CHAPTER XIV

NORMS - THEIR USE IN PERSONNEL SELECTION

The most difficult phase of aptitude-testing is interpretation of results. After the tests have been carefully administered and painstakingly scored, the findings must be appraised and translated into information helpful to the individual tested.

A test-score is meaningful only if it is properly understood. A score on a test is given some meaning by referring it to some group average.

A yardstick is, therefore, required to measure the magnitude of the deviation of a person's score from the general population average, or from the average of his group. A table of norms shows the range of the scores others have made and the way these scores are distributed. A norm is a standard of reference; so a table of norms serves as our yardstick.

It is generally recognised that valid norms are essential for dependable interpretations of individual and group measures. In fact, as Conrad[1] points out, our very language of thinking, involving and requiring such terms as "little", "much", "typical", etc. imply the recognition of norms. It is

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1 Monroe, W. S., "Encyclopedia of Educational Research", The MacMillan Company, New York, 1956, p. 795.

obvious, then, that norms are of basic importance.

Norms provide the user of a standardised test with the basis for a practical interpretation and application of the results. Unless the norms that accompany a test reflect an accurate picture of typical accomplishment, they are useless and they render the test itself useless.

Flanagan[1] defines test norms as "Estimates of some characteristic of a distribution of test scores for a specified population". Norms describe the actual performance of specified groups of individuals.

The terms 'norms' and 'standards' are frequently used interchangeably and the confusion arises over the fact that norms are used with standard tests and that a part of the process of standardisation is the derivation of norms. It is, therefore, necessary at the outset to distinguish clearly between a norm and a standard.

Flanagan[2] also emphasizes this distinction. He says,

> Standards, on the other hand, are desirable, or desired, levels of attain-ment, preferably expressed in terms of outcomes of instructions.

Greene, Jorgensen and Gerberick[3] point out the difference between a norm and a standard more clearly. They say,

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1 Lindquist,E.F.,"Educational Measurement", American Council on Education,Washington, D.C., 1955, p. 698.
2 Ibid., p. 698.
3 Greene,H.A.,Jorgensen,A.N.,& Gerberich,J.R.,"Measurement and Evaluation in the Secondary School",Longmans,Green and Co., New York, 1955, p.102.

> The term standard, when used to refer to a level of pupil achievement , implies an ultimate goal to be achieved, while norms are the levels of achievement which typical pupils actually attain.

Standards are formulated arbitrarily to suit one's requirement. Norms are derived from test results. The first ones are subjective while the second ones are objective. In the present case norms are established for the test results.

CLASSIFICATION OF NORMS

According to Conrad,[1] norms may be classified with respect to:

(a) the type of standardisation sample on which they are based;

(b) the variable for which they are obtained;

(c) the type of unit in which they are expressed;

and (d) the fineness of classification that they yield.

Thorndike and Hagen[2] suggest,

> There are two general ways that we may relate a person's score to a more general framework. One way is to compare him with a graded series of groups and see which one he matches. Each group in the

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1 Monroe, W. S., Op.Cit., p. 796.

2 Thorndike, R.L., & Hagen, Elizabeth, "Measurement and Evaluation in Psychology and Education", John Wiley & Sons, Inc., New York, 1958, p. 156.

series usually represents a particular school grade or a particular chronological age. The other way is to find where he falls in a particular group, in terms of the per cent of the group he surpasses or in terms of the group's mean and standard deviation. Thus, we find four main patterns for interpreting the score of an individual.

They show these four types schematically in a table like the following one.

TABLE NO. 87

SCHEMATIC PRESENTATION OF THE MAIN TYPES OF NORMS

Sr. No.	Type of Norm	Type of Comparison	Type of Group
1	Age norms	Individual matched to group he equals	Successive age groups
2	Grade norms	Same as above	Successive grade groups
3	Percentile norms	Per cent of group surpassed by individual	Single age or grade group to which individual belongs
4	Standard score norms	Number of SD's individual falls above or below average group	Same as above

Most generally, the norms, based on the type of unit in which they are expressed, are reported by the investigators. These types of norms are, therefore, discussed very briefly here.

Educational norms are occasionally expressed in terms

of the original or "raw" scores but more often in terms of "derived" scores. The most common norms based on units in which they are expressed are:

(i) Raw-score norms

(ii) Age norms

(iii) Grade norms

(iv) Percentile norms

(v) Standard score norms

(vi) T-score norms.

Raw-score norms: "Cut-off" points or "cutting scores" are generally expressed in terms of raw scores.

Age norms: An age norm is a statement of the mean or median performance on an intelligence or achievement test by a group of pupils of a designated chronological age. Age norms are especially useful in the standardisation of intelligence, or mental ability tests.

Grade norms: A grade norm may be defined as the mean or median achievement of pupils in a given school grade on a given standardised test. Or it may be defined as the average status of pupils in a given grade in regard to a single factor such as spelling ability, reading comprehension, or arithmetic ability.

Percentile norms: A percentile norm may be defined as a point on a scale of measurement determined by the -

percentage of individuals in a given population that lies below this point. Percentile norms are widely used on readiness tests for first-grade children, on achievement tests in various subjects for high-school children, on interest inventories, personality inventories, and rating scales.

Standard-Score norms: A standard score is expressed as a deviation of a score from the arithmetic average of the normative group in which the standard deviation of the normative group is used as the unit of measurement.

Such scores simplify interpretation and increase comparability. The standard score is used most frequently by psychologists and research workers.

T-Score norms: The well-known T scale overcomes the objections raised against standard scores. It adopts as its unit one-tenth of a standard deviation, so that an ordinary distribution with a range of 5 σ to 6 σ on its base line yields 50 to 60 integral T-scale scores. In addition, the T-scale goes beyond any ordinary distribution, extending over a spread of 10 standard deviations, or 100 units in all.

For the present test results, the following norms are found out:

(i) Standard-score norms

(ii) T-score norms

(iii) Percentile norms.

STANDARD-SCORE NORMS

The raw scores obtained on the test were converted into the standard scores with the help of the following formula[1]. The shift from raw to standard score requires a linear transform-ation. This transmutation does not change the shape of the distribution in any way.

The formula for conversion is:

$$\frac{X' - M'}{\sigma'} = \frac{X - M}{\sigma}$$

$$\text{or } X' = \frac{\sigma'}{\sigma}(X - M) + M'$$

Where X = a score on the original distribution

X' = a standard score on the new distribution

M & M' = means of the raw score and standard score distributions respectively

σ & σ' = SD's of raw and standard scores respectively.

The above equation, is the equation of a straight line, analogous to the general equation of a straight line, $y = mx + b$.

The raw scores on the present aptitude test are expressed as standard scores in a distribution of M = 100 and

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1 Garrett, H. E., "Statistics in Psychology and Education", Longmans, Green & Co., New York, 1958, pp.312-313.

σ = 20 as well as in a distribution of M = 50 and σ = 10. These standard scores obtained are given in table No. 88, with their corresponding raw scores.

THE T-SCORE NORMS

Instead of σ scores, the obtained scores of a frequency distribution may be converted into a system of "normalised" σ scores by transforming them directly into equivalent points in a normal distribution.

Normalised standard scores are generally called T scores. T scaling was devised by McCall.

T-scores are normalised standard scores converted into a distribution with a mean of 50 and σ of 10.

The procedure suggested by Garrett[1] for calculating the T-scores, was followed in toto.

A model of a work-sheet table required to be prepared for the calculation of T-scores is given below. No computational details are given. The table illustrates only how the T-scores were calculated.

(1)	(2)	(3)	(4)	(5)	(6)
Test score	f	Cum.f.	Cum.f below score +½ on given score	Col.(4) in %'s	T-scores

1 Garrett, H.E., Op.Cit., pp. 315-317.

The T-scores are given in table No. 88, alongwith their corresponding raw-scores and standard scores.

TABLE NO. 88

RAW-SCORES AND THEIR CORRESPONDING STANDARD SCORES AND T-SCORES

Raw-Scores	Standard scores M = 100, SD = 20	Standard scores M = 50, SD = 10	T-scores
1	-68.5	-34.2	-
2	-66.3	-33.2	-
3	-64.2	-32.1	-
4	-62.0	-31.0	-
5	-59.8	-29.9	-
6	-57.7	-28.8	-
7	-55.5	-27.8	-
8	-53.4	-26.7	-
9	-51.2	-25.6	-
10	-49.1	-24.5	-
11	-46.9	-23.4	-
12	-44.7	-22.4	-
13	-42.6	-21.3	-
14	-40.4	-20.2	-
15	-38.3	-19.1	-
16	-36.1	-18.1	-
17	-34.0	-17.0	-
18	-31.8	-15.9	-
19	-29.6	-14.8	-

Raw-Scores	Standard scores M = 100,SD = 20	Standard scores M = 50, SD = 10	T-scores
20	-27.5	-13.7	-
21	-25.3	-12.7	-
22	-23.2	-11.6	-
23	-21.0	-10.5	-
24	-18.9	- 9.4	-
25	-16.7	- 8.3	-
26	-14.5	- 7.3	-
27	-12.4	- 6.2	-
28	-10.2	- 5.1	-
29	- 8.1	- 4.0	-
30	- 5.9	- 2.9	-
31	- 3.8	- 1.9	-
32	- 1.6	- 0.8	-
33	0.6	0.3	-
34	2.7	1.4	-
35	4.9	2.4	-
36	7.0	3.5	-
37	9.2	4.6	-
38	11.3	5.7	-
39	13.5	6.8	-
40	15.7	7.8	-
41	17.8	8.9	-
42	20.0	10.0	-
43	22.1	11.1	-

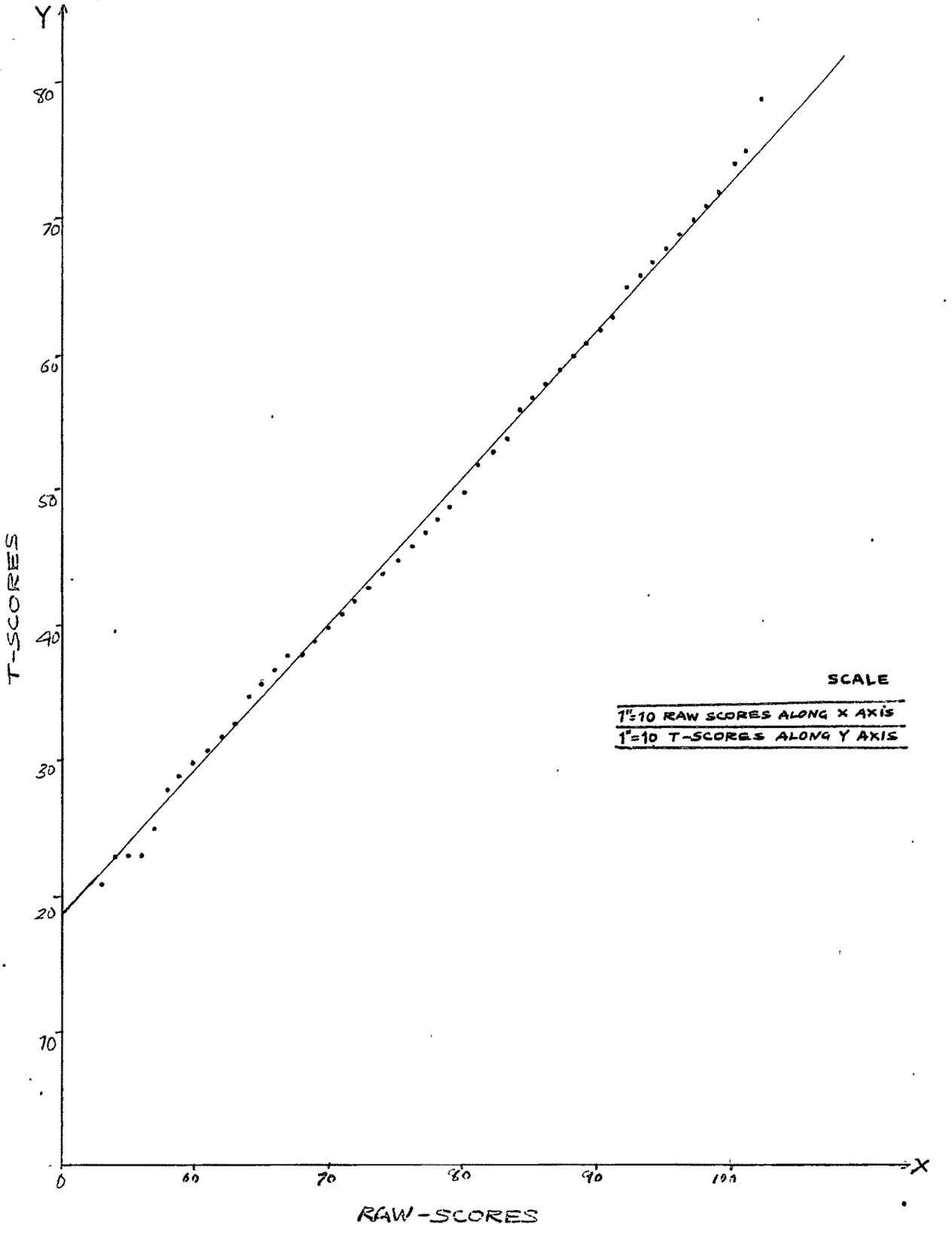
Raw-scores	Standard scores M = 100,SD = 20	Standard scores M = 50, SD = 10	T-scores
44	24.3	12.2	-
45	26.5	13.2	-
46	28.6	14.3	-
47	30.8	15.4	-
48	32.9	16.5	-
49	35.1	17.6	-
50	37.2	18.6	-
51	39.4	19.7	-
52	41.6	20.8	-
53	43.7	21.9	21
54	45.9	22.9	23
55	48.0	24.0	23
56	50.2	25.1	23
57	52.3	26.2	25
58	54.5	27.3	28
59	56.7	28.3	29
60	58.8	29.4	30
61	61.0	30.5	31
62	63.1	31.6	32
63	65.3	32.7	33
64	67.4	33.7	35
65	69.6	34.8	36
66	71.8	35.9	37
67	73.9	37.0	38
68	76.1	38.1	38

Raw-Scores	Standard scores M = 100, SD = 20	Standard scores M = 50, SD = 10	T-scores
69	78.2	39.1	39
70	80.4	40.2	40
71	82.5	41.3	41
72	84.7	42.4	42
73	86.9	43.4	43
74	89.0	44.5	44
75	91.2	45.6	45
76	93.3	46.7	46
77	95.5	47.8	47
78	97.6	48.8	48
79	99.8	49.9	49
80	102.0	51.0	50
81	104.1	52.1	52
82	106.3	53.2	53
83	108.4	54.2	54
84	110.6	55.3	56
85	112.8	56.4	57
86	114.9	57.5	58
87	117.1	58.6	59
88	119.2	59.6	60
89	121.4	60.7	61
90	123.5	61.8	62
91	125.7	62.9	63
92	127.9	64.0	65

Raw-Scores	Standard scores M = 100,SD = 20	Standard scores M = 50, SD = 10	T-scores
93	130.0	65.0	66
94	132.2	66.1	67
95	134.3	67.2	68
96	136.5	68,3	69
97	138.6	69.3	70
98	140.8	70.4	71
99	143.0	71.5	72
100	145.1	72.6	74
101	147.3	73.7	75
102	149.4	74.7	79
103	151.6	75.8	-
104	153.7	76.9	-
105	155.9	78.0	-
106	158.1	79.1	-
107	160.2	80.1	-
108	162.4	81.2	--
109	164.5	82.3	-
110	166.7	83.4	-
111	168.8	84.5	-
112	171.0	85.5	-
113	173.2	86.6	-
114	175.3	87.7	-
115	177.5	88.8	-
116	179.6	89.8	-

Raw-Scores	Standard scores M = 100,SD = 20	Standard scores M = 50, SD = 10	T-scores
117	181.8	90.9	-
118	183.9	92.0	-
119	186.1	93.1	-
120	188.3	94.2	-
121	190.4	95.2	-
122	192.6	96.3	-
123	194.7	97.4	-
124	196.9	98.5	-
125	199.1	99.6	-
126	201.2	100.6	-
127	203.4	101.7	-
128	205.5	102.8	-
129	207.7	103.9	-
130	209.8	105.0	-
131	212.0	106.0	-
132	214.2	107.1	-

A graph showing the relation between the raw-scores and the T-scores is drawn. The graph obtained is a straight line. This proves that there is a linear relation between the two sets of scores. From the graph, a T-score corresponding to a raw score can be readily found out. The 'raw-score - T-score' graph is shown on page No. 414 of this chapter.



A GRAPH SHOWING RELATION BETWEEN RAW-SCORES & T-SCORES

PERCENTILE NORMS

To calculate percentiles, the following formula[1] was used.

$$P_p = \ell + \left(\frac{pN - F}{fp}\right) \times i$$

Where

P_p = percentage of the distribution wanted,

ℓ = exact lower limit of the class interval upon which P_p lies,

pN = part of N to be counted off in order to reach P_p,

F = sum of all scores upon intervals below ℓ,

f_p = number of scores within the interval upon which P_p falls,

i = length of the class interval.

The percentile norms are given in table No. 89.

TABLE NO. 89
PERCENTILE NORMS

Percentile	Score	Percentile	Score
P1	56.57	P4	61.51
P2	59.61	P5	62.46
P3	60.56	P6	63.40

1 Garrett, H.E., Op.Cit., p.65.

Percentile	Score	Percentile	Score
P7	64.35	P32	75.18
P8	65.01	P33	75.44
P9	65.61	P34	75.70
P10	66.22	P35	75.96
P11	66.82	P36	76.22
P12	67.42	P37	76.48
P13	68.03	P38	76.74
P14	68.63	P39	77.00
P15	69.23	P40	77.26
P16	69.70	P41	77.52
P17	70.06	P42	77.78
P18	70.42	P43	78.04
P19	70.78	P44	78.30
P20	71.14	P45	78.56
P21	71.49	P46	78.82
P22	71.85	P47	79.08
P23	72.21	P48	79.35
P24	72.57	P49	79.59
P25	72.93	P50	79.80
P26	73.29	P51	80.01
P27	73.65	P52	80.22
P28	74.01	P53	80.43
P29	74.37	P54	80.64
P30	74.66	P55	80.85
P31	74.92	P56	81.06

Percentile	Score	Percentile	Score
P57	81.27	P81	87.38
P58	81.48	P82	87.71
P59	81.70	P83	88.05
P60	81.91	P84	88.38
P61	82.12	P85	88.71
P62	82.33	P86	89.04
P63	82.54	P87	89.37
P64	82.75	P88	89.86
P65	82.96	P89	90.45
P66	83.17	P90	91.04
P67	83.38	P91	91.63
P68	83.59	P92	92.22
P69	83.80	P93	92.81
P70	84.01	P94	93.40
P71	84.22	P95	93.99
P72	84.44	P96	94.74
P73	84.73	P97	96.40
P74	85.06	P98	98.06
P75	85.39	P99	100.19
P76	85.72	-	-
P77	86.05		
P78	86.39		
P79	86.72		
P80	87.05		

PERCENTILE RANKS

The percentile ranks corresponding to the raw-scores obtained were also calculated. The procedure suggested by Garrett[1] for computing percentile ranks was followed. The percentile ranks corresponding to each raw score are given in table No. 90.

TABLE NO. 90

PERCENTILE RANKS

Raw scores	Percentile Ranks	Raw scores	Percentile Ranks
1	-	15	-
2	-	16	-
3	-	17	-
4	-	18	-
5	-	19	-
6	-	20	-
7	-	21	-
8	-	22	-
9	-	23	-
10	-	24	-
11	-	25	-
12	-	26	-
13	-	27	-
14	-	28	-

1 Garrett, H. E., Op.Cit., pp. 67-68.

Raw scores	Percentile Ranks	Raw scores	Percentile Ranks
29	-	53	0.26414
30	-	54	0.33961
31	-	55	0.52830
32	-	56	0.83019
33	-	57	1.13208
34	-	58	1.43397
35	-	59	1.73586
36	-	60	2.41509
37	-	61	3.47169
38	-	62	4.52829
39	-	63	5.58489
40	-	64	6.64149
41	-	65	8.00000
42	-	66	9.66038
43	-	67	11.32076
44	-	68	12.98114
45	-	69	14.64152
46	-	70	16.86791
47	-	71	19.66036
48	-	72	22.45281
49	-	73	25.24526
50	0.03773	74	28.03771
51	0.11320	75	31.35849
52	0.18867	76	35.20755

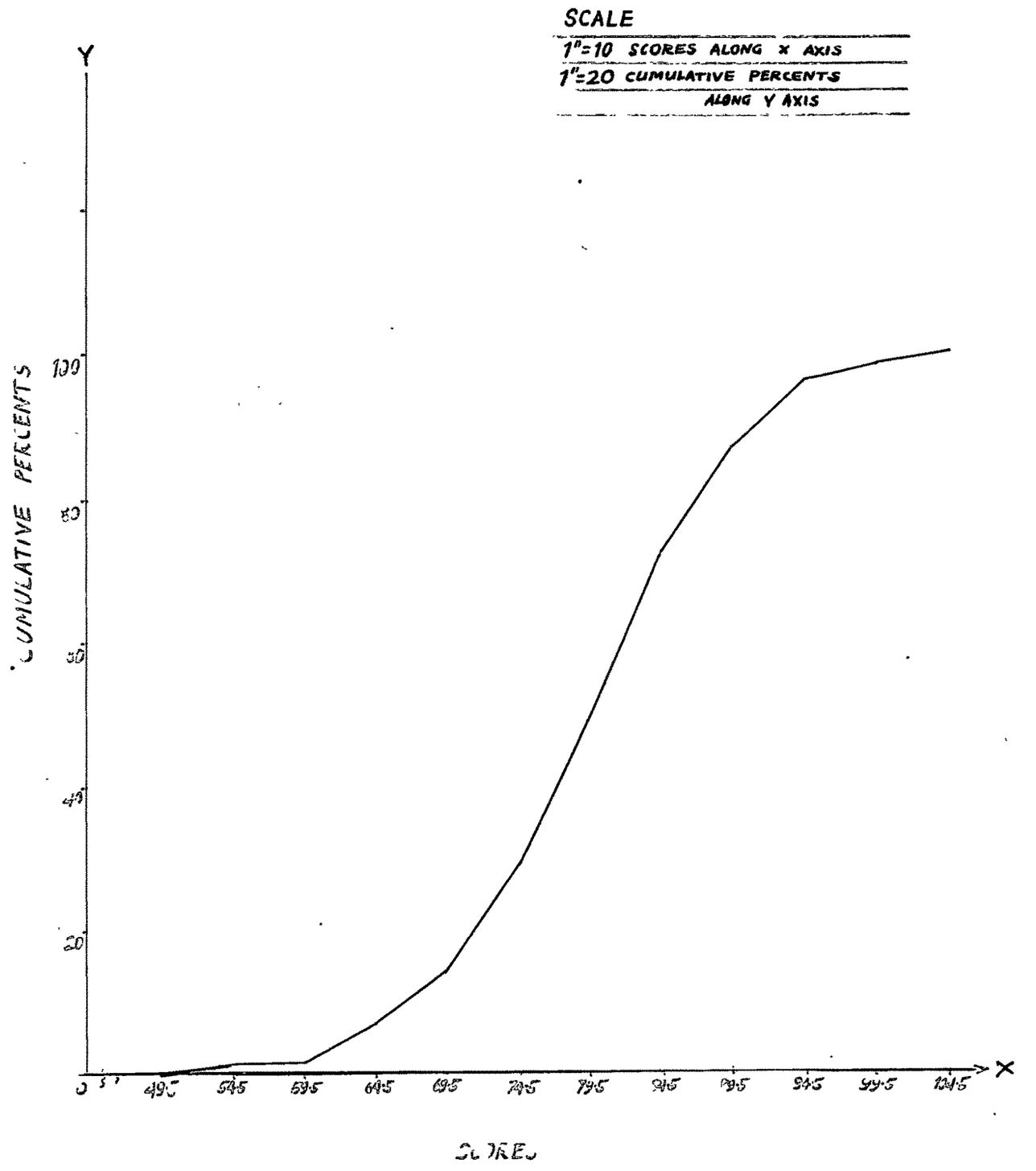
Raw Scores	Percentile Ranks	Raw scores	Percentile Ranks
77	39.05661	102	99.52828
78	42.90567	103	99.71696
79	46.75473	104	99.90564
80	51.05659	105	-
81	55.81131	106	-
82	60.56603	107	-
83	65.32075	108	-
84	70.07547	109	-
85	73.96224		
86	76.98111	110	-
87	79.99998	111	-
88	83.01885	112	-
89	86.03772	113	-
90	88.39620	114	-
91	90.09431	115	-
92	91.79242	116	-
93	93.49053	117	-
94	95.18864	118	-
95	96.33959	119	-
96	96.94336	120	-
97	97.54713	121	-
98	98.15090	122	-
99	98.75467	123	-
100	99.15092	124	-
101	99.33960	125	-

Raw scores	Percentile Ranks	Raw scores	Percentile Ranks
126	-	130	-
127	-	131	-
128	-	132	-
129	-		

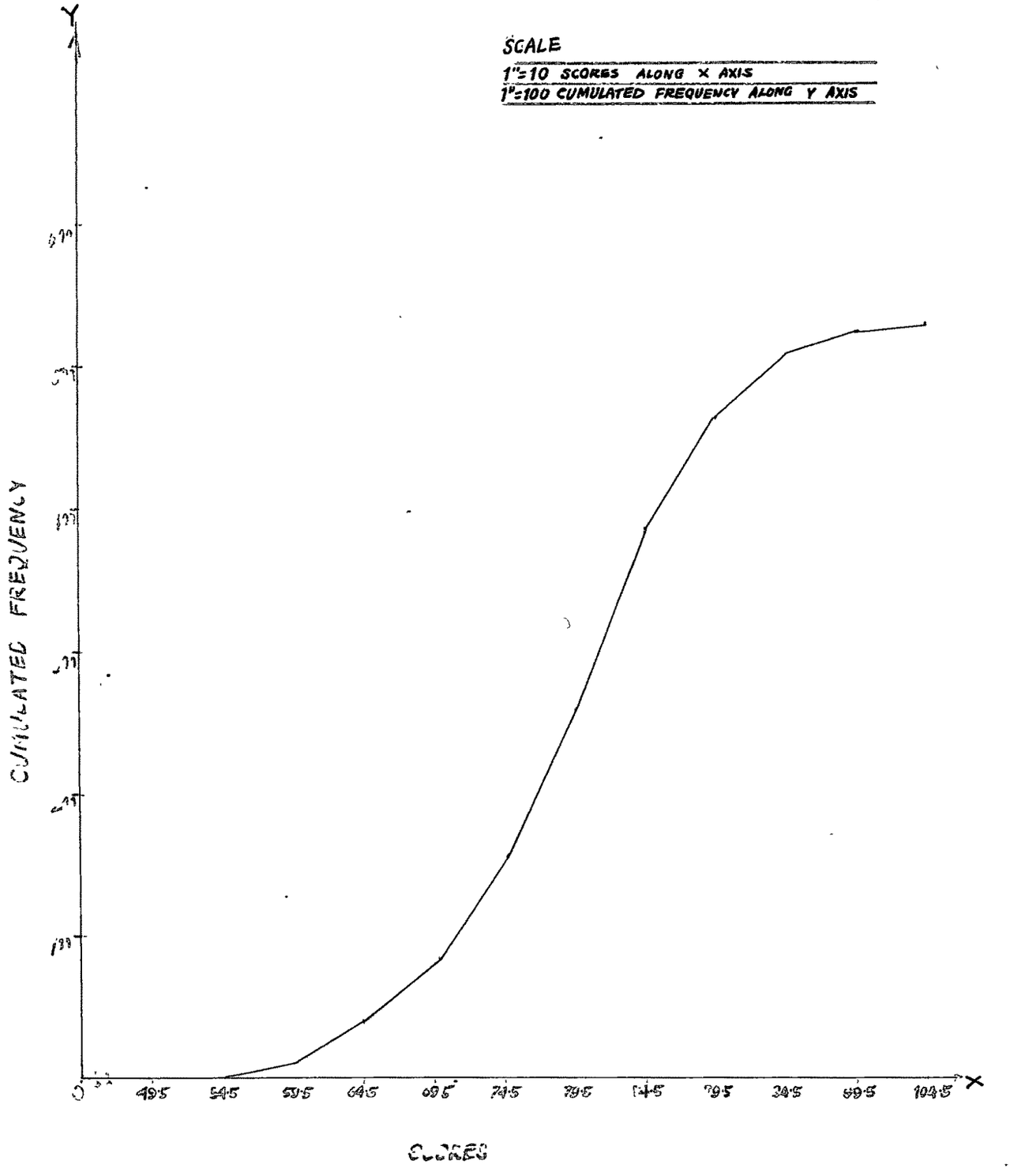
Percentiles and percentile ranks can be read directly from a cumulative percentage curve. This is an S-shaped curve. As it has a standardised height, it is called an ogive also. Two ogives are much more readily compared than two ordinary cumulative curves because of their common height. The nature of the curve testifies also to the normality of distribution of the test scores. The ogive is shown on page No. 422 of this chapter.

A cumulative frequency graph is also drawn. This is shown on page No. 423 of this chapter.

The data from which the two graphs were drawn are given in the table on the next page.



CUMULATIVE PERCENTAGE CURVE (OR OGIVE)



CUMULATIVE FREQUENCY GRAPH

TABLE NO. 91

CUMULATIVE AND CUMULATIVE PERCENT FREQUENCIES

(1) Scores	(2) f	(3) Cum.f.	(4) Cum.Percent. f.
100 - 104	5	530	100.00
95 - 99	16	525	99.10
90 - 94	45	509	96.00
85 - 89	80	464	87.50
80 - 84	126	384	72.50
75 - 79	102	258	48.70
70 - 74	74	156	29.40
65 - 69	44	82	15.50
60 - 64	28	38	7.20
55 - 59	8	10	1.90
50 - 54	2	2	0.40
N = 530			

M = 79.09

Mdn = 79.778

SD = 9.27

LETTER GRADES

The testees can be assigned letter grades in accordance with the raw scores they obtain on the test. It is shown earlier that the distribution of the test-scores is very nearly normal. The testees were grouped into seven different

grades; viz. A, B, C^+, C, C^-, D & E. For doing this, the base line of the normal curve was divided into seven equal parts, ($6\sigma \div 7 = 0.86\sigma$) each part being equal to 0.86σ unit. Then the limits of the raw scores and also of the standard scores for different letter grades were marked off. These limits are shown in table No. 92. The graphical representation of the same is given on page No. 426.

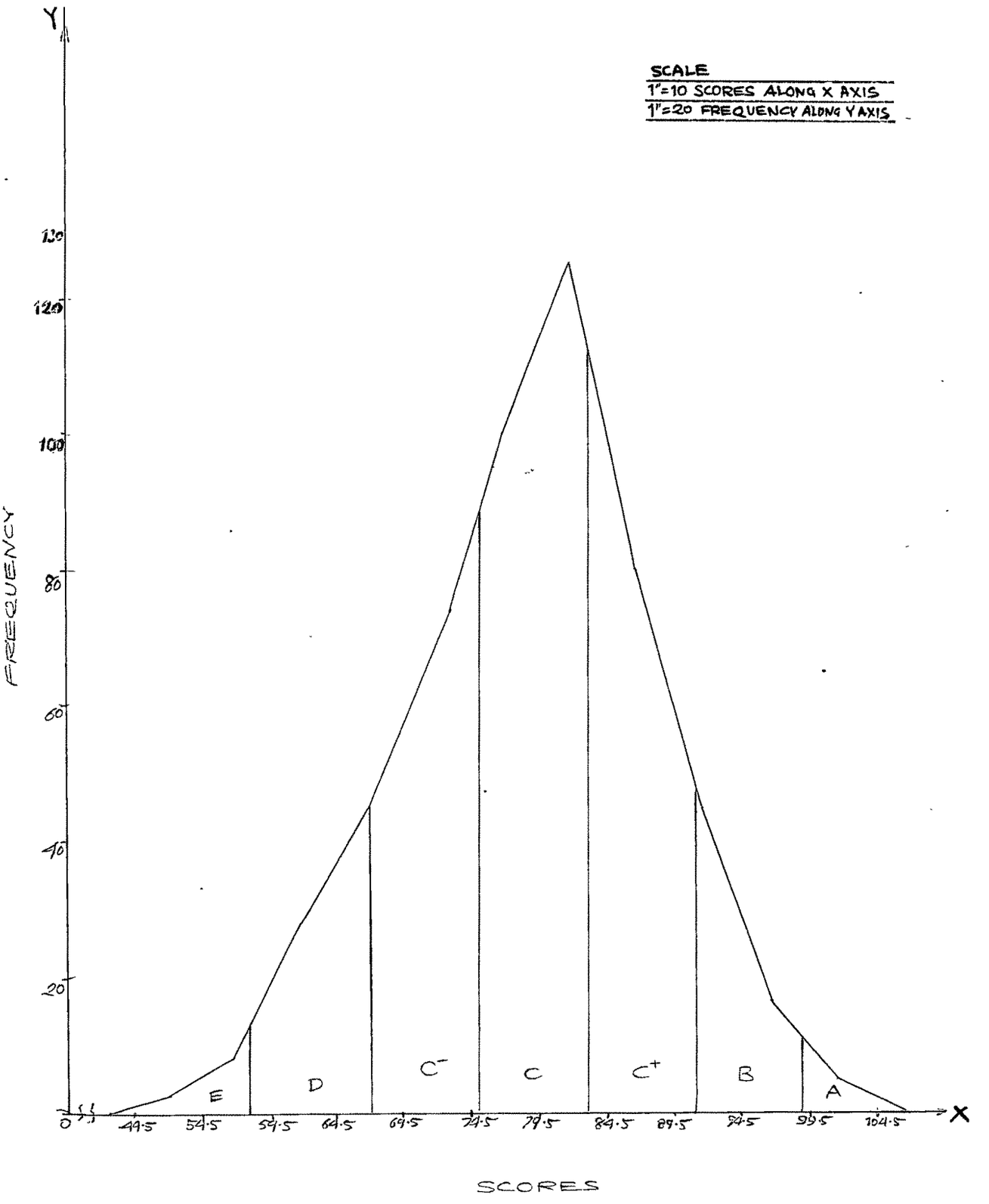
TABLE NO. 92

ASSIGNING LETTER GRADES TO SCORES

Letter grades	Limits in terms of σ- units	Limits in terms of raw scores	Limits in terms of standard scores M = 50, σ = 10
A	M + 2.15 σ and above	99 & above	72 & above
B	between M +1.29 σ & M + 2.15 σ	between 91 and 98	between 63 and 71
C^+	between M+0.43 σ & M + 1.29 σ	between 83 and 90	between 54 and 62
C	between M-0.43 σ & M + 0.43 σ	between 75 and 82	between 46 and 53
C^-	between M-1.29 σ & M - 0.43 σ	between 67 and 74	between 37 and 45
D	between M-2.15 σ & M - 1.29 σ	between 59 and 66	between 28 and 36
E	M - 2.15 σ & below	58 and below	27 and below

USING THE TEST NORMS

The norms established through the present study may



SCHEMATIC REPRESENTATION OF THE GRADE ASSIGNMENT

be applied in comparing the performance of any other testee selected from the population described earlier on the present aptitude test. He can be easily placed in a particular grade and from this it can be judged how far he will be successful in the profession. The multiple-regression equation derived in chapter XII, will help the user of the test in predicting the testee's criterion score. This gives some idea as to the testee's aptitude for teaching. The norms established here together with the predicting formula established in this study will help to a reasonable extent in screening out the teachers who really possess aptitude for teaching.

The test norms will be mainly useful in selecting prospective teachers for training. As there is a great dearth of trained teachers in this country, the schools are required to employ untrained teachers also. Such school-authorities may profitably use the test in appointing the teachers who have aptitude for teaching and therefore, who are most likely to be successful teachers after they have received necessary training.

The test will be useful for vocational guidance also. If a fresh graduate takes the test and if it is found out through the test result that he possesses a good deal of aptitude for teaching, he may be advised to take up the teaching profession.