies are given in the following table:

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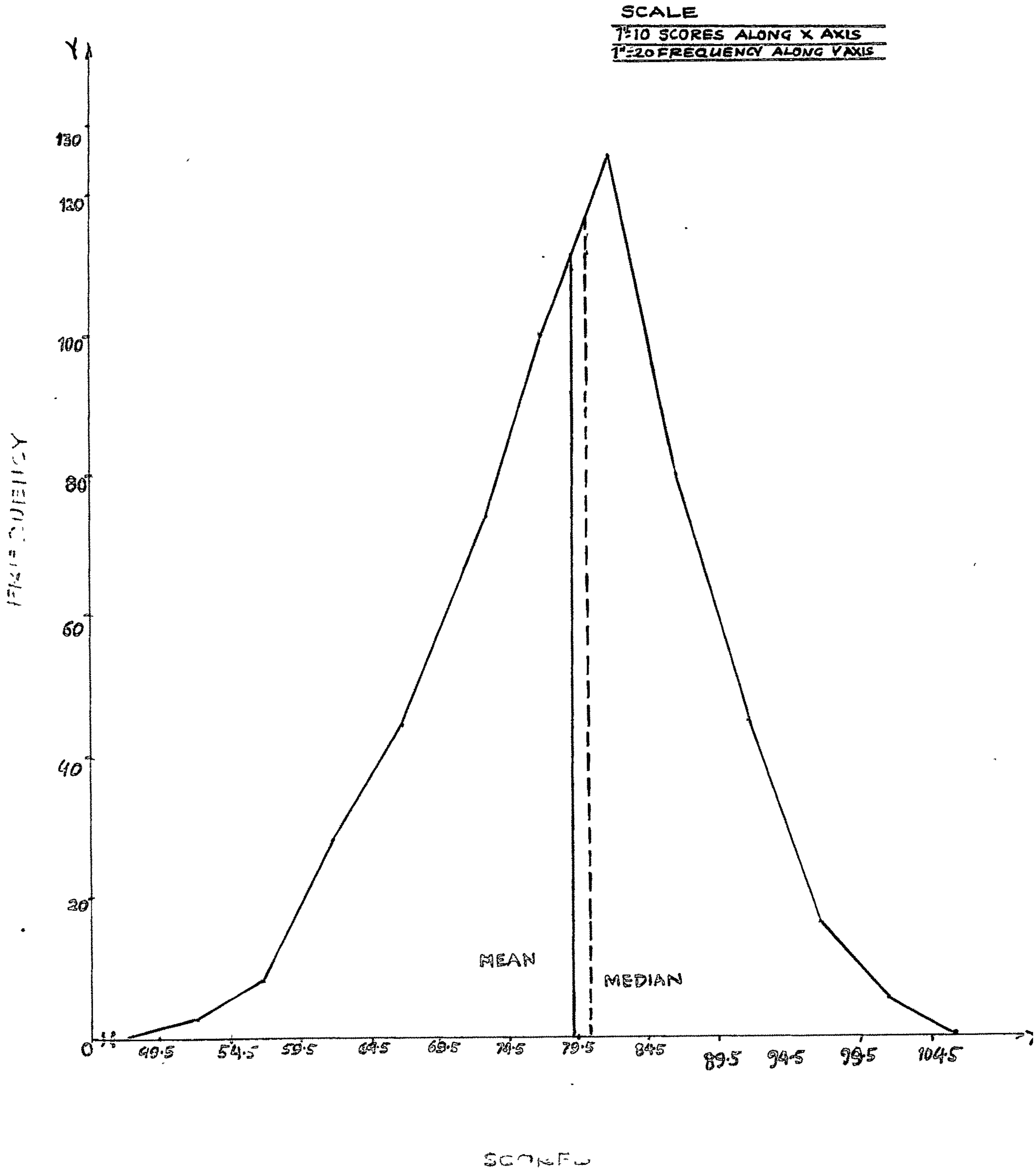
1 Garrett, H. E., Op.Cit., p. 10.

2 Garrett, H. E., Op.Cit., p. 13.



FREQUENCY POLYGON

TABLE NO. 38

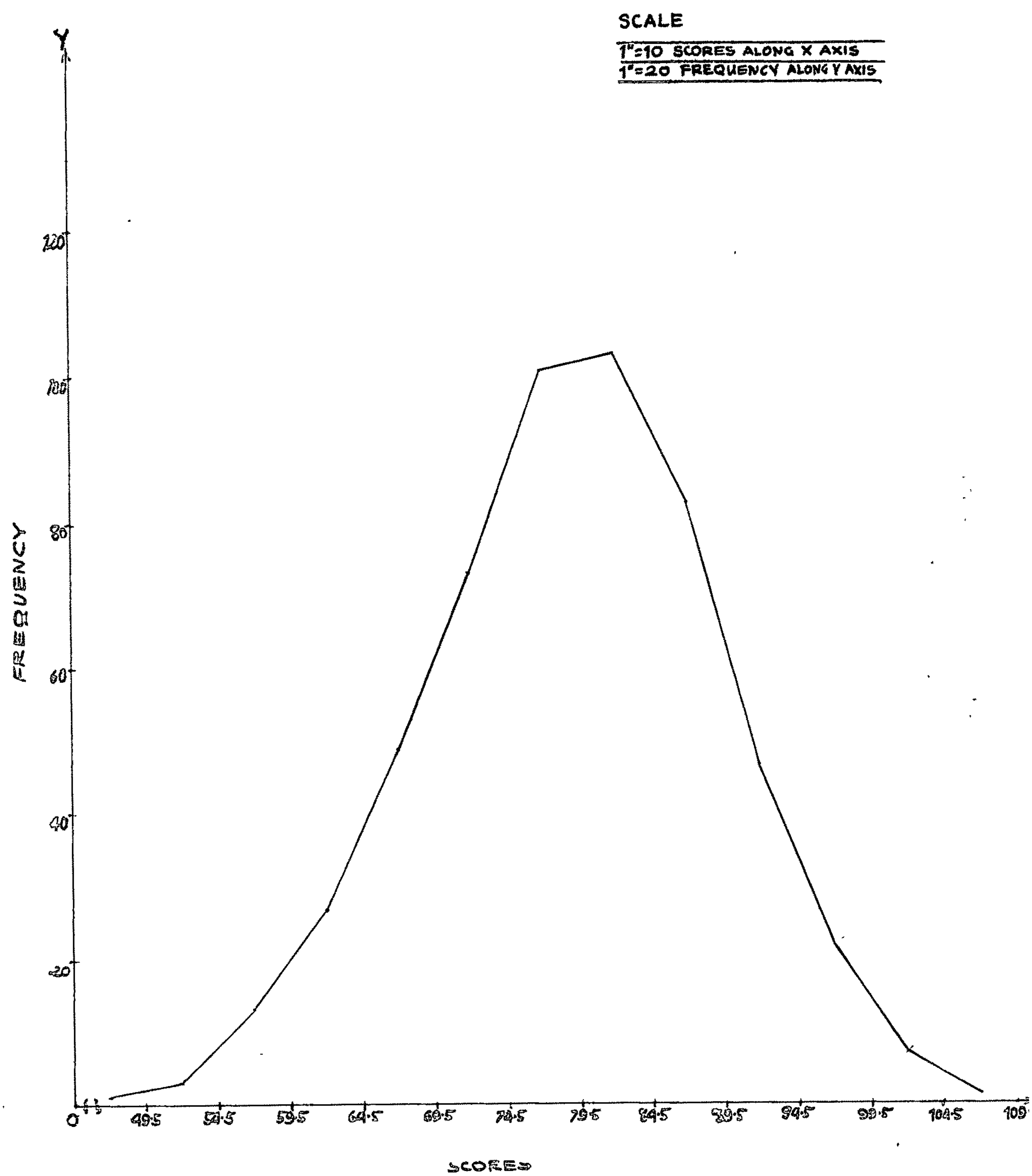
SHOWING SMOOTHED FREQUENCIES - DATA REPRODUCED FROM THE TABLE NO. 18 ON PAGE NO. 242

Scores	Original frequency	Smoothed frequency
104.5 - 109.5	0	1.67
99.5 - 104.5	5	7.00
94.5 - 99.5	16	22.00
89.5 - 94.5	45	47.00
84.5 - 89.5	80	83.67
79.5 - 84.5	126	102.67
74.5 - 79.5	102	100.67
69.5 - 74.5	74	73.33
64.5 - 69.5	44	48.67
59.5 - 64.5	28	26.67
54.5 - 59.5	8	12.67
49.5 - 54.5	2	3.33
44.5 - 49.5	0	0.67

The smoothed frequency polygon is shown on page No. 277

(3) The histogram: Another way of representing a frequency distribution graphically is by means of a histogram. To construct the histogram also, the method suggested by Garrett[1] was used.

1 Garrett, H. E., Op.Cit., p. 15.



SMOOTHED FREQUENCY POLYGON

The histogram is shown on page No. 279.

(4) The best fitting normal-distribution curve for the test data.

The equation[1] of the normal probability curve reads as follows:

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

Where

x = scores (expressed as deviations from the mean) laid off along the base line.

y = the height of the curve above the X-axis.

N = number of cases.

σ = standard deviation of the distribution.

π = 3.1416.

e = 2.7183 (base of the Napierian system of logarithms).

The best fitting normal curve is to be superimposed on the obtained histogram. To plot a normal curve over this histogram, the height of the maximum ordinate (y_o) should first be calculated. This can be determined from the equation of the normal curve given above.

The 'x' at the mean of the normal curve is '0'.

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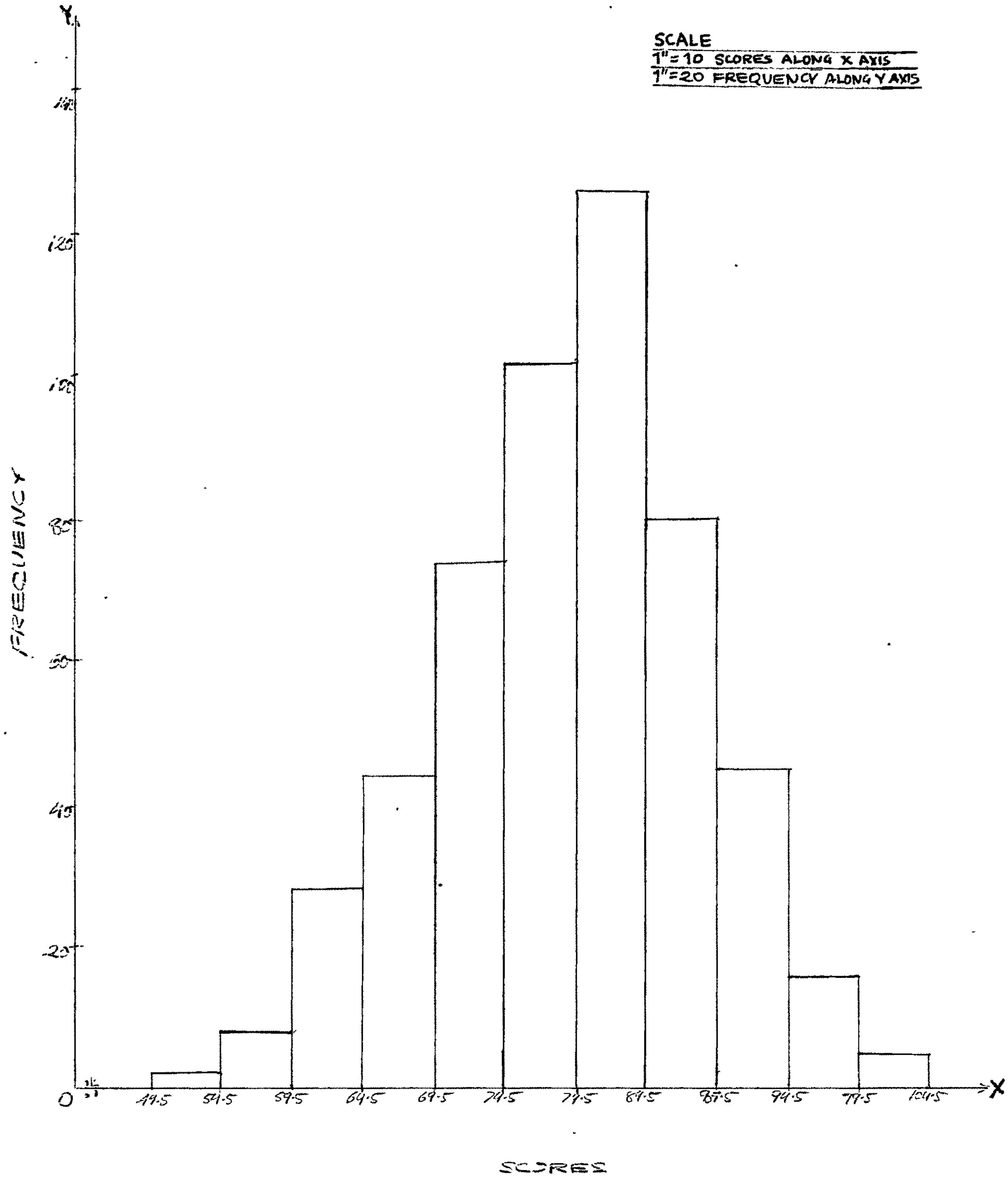
1 Garrett, H. E., Op.Cit., p. 96.


SCALE
1"=10 SCORES ALONG X AXIS
1"=20 FREQUENCY ALONG Y AXIS
Y
X
O
FREQUENCY
SCORES

HISTOGRAM

$\therefore$ When $x = 0$, $e^{-\frac{x^2}{2\sigma^2}} = 1$

$$\therefore yo = \frac{N}{\sigma\sqrt{2\pi}}$$

The σ in interval units is used in the equation, since the units on the x-axis are in terms of class-intervals. yo is the frequency at the mean point in the score distribution.

In the present problem,

$N = 530$; $\sigma = 1.854$ and $\sqrt{2\pi} = 2.51$

$$\therefore yo = \frac{N}{\sigma\sqrt{2\pi}}$$

$$= \frac{530}{1.854 \times 2.51}$$

$$= 113.9$$

$$\therefore yo = 113.9$$

The values of y's, the heights of ordinates at different σ - distances from the mean were found out from the statistical table, and the corresponding values of y's, when yo = 113.9, were computed.

In the table below, the final values of ordinates at different σ - distances are shown.

TABLE NO. 39

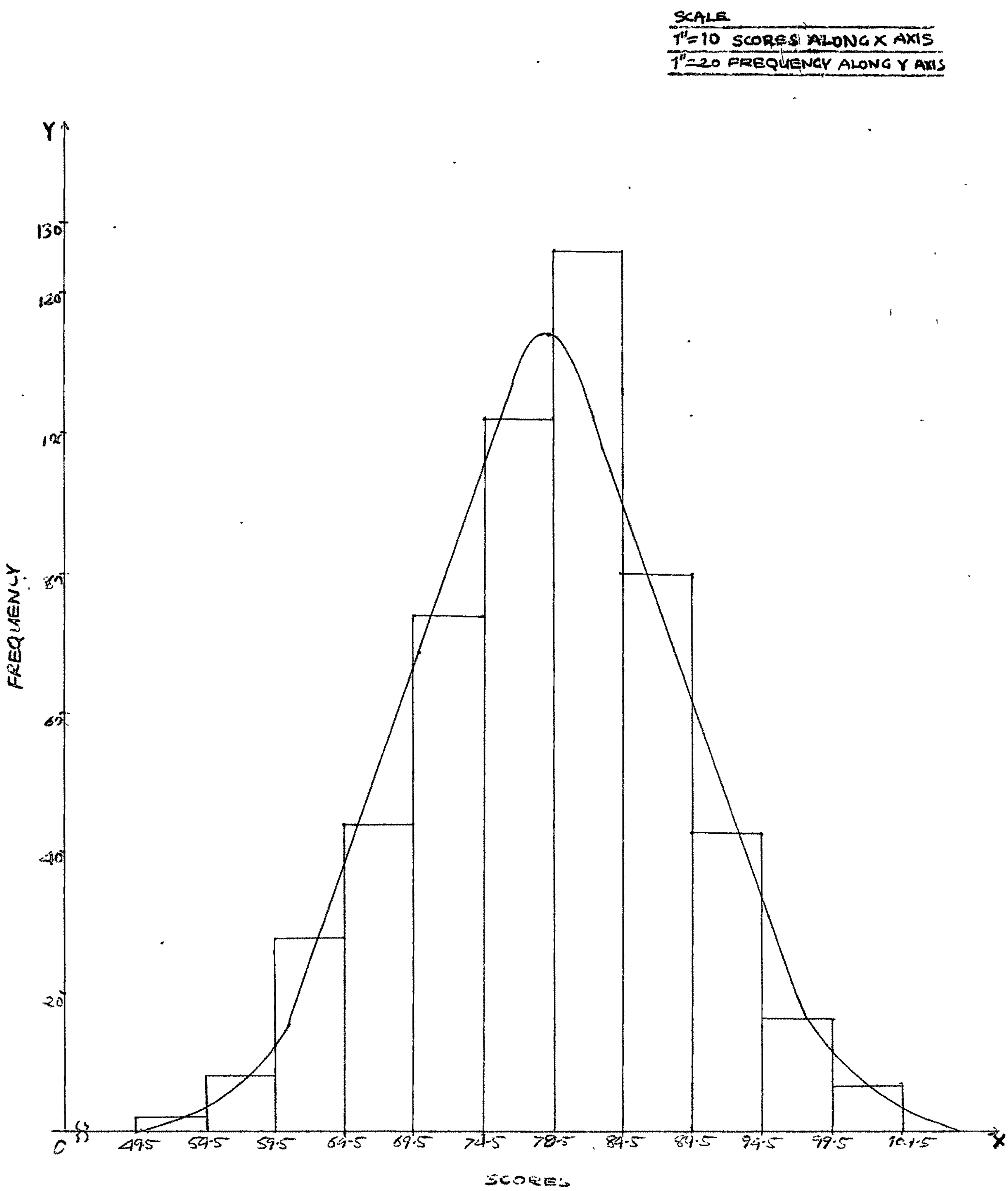
SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\sigma$, $\pm 2\sigma$, and $\pm 3\sigma$.
(y_o = 113.9)

σ- distance from the mean	Value of y, when y_o = 1 (Read from table)	Value of y when y_o = 113.9 (obtained from the data)	Height of the ordinate
$\pm 1\sigma$	0.60653	0.60653 x 113.9	69.1
$\pm 2\sigma$	0.13534	0.13534 x 113.9	15.4
$\pm 3\sigma$	0.01111	0.01111 x 113.9	1.3

The above data were used to superimpose the ideal (best-fitting) normal curve on the obtained histogram. This curve is shown on page No. 282.

The skewness of the obtained distribution is found to be -1.205. This small value indicates a low degree of negative skewness in the data. The kurtosis of the distribution is 0.251, and the distribution is slightly leptokurtic. Neither measure of divergence, however, is significant of a "real" discrepancy between the data and those of the normal distribution. The normal curve plotted on page No. 282, on the whole, fits the obtained distribution well enough to warrant our treating these data as sensibly normal.

The best-fitting normal-distribution curves for all the five sub-test data are also drawn. The normal curve



SUPERIMPOSITION OF A BEST FITTING NORMAL CURVE
ON THE OBTAINED DISTRIBUTION FOR WHOLE TEST

ordinates at mean, $\pm 1\sigma$, $\pm 2\sigma$ and $\pm 3\sigma$ for each of the sub-test data are given in table Nos. 40, 41, 42, 43 and 44.

TABLE NO. 40

SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\sigma$, $\pm 2\sigma$ and $\pm 3\sigma$

(for sub-test I - data)

N = 530; σ = 0.817 (in interval unit)

yo = 258.5

σ- distance from the mean	Value of y, when yo = 1 (Read from the table	Value of y, when yo = 258.5 (obtained from the data)	Height of the ordinate
$\pm 1\sigma$	0.60653	0.60653 x 258.5	156.8
$\pm 2\sigma$	0.13534	0.13534 x 258.5	35.0
$\pm 3\sigma$	0.01111	0.01111 x 258.5	2.9

TABLE NO. 41

SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\sigma$, $\pm 2\sigma$ and $\pm 3\sigma$

(for sub-test II - data)

N = 530; σ = 0.85 (in interval unit)

yo = 248.4

σ- distance from the mean	Value of y, when yo = 1 (Read from the table)	Value of y, when yo = 248.4 (obtained from the data)	Height of the ordinate
$\pm 1\sigma$	0.60653	0.60653 x 248.4	150.7
$\pm 2\sigma$	0.13534	0.13534 x 248.4	33.6
$\pm 3\sigma$	0.01111	0.01111 x 248.4	2.8

TABLE NO. 42

SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\sigma$, $\pm 2\sigma$ and $\pm 3\sigma$

(for sub-test III - data)

N = 530; σ = 0.64 (in interval unit)

yo = 329.9

σ- distance from the mean	Value of y, when yo = 1 (Read from the table)	Value of y, when yo = 329.9 (obtained from the data)	Height of the ordinate
$\pm 1\sigma$	0.60653	0.60653 x 329.9	200.1
$\pm 2\sigma$	0.13534	0.13534 x 329.9	44.6
$\pm 3\sigma$	0.01111	0.01111 x 329.9	3.7

TABLE NO. 43

SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\sigma$, $\pm 2\sigma$ and $\pm 3\sigma$

(for sub-test IV - data)

N = 530; σ = 0.55 (in interval unit)

yo = 383.9

σ- distance from the mean	Value of y, when yo = 1 (Read from the table)	Value of y, when yo = 383.9 (obtained from the data)	Height of the ordinate
$\pm 1\sigma$	0.60653	0.60653 x 383.9	232.8
$\pm 2\sigma$	0.13534	0.13534 x 383.9	52.0
$\pm 3\sigma$	0.01111	0.01111 x 383.9	4.3

TABLE NO. 44

SHOWING NORMAL CURVE ORDINATES AT MEAN, $\pm 1\ \sigma$, $\pm 2\ \sigma$ and $\pm 3\ \sigma$

(for sub-test V - data)

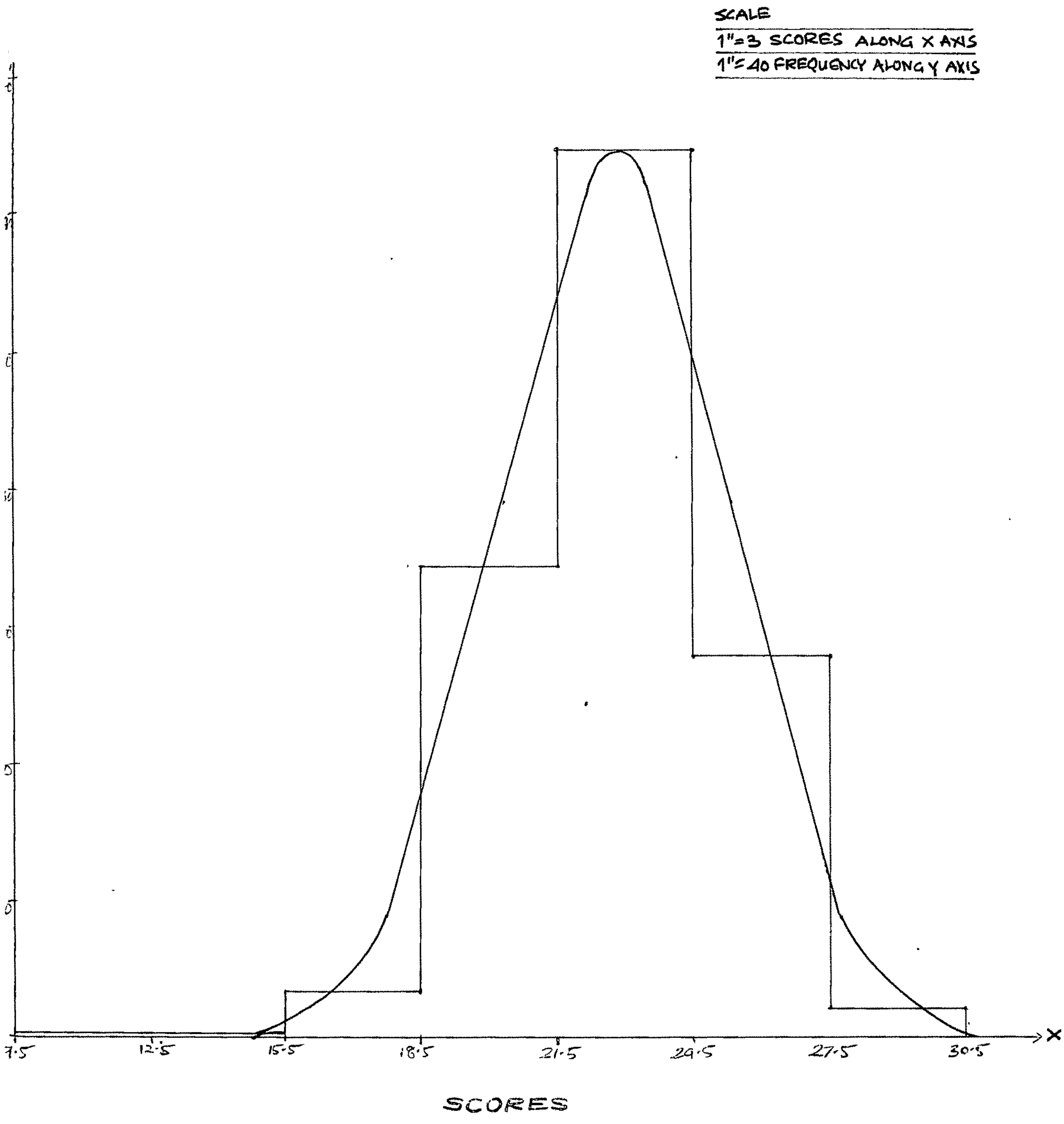
N = 530; σ = 0.68 (in interval unit)

y_o = 310.5

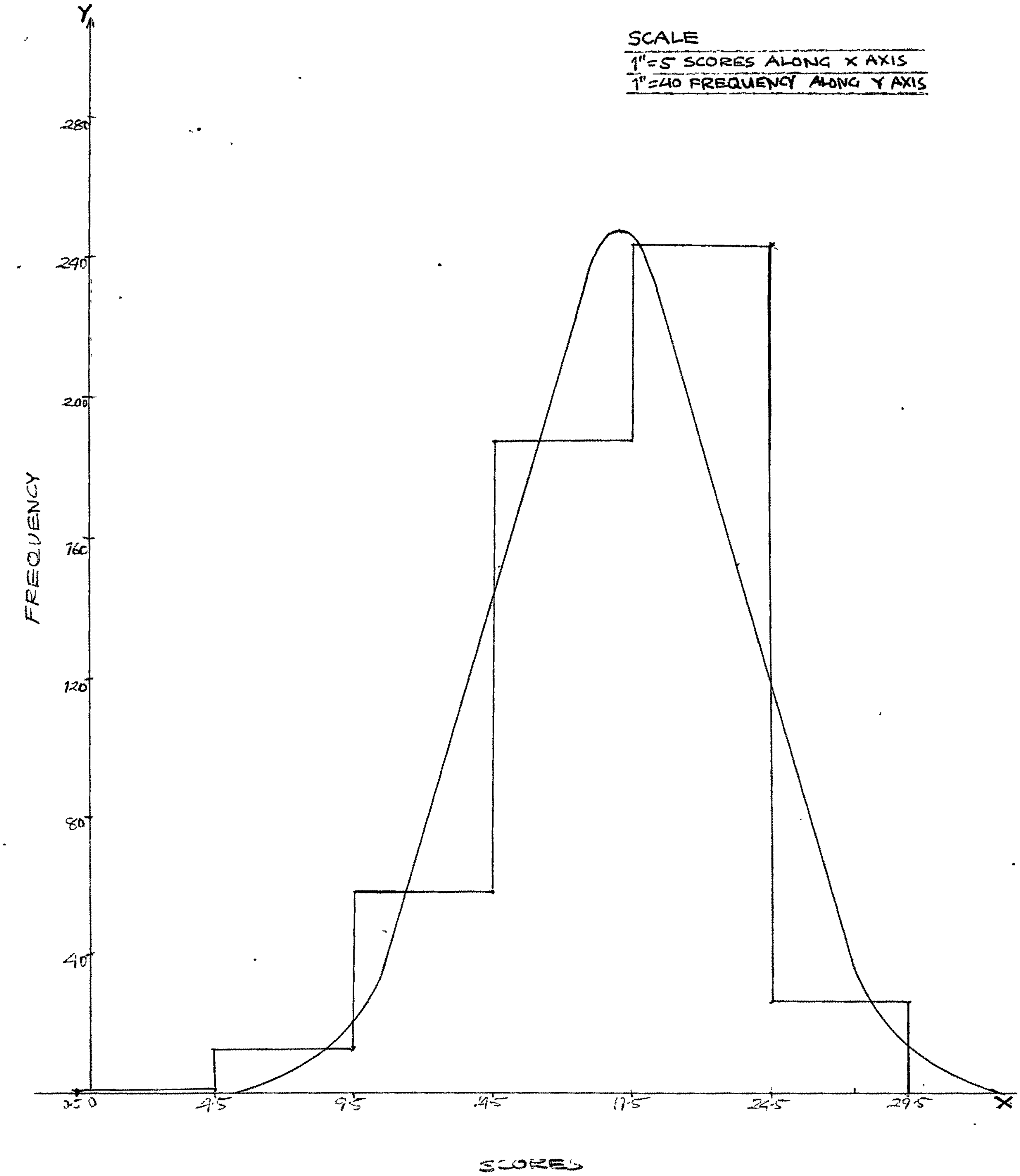
σ- distance from the mean	Value of y, when y_o = 1 (Read from the table)	Value of y, when y_o = 310.5 (obtained from the data)	Height of the ordinate
$\pm 1\ \sigma$	0.60653	0.60653 x 310.5	188.3
$\pm 2\ \sigma$	0.13534	0.13534 x 310.5	42.0
$\pm 3\ \sigma$	0.01111	0.01111 x 310.5	3.4

All these five curves are shown on page Nos. 286, 287, 288, 289, and 290 respectively.

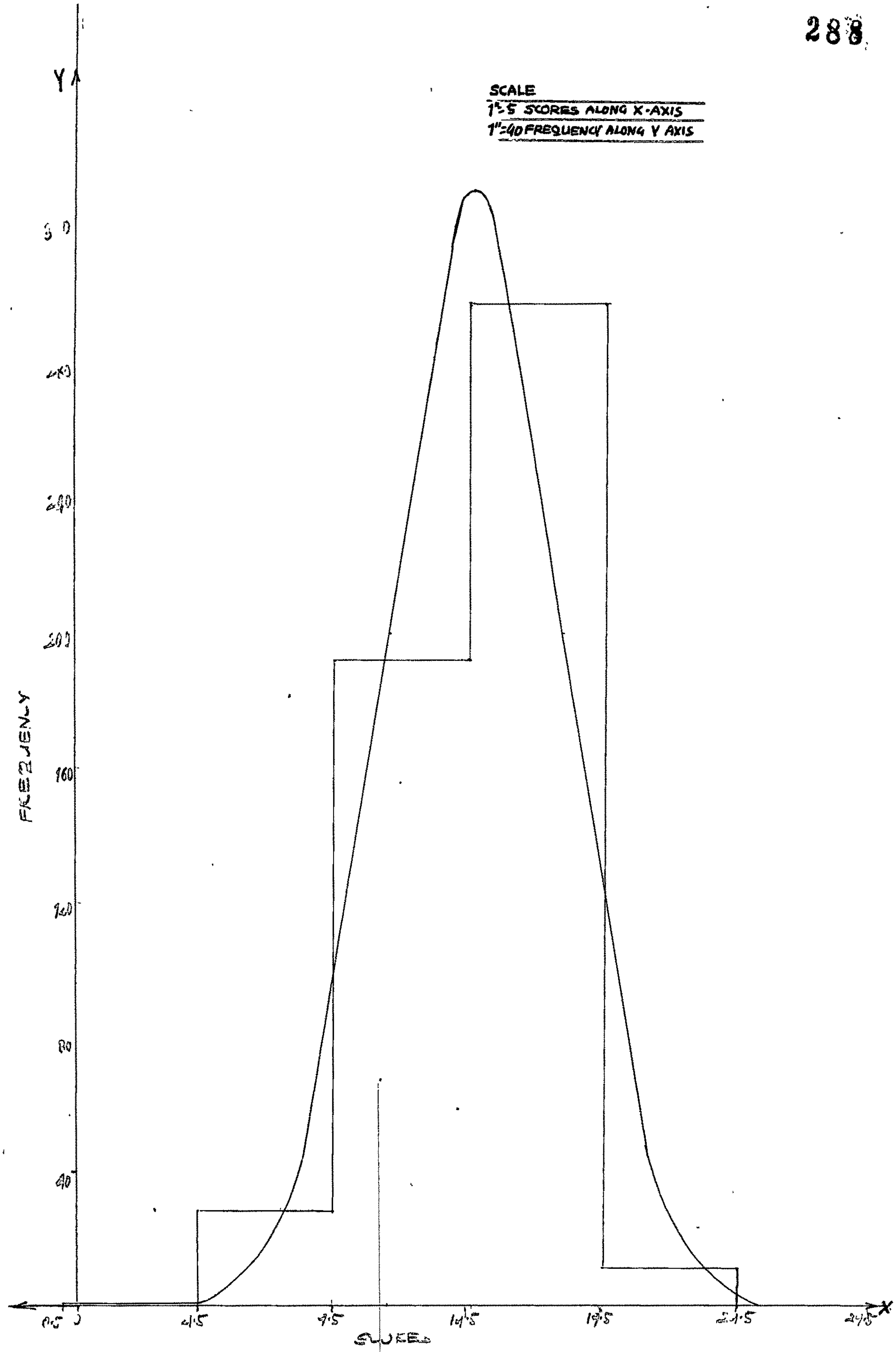
The nature of the distributions of total test score and sub-test scores was, thus, studied by three different techniques. The table, summarising these results in a nutshell is given on the next page.



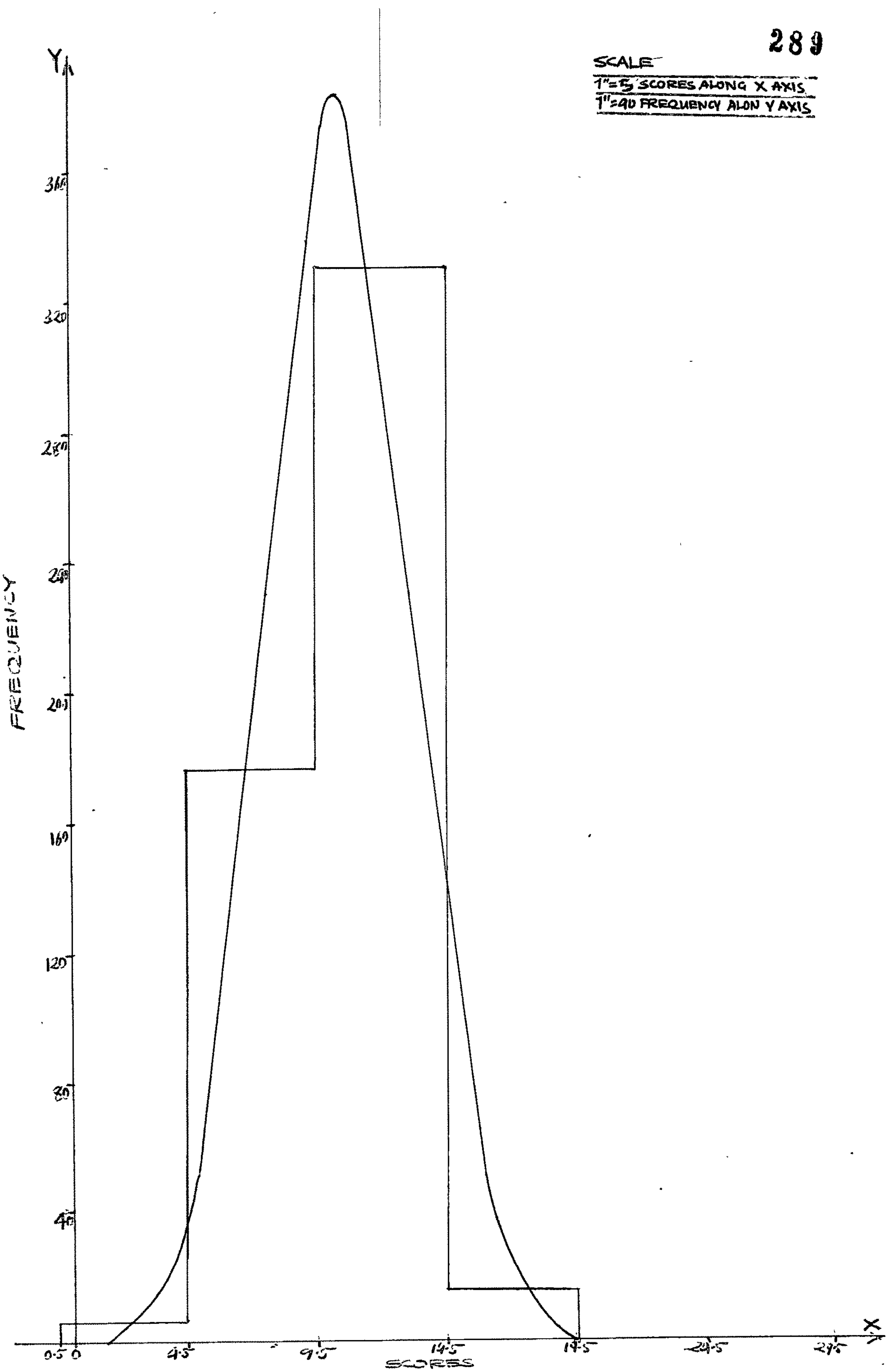
SUPERIMPOSITION OF A BEST FITTING NORMAL CURVE ON THE OBTAINED DISTRIBUTION FOR SUB-TEST I



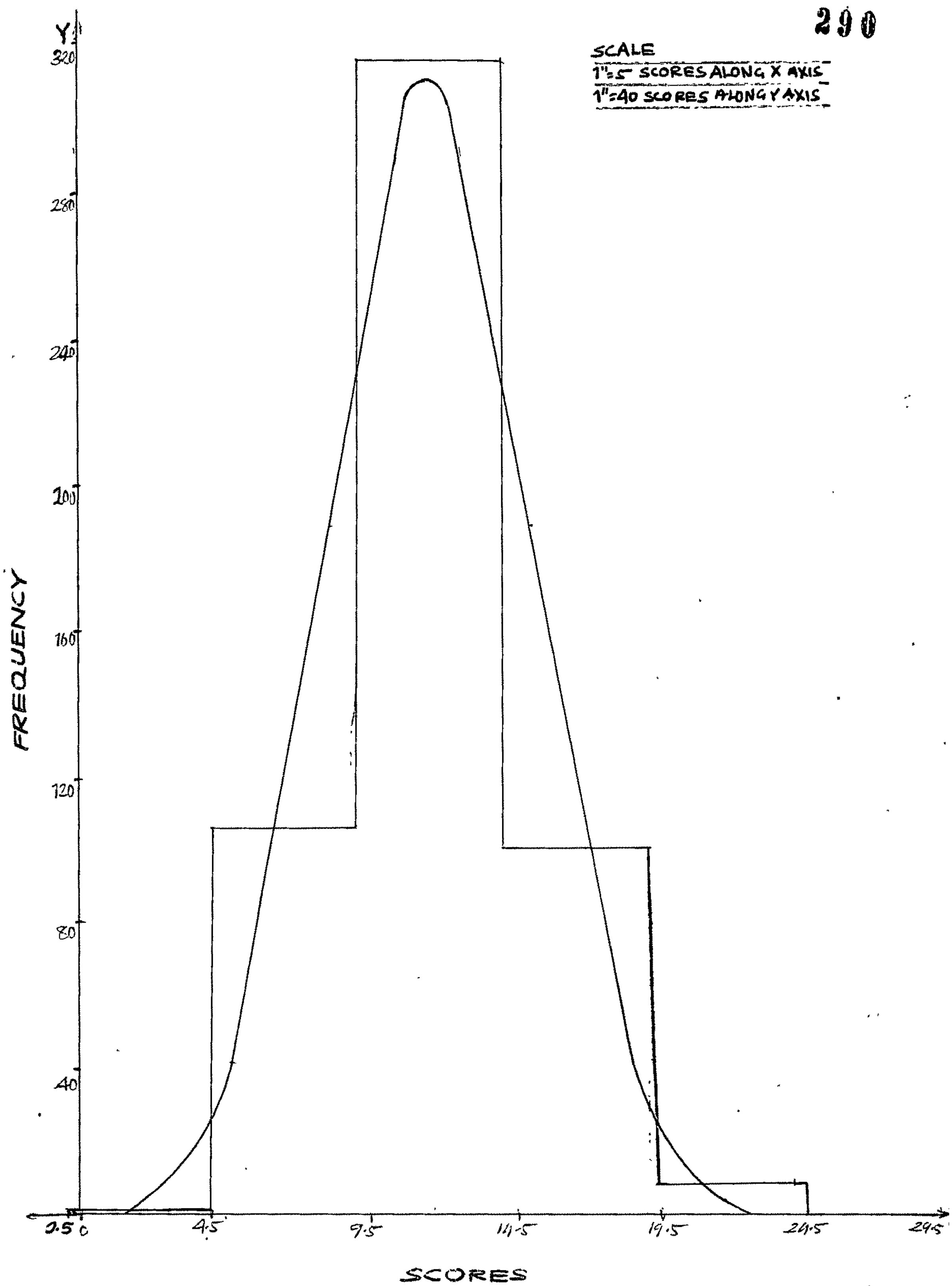
SUPERIMPOSITION OF A BEST FITTING NORMAL CURVE ON THE OBTAINED DISTRIBUTION FOR SUB TEST II



SUPERIMPOSITION OF A BEST-FITTING NORMAL CURVE ON THE OBTAINED DISTRIBUTION FOR SUB-TEST III



SUPERIMPOSITION OF A BEST FITTING NORMAL CURVE ON THE OBTAINED DISTRIBUTION FOR SUB-TEST IV



SUPERIMPOSITION OF A BEST-BITTING NORMAL CURVE ON THE OBTAINED DISTRIBUTION FOR SUB-TEST - V

TABLE NO. 45

SHOWING THE COMPARISON OF RESULTS OBTAINED FROM THE STUDY, OF THE NATURE OF CURVES OBTAINED, BY THREE DIFFERENT TECHNIQUES

Test	Nature of the curve revealed through measures of divergence	Nature of the curve revealed through chi-test	Nature of the curve revealed through superimposition of an ideal curve	Conclusion
Total Test	Normal distribution	Normal distribution	Normal distribution	Normal distribution
Sub-Test I	Normal distribution	Fairly Normal distribution	Fairly normal	Fairly normal
Sub-Test II	distribution asymmetric	distribution highly asymmetric	Asymmetric	Asymmetric
Sub-Test III	distribution asymmetric	distribution highly asymmetric	Asymmetric	Asymmetric
Sub-Test IV	distribution asymmetric	distribution asymmetric	Asymmetric	Asymmetric
Sub-Test V	distribution asymmetric	distribution a little asymmetric	Asymmetric	Asymmetric

It can, thus, be concluded safely that the distribution of the total test scores, though, not perfectly normal, is much sensibly normal.

The distribution of the sub-test I scores is also justifiably normal.

The distributions of the scores on the remaining sub-tests are unquestionably asymmetric.