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A Study to Show the Correlation between Students' S.R.A. Math Scores and their Ability to Accurately Employ a Measuring Scale and Math Functions on Practical Problems

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A study to show the correlation between students' S.R.A. math scores and their ability to accurately employ a measuring scale and math functions on practical problems.

RESEARCH REPORT

Presented to the Graduate Council of
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by
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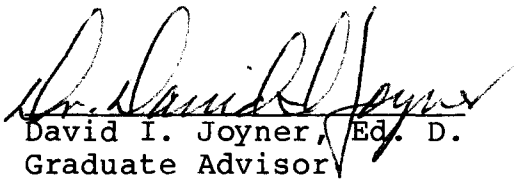
Approved, May 1983



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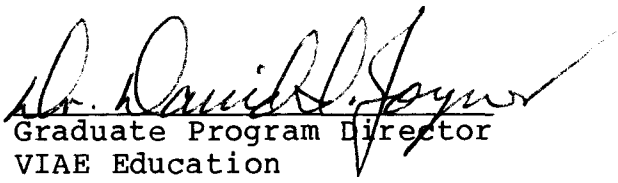

Graduate Program Director
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Chapter 1

INTRODUCTION

STATEMENT OF THE PROBLEM

The problem of this study was to examine the correlation between mathematical knowledge and mathematical measurement skills. While students are taught math skills from grade four onward, many are unable to practically apply this knowledge to the area of measurement. Is the task of measurement ability related to lack of mathematical knowledge?

PURPOSE OF THE STUDY

The purpose of this study was to make a correlation between written or oral math functions (addition, subtraction, multiplication, and division of whole numbers and fractions) to which students were introduced to in the primary grades and formally tested on in the eighth grade by the S.R.A. (1) test battery, and their ability to use their knowledge on a practical level involving the use of measuring scales to accurately determine distances between two points or the length of line segments.

RESEARCH QUESTIONS

The basic questions under study in this thesis are:

1. Can students who have mastered mathematical theories and concepts apply this knowledge in practical situations?

2. Is the use of a measuring instrument such as a standard 12 inch ruler subdivided into inches and 1/16 inch increments a more difficult operation than has previously been supposed?

3. Does mastery of mathematical concepts ensure measurement skills?

BACKGROUND AND SIGNIFICANCE OF THE STUDY

It is well known to most Vocational and Industrial Arts Education teachers that most students entering their courses lack the ability to read a measuring scale accurately. In some cases the student has no knowledge of measuring whatsoever. This problem apparently has plagued teachers since public education began offering Vocational or Industrial Arts courses. Most teachers are required to spend several weeks of class time teaching the basic skills of measuring before they are able to begin teaching the course work that they are supposed to present. The problem is present and definitely real, as can be attested to by most Vocational or Industrial Arts teachers.

After spending many hours researching this problem, I have been unable to find any published studies of this problem. A computer search by the university's library has yielded nothing in the form of a related study at this point in time.

It is possible that no one has pursued this problem even though its existence has long been known. I am assuming that this is the case and am considering this study to be original.

DEFINITION OF TERMS

Math scores used in this study will be taken from the S.R.A. test that is administered in the 8th grade and the scores from the researcher's test instrument.

The measuring scale for this study will be a standard wooden 12 inch ruler with inch divisions and subdivisions of 1/16th inch. All rulers will be of the type generally used by the school system and will be previously unused to ensure that each end or starting point has not been damaged and are as consistent as manufacturer's tolerance allows.

Mathematics and mathematical functions means that the student is aware of, and understands, the Arabic numbering system and can perform the functions of addition, subtraction, multiplication, and division with both whole numbers and fractional parts of the whole numbers containing both numerators and denominators that are greater than "0", but not more than "16".

S.R.A. test math scores will be taken from the Achievement Series: Science Research Associated, Inc., Red Level - Grades 8-9.

LIMITATIONS OF THE STUDY

Since this study involves the use of measuring instruments, problems of manual dexterity, eye-hand coordination, optical resolution, and the physical maturation of the students will provide definite limitations to the accuracy of the test scores. Such factors as short people sitting in normal sized desks provide problems in that they place their eyes too close to the scale to obtain proper focus and resolution for maximum accuracy.

It is also noted that a large percentage of students do not realize the "zero" point in a numbering system, and that this can cause inaccuracies because they fail to start measuring with the end of a rule or other calibrated measuring device.

The test instrument will be printed on a high quality offset printing press in an effort to minimize distortions or inaccuracies inherent in some types of duplicated equipment, but even then problems of obtaining 100% $\pm$ 0 reproduction size are present.

BASIC ASSUMPTIONS

1. Since this study questions the correlation of basic math skills and the practical application of these skills,

it is assumed that those students who have scored well on achievement tests will not necessarily score well on the practical application test.

2. It is also assumed that the results of this study will show that students are not adequately taught practical applications of math theories.

3. This study also assumes that there are problems involved in teaching measurement skills that have not been fully identified and realized by most teachers.

PROCEDURES FOR COLLECTING DATA

Math scores will be collected from the S.R.A. test scores that are on file in each student's folder. Since the eighth grade students took these tests in April of 1982, the information will be only one school year old and easily accessible.

A commercially produced measuring instrument will be used to cover the practical application section of this research study and will be administered to the students during their mathematics classes. Since all ninth grade students are required to take a general mathematics course, this will ensure a random selection of participants and in no way reflect their race, sex, socioeconomic level, or course of study. Since there are three level groupings in each course, one class of each level will be picked to further ensure a random sampling.

CHAPTER BIBLIOGRAPHY

1. Buros, Oscar Krisen, "Achievement Series: S.R.A. Assessment Survey, Multilevel Edition - Red Level - Grades 8-9." The Eighth Mental Measurements Yearbook, Vol. I, Highland Park, New Jersey, The Gryphon Press, 1978.

CHAPTER 2

REVIEW OF RELATED LITERATURE

The research done in order to write this chapter has proven to be negative as far as related material is concerned. Only material that involved testing using some type of measuring device was studied. No results were found that were even remotely related to the problem that this study deals with.

The following is a list of reference sources that were examined in depth either manually and/or by computer search:

1. Education Research Information Center (ERIC). This source was searched both manually and by the university's library computer using every descriptor and identifier that even remotely related. No correlation or resemblance was found.

2. Research Library at Old Dominion University - found nothing related/suitable.

3. Journal of Educational Measurement. Every article in Volumes 1-14 (1964-1977) was studied with no results.

4. School Shop Magazine. Volumes 34 through 40, covering from July, 1974, through November, 1980, were searched. No results.

5. Psychological Testing, Fourth Edition. By Anne Anastasi, MacMillan Publishing Company, Inc. No results.

6. Mental Measurements Yearbook. The Third through the Seventh Editions were searched. Edited by Oscar Krisen Buros, The Gryphon Press, Highland Park, New Jersey. No results.

The following people were questioned about the possibility of having either used or having knowledge of any study, test, or related information pertaining to the problem of this study:

1. Gibbs, William F., M.D., practicing psychiatrist. No results obtained.

2. Holmes, James H., M.D., practicing psychiatrist and psychiatric test evaluator. No results obtained.

3. Chapunoff, Marcos, M.D., child psychiatrist. No results.

4. Called psychological services at U. S. Naval Hospital for information. No results.

5. Called Job Corps - Mid-City Shopping Center. No results.

CHAPTER 3

METHODS AND PROCEDURES

This chapter discusses criteria for the selection of subjects and the manner in which they were selected. It also shows how the material was handled and correlated.

TARGET POPULATION

The subjects sampled in this study were selected from the ninth grade mathematics classes at Churchland High School. This group was chosen because all of these students had taken the S.R.A. test battery in April of the previous school year.

SELECTION OF SUBJECTS

Students from the ninth grade mathematic classes were accepted as study subjects only if they all took the same math courses and if none were taking an Industrial Arts class. The objective was to standardize the subjects while still surveying a random sample of all students enrolled in the ninth grade at Churchland High School.

CONDITIONS OF DATA COLLECTION

Prior to the collection of any data, permission was obtained from Mr. J. R. Glisson, principal of Churchland Junior High School, to use the S.R.A. math scores and to give the subjects a practical test during their regular mathematics class. The practical test instrument was administered by the class's own mathematics teacher so that anxiety caused by a new person in the classroom would be eliminated. The test was administered to the students on a Wednesday, as this seems to be the day that more students are present and their activities are more "normal".

MEASURING INSTRUMENTS

1. Measures of Central Tendency

   a. Mean $\overline{x} = \frac{\Sigma x}{N}$

   where: $\overline{x}$ = the mean
   Σ = the sum of
   x = each of the values in the distribution
   N = number of cases

   b. Mode - determined by inspection alone - see frequency polygon.

   c. Median - $Md = L + \left(\frac{N/2 - fb}{fw}\right) i$

where:

Md = the median
N = the number of cases in the distribution
L = the lower limit of the interval within which the median lies
fb = the total frequency in all intervals below the interval containing the median
fw = the frequency of cases within the interval containing the median
i = interval size

2. Measures of Variability

a. Range - unreliable index of variability

b. Quartile Deviation

$$Q_1 = L + \left(\frac{N/4 - fb}{fw}\right) i$$

$$Q_3 = L + \left(\frac{3N/4 - fb}{fw}\right) i$$

where:

Q_3 = the upper quartile
Q_1 = the lower quartile
N = the number of cases in the distribution
L = the lower limit of the interval containing the quartile
fb = the frequency below the interval containing the quartile
fw = the frequency of cases within the interval containing the quartile
i = the interval size

c. Standard Deviation

$$\sigma = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{N}}{N}}$$

where:

σ = the standard deviation
Σx^2 = sum of the square of each score
$(\Sigma x)^2$ = sum of the scores squared
N = the number of cases

3. Correlation Relationships

a. Pearson Product Moment Correlation

$$r = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{N}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right]\left[\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right]}}$$

where:

r = Pearson r
Σx = sum of the scores in the x distribution
Σy_2 = sum of the scores in the y distribution
Σx^2 = sum of the squared scores in the x distribution
Σy^2 = sum of the squared scores in the y distribution
Σxy = sum of the product of the paired x and y scores
N = the number of paired x and y scores (subjects)

b. Spearman rho rank difference correlation coefficient

$$P = 1 - \frac{6 \Sigma D^2}{N(N^2 - 1)}$$

where:
P = the Spearman correlation
D = difference between ranks
N = number of cases involved

SUMMARY

This chapter describes the target population as being those students who have attended Churchland Junior High School during the school year 1981-82, have taken the mathematical section of the S.R.A. test, and are now taking general mathematics in the ninth grade at Churchland High School.

The chapter also describes the statistical methods used to determine if a significant degree of correlation exists between the S.R.A. mathematics test scores and the scores from a separate test instrument.

CHAPTER 4

RESEARCH FINDINGS

This study was designed to determine the relationship between students' S.R.A. math test scores and their ability to accurately employ a measuring scale and math function on practical problems.

The data used for this study were derived from the students' S.R.A. total math scores, their total measurement test score, and the score they made on the practical applications section of the measurement test. This provides three sets of data to be correlated and compared.

The students that participated in the study were randomly picked and comprise 14.7 percent of the total class population (50 out of 340).

Table 1, this chapter, gives a summary of the findings made during the course of this study.

TABLE 1

Summary of Information Found

1. Measures of Central Tendency

		(x) S.R.A.	(y) Total Measurement	(z) Practical Applications
a.	Mean	50	77	58
b.	Mode	61	94	94
c.	Median	47	76	62
2.	Measures of Variability			
a.	Range	97	49	100
b.	Quartile Deviation			
	Q_1	33	69	34
	Q_3	66	90	82
	QD	17	11	24
c.	Standard Deviation	23.5	13.7	28.6

3. Correlations Relationships

a. Pearson Product Moment Correlation. See Tables 3, 3A, 3B. Appendix A, page 25.

xy +.6 xz +.64 yz +.9

b. Spearman rho rank difference correlation coefficent. See Tables 4, 4A, 4B. Appendix A, page 31.

xy +.62 xz +.65 yz +.9

The findings which seem to be most central are as follows:

1. Forty-four of the 50 students who took the measurement test performed worse on the practical section than on the conceptual portion. Eighty-eight percent fell when faced with using the ruler.

2. Of the students with less than 90 percent on total measurement test, 34/36 students' scores were lower on the practical section than on the conceptual portion.

3. Of the 14 students with scores above 90 percent on the total measurement test, ten scored lower on the practical questions; yet they rarely fell more than 5 percent.

4. Of those with the top 10 S.R.A scores (over 80th percentile), only one scored lower than 85 percent on the measurement test.

5. The correlation between the S.R.A. scores of pure math knowledge/ability and the measurement scores are fairly random.

CHAPTER FIVE

SUMMARY, CONCLUSION, AND RECOMMENDATIONS

Summary

The research findings prove the thesis of this paper--that students are poor at using a physical, practical measurement device, although they may understand the mathematical concepts involved in the process. Nearly all students (88 percent) are worse at the practical side. The better S.R.A. and total measurement students are still better when dealing with the practical use of the ruler, but the poorest students are completely incompetent.

Conclusion

The conclusions which can be drawn from the data are that (1) students who understand math may or may not understand measurement in general. (2) Students who understand measurement concepts seem to do quite well on the practical aspects of these skills. (3) Students who do not show mastery of the mathematical and measurement skills are very poor on the practical skills.

The conclusion which is most glaring, which is not crucial to this study, and which totally supports the thesis, however, is that students are poor at physically

utilizing the physical item provided, a ruler. Virtually nine of every ten students were worse at physically using the instrument.

Recommendations

There are numerous ramifications to be dealt with from these findings.

1. Education courses preparing math and industrial arts teachers should make the future educators aware of this problem.

2. Inservice programs and city-wide departmental meetings should stress this problem--both in mathematics and industrial arts--for the current teachers.

3. Obviously students in the grades leading to 8th and 9th grade industrial arts courses need to be given practical applications practice in their math classes.

4. Industrial arts courses of study should include a "review of basics" section. Otherwise they are not realistically dealing with a very real problem. In short, the curriculum of most schools and school systems needs to be altered to deal with this problem, either in their mathematics or industrial arts departments.

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BIBLIOGRAPHY

Isaac, Stephen, Handbook in Research and Evaluation, San Diego, California, Edits Publishers, 1980.

Turney, Billy, and Robb, George, Research in Education: An Introduction, Hindsdale, Ill., The Dryden Press, 1971.

Bunin, David, "Correlation Between Intelligence and Proficiency in a Trade Skill," unpublished master's thesis, Old Dominion University, 1978.

APPENDICES

TABLE 1

CHART OF TEST SCORES

S.R.A. (Total Math) Percentile
Measurement Test Score

Student Number	S.R.A. Total Math Percentile	Total Measurement Test Score	Practical Application Section Only
1	61	97	100
2	55	51	0
3	42	54	28
4	73	92	94
5	13	54	0
6	61	74	67
7	34	62	33
8	43	77	39
9	21	57	11
10	61	86	67
11	41	72	28
12	19	77	61
13	32	71	50
14	30	95	94
15	50	63	45
16	48	69	33
17	32	71	45
18	34	72	67
19	37	48	17
20	41	80	89
21	61	77	67
22	21	60	11
23	73	83	50
24	46	69	50
25	37	60	33

TABLE 1 CONTINUED

Student Number	S.R.A. Total Math Percentile	Total Measurement Test Score	Practical Application Section Only
26	13	59	22
27	48	71	39
28	1	65	28
29	46	86	72
30	7	83	61
31	72	86	61
32	60	74	39
33	65	82	72
34	95	74	72
35	77	88	94
36	79	94	94
37	64	94	89
38	59	95	94
39	67	94	83
40	94	97	100
41	48	94	78
42	69	91	89
43	60	92	94
44	94	95	89
45	85	94	83
46	98	91	89
47	26	71	22
48	24	79	44
49	45	82	50
50	37	68	39

TABLE 2

FREQUENCY POLYGON

S.R.A. Score (Total Math)

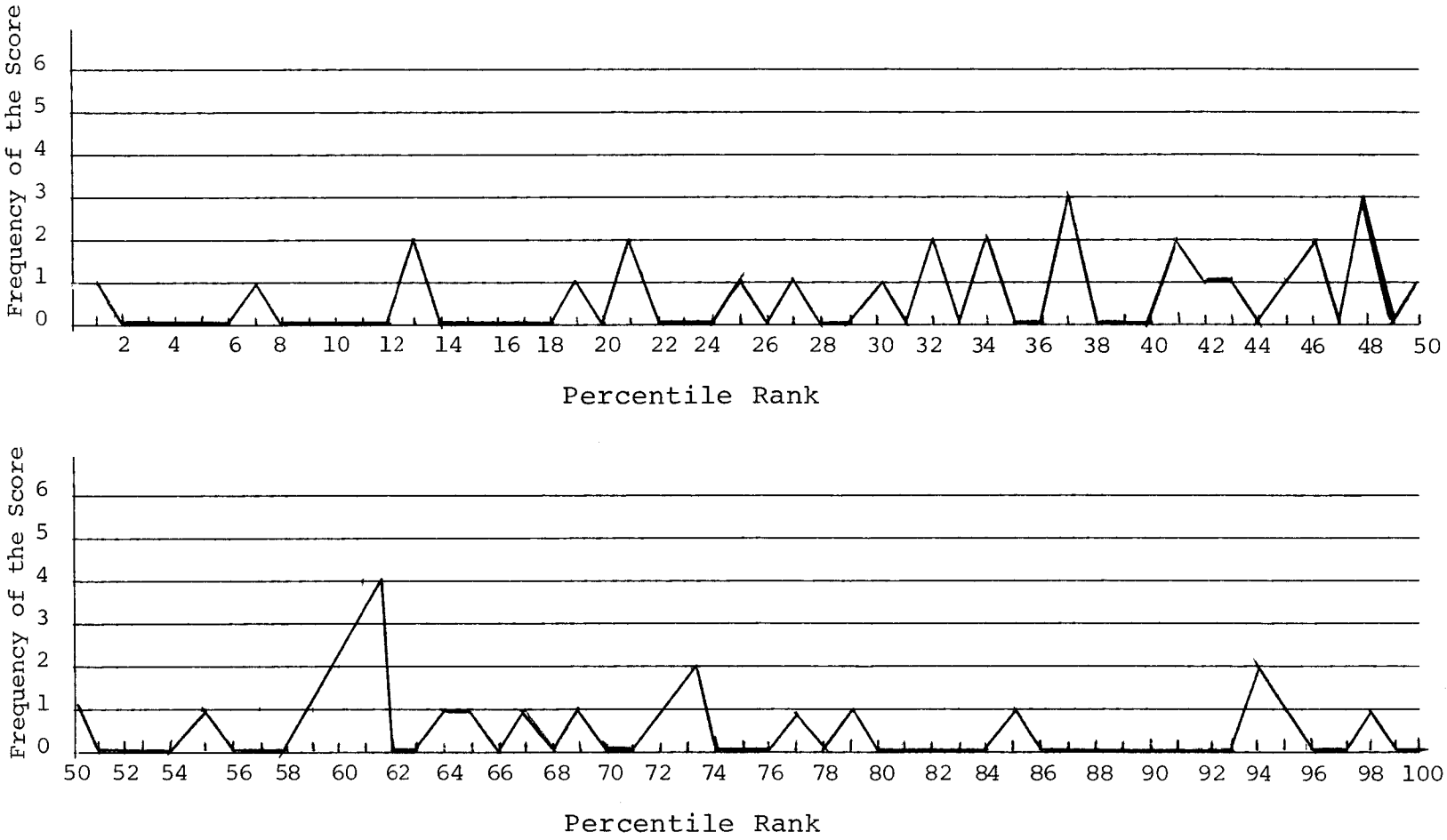


TABLE 2A

FREQUENCY POLYGON

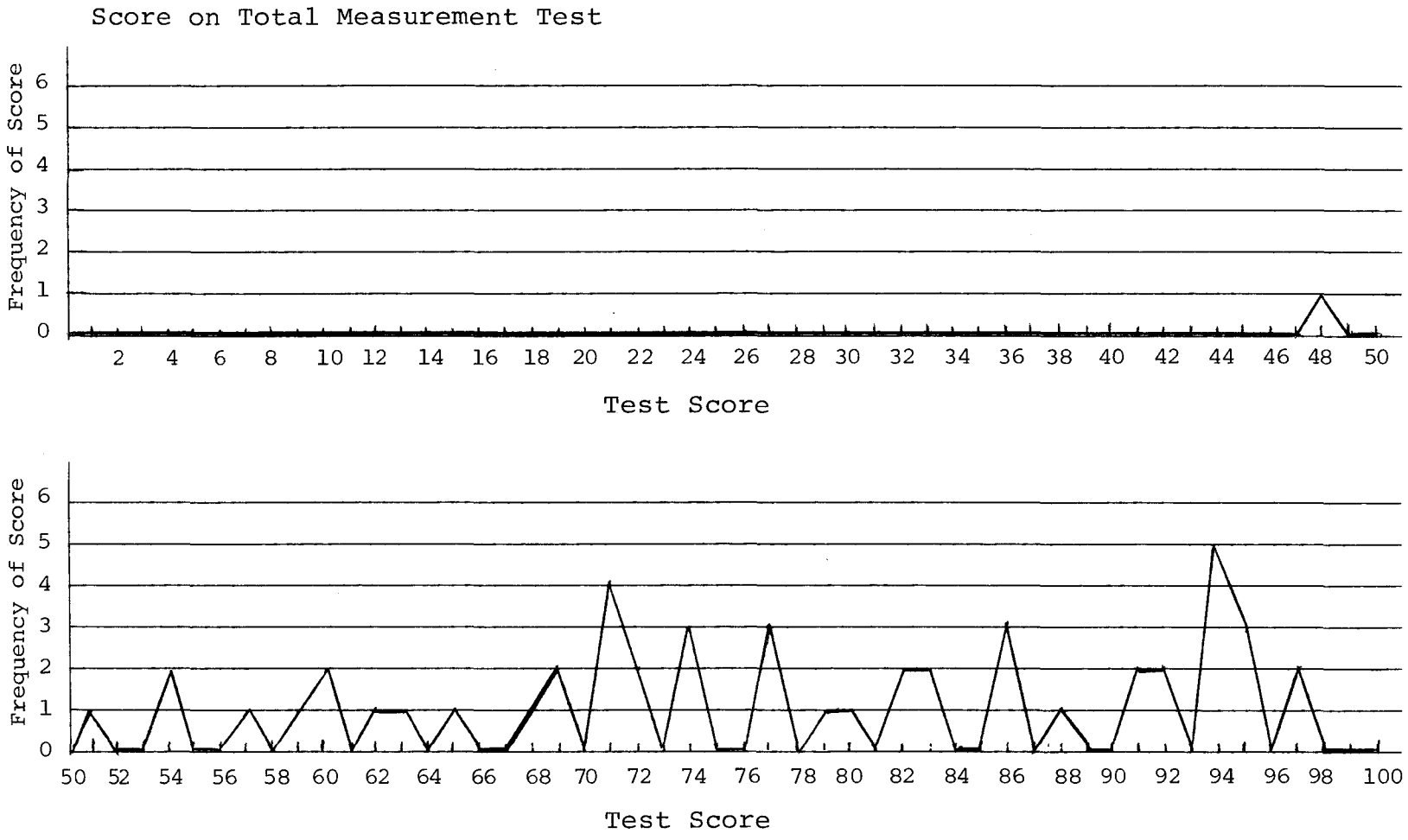
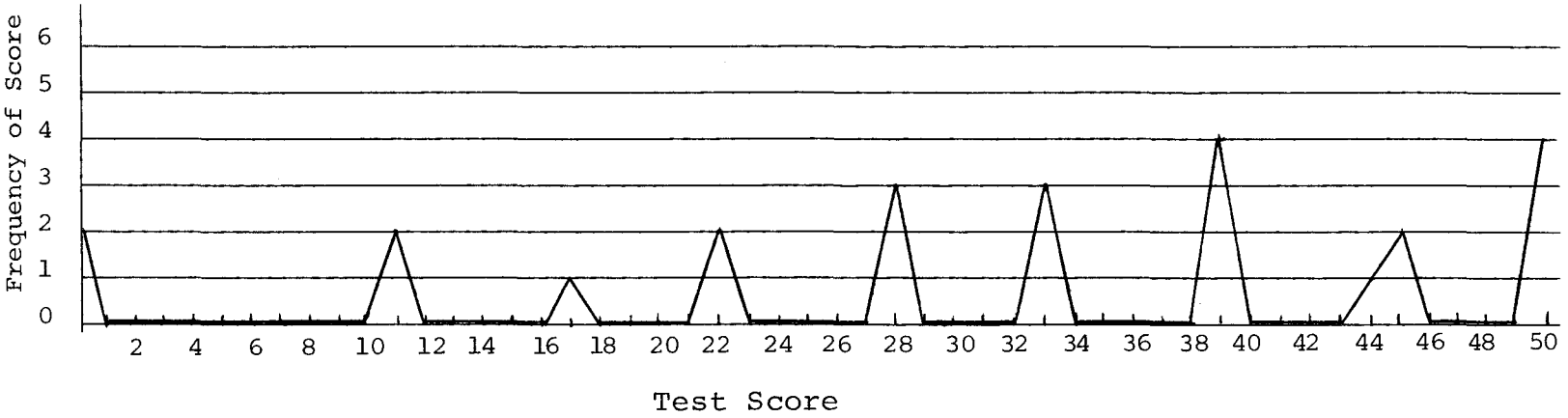


TABLE 2B

FREQUENCY POLYGON

Score on Practical Application Section of Measurement Test



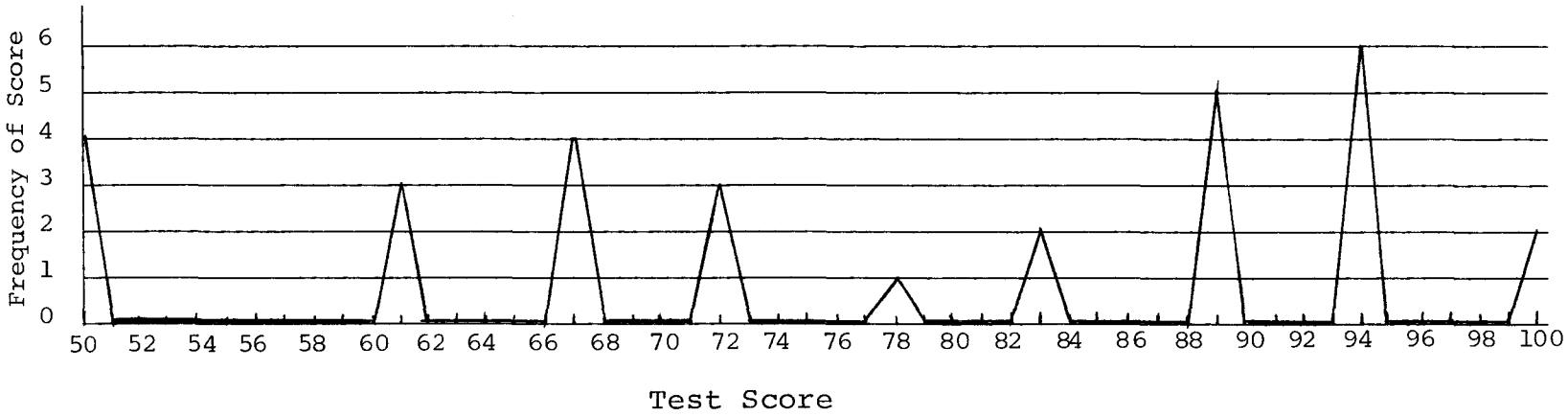


TABLE 3

STANDARD DEVIATION

S.R.A. (Total Math)

Student Number	S.R.A Total Math x	x^2
1	61	3,721
2	55	3,025
3	42	1,764
4	73	5,329
5	13	169
6	61	3,721
7	34	1,156
8	43	1,849
9	21	441
10	61	3,721
11	41	1,681
12	19	361
13	32	1,024
14	30	900
15	50	2,500
16	48	2,304
17	32	1,024
18	34	1,156
19	37	1,369
20	41	1,681
21	61	3,721
22	21	441
23	73	5,329
24	46	2,116
25	37	1,369

TABLE 3 CONTINUED

Student Number	S.R.A Total Math x	x^2
26	13	169
27	48	2,304
28	1	1
29	46	2,116
30	7	49
31	72	5,184
32	60	3,600
33	65	4,225
34	95	9,025
35	77	5,929
36	79	6,241
37	64	4,096
38	59	3,481
39	67	4,489
40	94	8,836
41	48	2,304
42	69	4,761
43	60	3,600
44	94	8,836
45	85	7,225
46	98	9,604
47	26	676
48	24	576
49	45	2,025
50	37	1,369
Totals	2,499	152,593

$$\sigma = \sqrt{\frac{\Sigma x^2 - \frac{(\Sigma x)^2}{N}}{N}} \sim 23.5$$

TABLE 3A

STANDARD DEVIATION

Measurement Test

Student Number	Measurement Test Scores y	y^2
1	97	9,409
2	51	2,601
3	54	2,916
4	92	8,464
5	54	2,916
6	74	5,476
7	62	3,844
8	77	5,929
9	57	3,249
10	86	7,396
11	72	5,184
12	77	5,929
13	71	5,041
14	95	9,025
15	63	3,969
16	69	4,761
17	71	5,041
18	72	5,184
19	48	2,304
20	80	6,400
21	77	5,929
22	60	3,600
23	83	6,889
24	69	4,761
25	60	3,600

TABLE 3A CONTINUED

Student Number	Measurement Test Scores y	y^2
26	59	3,481
27	71	5,041
28	65	4,225
29	86	7,396
30	83	6,889
31	86	7,396
32	74	5,476
33	82	6,724
34	74	5,476
35	88	7,744
36	94	8,836
37	94	8,836
38	95	9,025
39	94	8,836
40	97	9,409
41	94	8,836
42	91	8,281
43	92	8,464
44	95	9,025
45	94	8,836
46	91	8,281
47	71	5,041
48	79	6,241
49	82	6,724
50	68	4,624
Totals	3,870	308,960

$$\sigma = \sqrt{\frac{\Sigma y^2 - \frac{(\Sigma y)^2}{N}}{N}} \sim \quad 13.7$$

TABLE 3B

STANDARD DEVIATION

Practical Application Section

Student Number	Practical Application z	z^2
1	100	10,000
2	0	0
3	28	784
4	94	8,836
5	0	0
6	67	4,489
7	33	1,089
8	39	1,521
9	11	121
10	67	4,489
11	28	784
12	61	3,721
13	50	2,500
14	94	8,836
15	45	2,025
16	33	1,089
17	45	2,025
18	67	4,489
19	17	289
20	89	7,921
21	67	4,489
22	11	121
23	50	2,500
24	50	2,500
25	33	1,089

TABLE 3B CONTINUED

Student Number	Practical Application z	z^2
26	22	484
27	39	1,521
28	28	784
29	72	5,184
30	61	3,721
31	61	3,721
32	39	1,521
33	72	5,184
34	72	5,184
35	94	8,836
36	94	8,836
37	89	7,921
38	94	8,836
39	83	6,889
40	100	10,000
41	78	6,084
42	89	7,921
43	94	8,836
44	89	7,921
45	83	6,889
46	89	7,921
47	22	484
48	44	1,936
49	50	2,500
50	39	1,521
Totals	2,876	206,342

$$\sigma = \sqrt{\frac{\Sigma z^2 - \frac{(\Sigma z)^2}{N}}{N}} \sim 28.6$$

TABLE 4

PRODUCT MOMENT CORRELATION (PEARSON r)

S.R.A. (Total Math Scores) - x
Measurement Test - y

Student Number	x	y	x^2	y^2	xy
1	61	97	3,721	9,409	5,917
2	55	51	3,025	2,601	2,805
3	42	54	1,764	2,916	2,268
4	73	92	5,329	8,464	6,716
5	13	54	169	2,916	702
6	61	74	3,721	5,476	4,514
7	34	62	1,156	3,844	2,108
8	43	77	1,849	5,929	3,311
9	21	57	441	3,249	1,197
10	61	86	3,721	7,396	5,246
11	41	72	1,681	5,184	2,952
12	19	77	361	5,929	1,463
13	32	71	1,024	5,041	2,272
14	30	95	900	9,025	2,850
15	50	63	2,500	3,969	3,150
16	48	69	2,304	4,761	3,312
17	32	71	1,024	5,041	2,272
18	34	72	1,156	5,184	2,448
19	37	48	1,369	2,304	1,776
20	41	80	1,681	6,400	3,280
21	61	77	3,721	5,929	4,697
22	21	60	441	3,600	1,260
23	73	83	5,329	6,889	6,059
24	46	69	2,116	4,761	3,174
25	37	60	1,369	3,600	2,220
26	13	59	169	3,481	767
27	48	71	2,304	5,041	3,408
28	1	65	1	4,225	65
29	46	86	2,116	7,396	3,956
30	7	83	49	6,889	581
31	72	86	5,184	7,396	6,192
32	60	74	3,600	5,476	4,440

TABLE 4 CONTINUED

Student Number	x	y	x^2	y^2	xy
33	65	82	4,225	6,724	5,330
34	95	74	9,025	5,476	7,030
35	77	88	5,929	7,744	6,776
36	79	94	6,241	8,836	7,426
37	64	94	4,096	8,836	6,016
38	59	95	3,481	9,025	5,605
39	67	94	4,489	8,836	6,298
40	94	97	8,836	9,409	9,118
41	48	94	2,304	8,836	4,512
42	69	91	4,761	8,281	6,279
43	60	92	3,600	8,464	5,520
44	94	95	8,836	9,025	8,930
45	85	94	7,225	8,836	7,990
46	98	91	9,604	8,281	8,918
47	26	71	676	5,041	1,846
48	24	79	576	6,241	1,896
49	45	82	2,025	6,724	3,690
50	37	68	1,369	4,624	2,516
Totals	2,499	3,870	152,593	308,960	203,074

$$r = \frac{\Sigma xy - \frac{(\Sigma x)(\Sigma y)}{N}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right]\left[\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right]}} \sim +.6$$

TABLE 4A

PRODUCT MOMENT CORRELATION (PEARSON r)

S.R.A. (Total Math) - x
Practical Measurement - z

Student Number	x	z	x^2	z^2	xz
1	61	100	3,721	10,000	6,100
2	55	0	3,025	0	0
3	42	28	1,764	784	1,176
4	73	94	5,329	8,836	6,862
5	13	0	169	0	0
6	61	67	3,721	4,489	4,087
7	34	33	1,156	1,089	1,122
8	43	39	1,849	1,521	1,677
9	21	11	441	121	231
10	61	67	3,721	4,489	4,087
11	41	28	1,681	784	1,148
12	19	61	361	3,721	1,159
13	32	50	1,024	2,500	1,600
14	30	94	900	8,836	2,820
15	50	45	2,500	2,025	2,250
16	48	33	2,304	1,089	1,584
17	32	45	1,024	2,025	1,440
18	34	67	1,156	4,489	2,278
19	37	17	1,369	289	629
20	41	89	1,681	7,921	3,649
21	61	67	3,721	4,489	4,087
22	21	11	441	121	231
23	73	50	5,329	2,500	3,650
24	46	50	2,116	2,500	2,300
25	37	33	1,369	1,089	1,221
26	13	22	169	484	286
27	48	39	2,304	1,521	1,872
28	1	28	1	784	28
29	46	72	2,116	5,184	3,312
30	7	61	49	3,721	427
31	72	61	5,184	3,721	4,392
32	60	39	3,600	1,521	2,340

TABLE 4A CONTINUED

Student Number	x	z	x^2	z^2	xz
33	65	72	4,225	5,184	4,680
34	95	72	9,025	5,184	6,840
35	77	94	5,929	8,836	7,238
36	79	94	6,241	8,836	7,426
37	64	89	4,096	7,921	5,696
38	59	94	3,481	8,836	5,546
39	67	83	4,489	6,889	5,561
40	94	100	8,836	10,000	9,400
41	48	78	2,304	6,084	3,744
42	69	89	4,761	7,921	6,141
43	60	94	3,600	8,836	5,640
44	94	89	8,836	7,921	8,366
45	85	83	7,225	6,889	7,055
46	98	89	9,604	7,921	8,722
47	26	22	676	484	572
48	24	44	576	1,936	1,056
49	45	50	2,025	2,500	2,250
50	37	39	1,369	1,521	1,443
Totals	2,499	2,876	152,593	206,342	165,421

$$r = \frac{\Sigma xz - \frac{(\Sigma x)(\Sigma z)}{N}}{\sqrt{\left[\Sigma x^2 - \frac{(\Sigma x)^2}{N}\right]\left[z^2 \frac{(\Sigma z)^2}{N}\right]}} \sim +.64$$

TABLE 4B

PRODUCT MOMENT CORRELATION (PEARSON r)

Measurement Test - y
Practical Measurement - z

Student Number	y	z	y^2	z^2	yz
1	97	100	9,409	10,000	9,700
2	51	0	2,601	0	0
3	54	28	2,916	784	1,512
4	92	94	8,464	8,836	8,648
5	54	0	2,916	0	0
6	74	67	5,476	4,489	4,958
7	62	33	3,844	1,089	2,046
8	77	39	5,929	1,521	3,003
9	57	11	3,249	121	627
10	86	67	7,396	4,489	5,762
11	72	28	5,184	784	2,016
12	77	61	5,929	3,721	4,697
13	71	50	5,041	2,500	3,550
14	95	94	9,025	8,836	8,930
15	63	45	3,969	2,025	2,835
16	69	33	4,761	1,089	2,277
17	71	45	5,041	2,025	3,195
18	72	67	5,184	4,489	4,824
19	48	17	2,304	289	816
20	80	89	6,400	7,921	7,120
21	77	67	5,929	4,489	5,159
22	60	11	3,600	121	660
23	83	50	6,889	2,500	4,150
24	69	50	4,761	2,500	3,450
25	60	33	3,600	1,089	1,980
26	59	22	3,481	484	1,298
27	71	39	5,041	1,521	2,769
28	65	28	4,225	784	1,820
29	86	72	7,396	5,184	6,192
30	83	61	6,889	3,721	5,063
31	86	61	7,396	3,721	5,246
32	74	39	5,476	1,521	2,886
33	82	72	6,724	5,184	5,904

TABLE 4B CONTINUED

Student Number	y	z	y^2	z^2	yz
34	74	72	5,476	5,184	5,328
35	88	94	7,744	8,836	8,272
36	94	94	8,836	8,836	8,836
37	94	89	8,836	7,921	8,366
38	95	94	9,025	8,836	8,930
39	94	83	8,836	6,889	7,802
40	97	100	9,409	10,000	9,700
41	94	78	8,836	6,084	7,332
42	91	89	8,281	7,921	8,099
43	92	94	8,464	8,836	8,648
44	95	89	9,025	7,921	8,455
45	94	83	8,836	6,889	7,802
46	91	89	8,281	7,921	8,099
47	71	22	5,041	484	1,562
48	79	44	6,241	1,936	3,476
49	82	50	6,724	2,500	4,100
50	68	39	4,624	1,521	2,652
Totals	3,870	2,876	308,960	206,342	240,552

$$r = \frac{\Sigma yz - \frac{(\Sigma y)(\Sigma z)}{N}}{\sqrt{\left[\Sigma y^2 - \frac{(\Sigma y)^2}{N}\right]\left[\Sigma z^2 - \frac{(\Sigma z)^2}{N}\right]}} \sim +.9$$

TABLE 5

SPEARMAN CORRELATION COEFFICIENT OF TWO SETS OF RANKS

S.R.A. (Total Math) - R_1
Measurement Test - R_1

Student	R_1	R_2	Difference D	D^2
1	16.5	1.5	15	225
2	22	49	-27	729
3	31	47.5	-16.5	272.25
4	8.5	11.5	-3	9
5	47.5	47.5	0	0
6	16.5	29	-12.5	156.25
7	37.5	42	-4.5	20.25
8	30	26	4	16
9	44.5	46	-1.5	2.25
10	16.5	17	-.5	.25
11	32.5	31.5	1	1
12	46	26	20	400
13	39.5	34.5	5	25
14	41	4	37	1,369
15	23	41	-18	324
16	25	37.5	-12.5	156.25
17	39.5	34.5	5	25
18	37.5	31.5	6	36
19	35	50	-15	225
20	32.5	23	9.5	90.25
21	16.5	26	-9.5	90.25
22	44.5	43.5	1	1
23	8.5	19.5	-11	121
24	27.5	37.5	-10	100
25	35	43.5	-8.5	72.25
26	47.5	45	2.5	6.25
27	25	34.5	-9.5	90.25
28	50	40	10	100
29	27.5	17	10.5	110.25
30	49	19.5	29.5	870.25
31	10	17	-7	49
32	19.5	29	-9.5	90.25

TABLE 5 CONTINUED

Student	R_1	R_2	Difference D	D^2
33	13	21.5	-8.5	72.25
34	2	29	-27	729
35	7	15	-8	64
36	6	8	-2	4
37	14	8	6	36
38	21	4	17	289
39	12	8	4	16
40	3.5	1.5	2	4
41	25	8	17	289
42	11	13.5	-2.5	6.25
43	19.5	11.5	8	64
44	3.5	4	-.5	.25
45	5	8	-3	9
46	1	13.5	-12.5	156.25
47	42	34.5	7.5	56.25
48	43	24	19	361
49	29	21.5	7.5	56.25
50	35	39	-4	16
Totals			0	8,011

$$P = 1 - \frac{6 \sum D^2}{N(N^2 - 1)} \sim +.62$$

TABLE 5A

SPEARMAN CORRELATION COEFFICIENT OF TWO SETS OF RANKS

Total Measurement - R_2
Practical Measurement - R_3

Student	R_2	R_3	Difference D	D^2
1	1.5	1.5	0	0
2	49	49.5	-.5	.25
3	47.5	42	5.5	30.25
4	11.5	5.5	6	36
5	47.5	49.5	-2	4
6	29	21.5	7.5	56.25
7	42	39	3	9
8	26	35.5	-9.5	90.25
9	46	47.5	-1.5	2.25
10	17	21.5	-4.5	20.25
11	31.5	42	-10.5	110.25
12	26	25	1	1
13	34.5	28.5	6	36
14	4	5.5	-1.5	2.25
15	41	31.5	9.5	90.25
16	37.5	39	-1.5	2.25
17	34.5	31.5	3	9
18	31.5	21.5	10	100
19	50	46	4	16
20	23	11	12	144
21	26	21.5	4.5	20.25
22	43.5	47.5	-4	16
23	19.5	28.5	-9	81
24	37.5	28.5	9	81
25	43.5	39	4.5	20.25
26	45	44.5	.5	.25
27	34.5	35.5	-1	1
28	40	42	-2	4
29	17	18	-1	1
30	19.5	25	-5.5	30.25
31	17	25	-8	64
32	29	35.5	-6.5	42.25

TABLE 5A CONTINUED

Student	R_1	R_2	Difference D	D^2
33	21.5	18	3.5	12.25
34	29	18	11	121
35	15	5.5	9.5	90.25
36	8	5.5	2.5	6.25
37	8	11	-3	9
38	4	5.5	-1.5	2.25
39	8	14.5	-6.5	42.25
40	1.5	1.5	0	0
41	8	16	-8	64
42	13.5	11	2.5	6.25
43	11.5	5.5	6	36
44	4	11	-7	49
45	8	14.5	-6.5	42.25
46	13.5	11	2.5	6.25
47	34.5	44.5	-10	100
48	24	33	-9	81
49	21.5	28.5	-7	49
50	39	35.5	3.5	12.25
Totals			0	1,850

$$P = 1 - \frac{6\sum D^2}{N(N^2 - 1)} \sim +.9$$

TABLE 5B

SPEARMAN CORRELATION COEFFICIENT OF TWO SETS OF RANKS

S.R.A. Total Math - R_1
Practical Measurement - R_3

Student	R_1	R_3	Difference D	D^2
1	16.5	1.5	15	225
2	22	49.5	-27.5	756.25
3	31	42	-11	121
4	8.5	5.5	3	9
5	47.5	49.5	-2	4
6	16.5	21.5	-5	25
7	37.5	39	-1.5	2.25
8	30	35.5	-5.5	30.25
9	44.5	47.5	-3	9
10	16.5	21.5	-5	25
11	32.5	42	-9.5	90.25
12	46	25	21	441
13	39.5	28.5	11	121
14	41	5.5	35.5	1,260.25
15	23	31.5	-8.5	72.25
16	25	39	-14	196
17	39.5	31.5	8	64
18	37.5	21.5	16	256
19	35	46	-11	121
20	32.5	11	21.5	462.25
21	16.5	21.5	-5	25
22	44.5	47.5	-3	9
23	8.5	28.5	-20	400
24	27.5	28.5	-1	1
25	35	39	-4	16
26	47.5	44.5	3	9
27	25	35.5	-10.5	110.25
28	50	42	8	64
29	27.5	18	9.5	90.25
30	49	25	24	576
31	10	25	-15	225
32	19.5	35.5	-16	256

TABLE 5B CONTINUED

Student	R_1	R_3	Difference D	D^2
33	13	18	-5	25
34	2	18	-16	256
35	7	5.5	1.5	2.25
36	6	5.5	.5	.25
37	14	11	3	9
38	21	5.5	15.5	240.25
39	12	14.5	-2.5	6.25
40	3.5	1.5	2	4
41	25	16	9	81
42	11	11	0	0
43	19.5	5.5	14	196
44	3.5	11	-7.5	56.25
45	5	14.5	-9.5	90.25
46	1	11	-10	100
47	42	44.5	-2.5	6.25
48	43	33	10	100
49	29	28.5	.5	.25
50	35	35.5	-.5	.25
Totals			0	7,245.5

$$P = 1 - \frac{6 \sum D^2}{N(N^2 - 1)} \sim +.65$$

APPENDIX B

MATHEMATICS: CONCEPTS

Directions: This is a test to see how well you understand some important mathematical ideas. There are several different kinds of problems in the test. Here is an example:

S1. Which number would come next in the arithmetic progression 2, 4, 6, . . . ?

A. 7
B. 8
C. 14
D. 20

The number 8 would come next in the progression, so you should blacken space B for question S1 in the Concepts section of your answer sheet.

Remember to blacken only *one* space for each question. Make sure you blacken the correct space for your answer. If you need space to work any of the problems, use the scratch paper you were given.

When you are told to begin, work until time is called or until you come to the words STOP HERE.

1. After Jim gave 27 marbles to a friend, he had 85 marbles left. How many marbles did he have to begin with?

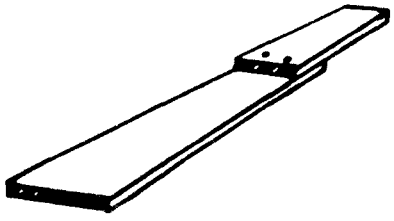
   A. 58
   B. 68
   C. 102
   D. 112

2. Jim bought a model car for $1.39. He gave the clerk $2. What change should he receive?

   A. 1 penny, 1 dime, 1 half-dollar
   B. 1 penny, 1 nickel, 1 half-dollar
   C. 1 penny, 1 nickel, 1 quarter
   D. 1 penny, 2 dimes, 1 half-dollar

3. John has one board 5 feet long and another board 8 feet long. If he nails the boards together so that they overlap by 1 foot, what will be the length of the two boards together?

   A. 14 feet
   B. 13 feet
   C. 12 feet
   D. 11 feet



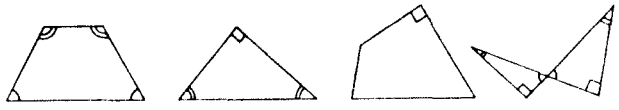
4. 1 yard 2 feet 5 inches is equal to how many inches?

   A. 50
   B. 55
   C. 60
   D. 65

5. Seven and five-sixths equals

   A. $7 + \frac{5}{6}$
   B. $7 + \frac{5}{6}$
   C. $7 \times \frac{5}{6}$
   D. $7 \times \frac{5}{6}$

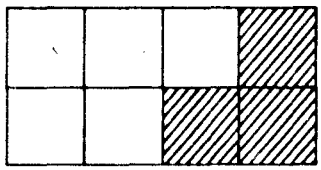
6. Which picture represents a figure containing two parallel line segments?



A. **B.** **C.** **D.**

21. What part of this rectangular region is shaded?

A. $\frac{3}{5}$
B. $\frac{3}{8}$
C. $\frac{5}{8}$
D. $\frac{5}{3}$

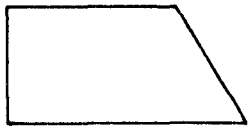


22. Which is the shortest time?

A. $\frac{1}{2}$ hour
B. 2 minutes
C. 100 seconds
D. $\frac{1}{12}$ day

23. The distance around this field is called the

A. perimeter
B. diagonal
C. circumference
D. altitude



24. What are the next two numbers in the geometric progression 1, 3, 9, 27, 81, . . .?

A. 243, 729
B. 108, 189
C. 99, 117
D. 27, 9

25. Susan divided 2369 by a mystery number. She got a remainder of 4. The mystery number could be

A. 2
B. 3
C. 5
D. 7

26. How many whole numbers are greater than 9 and less than 12?

A. None
B. Exactly two
C. Exactly three
D. Exactly four

27. If $t \div t = t$, then t must be

A. a fraction
B. the number 1
C. a number greater than 1
D. impossible to find

28. The infinite set {4, 6, 8, 10, . . .} is the set of

A. even numbers
B. even numbers greater than 0
C. numbers greater than 2
D. even numbers greater than 2

29. In which numeral does the 2 mean "2 thousands"?

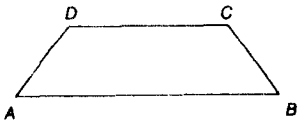
A. 29,475
B. 12,391
C. 3,627
D. 1,268

30. Anita is helping to put eggs in cartons. If she has 312 eggs and each carton holds one dozen, how many cartons will she need?

A. 24
B. 26
C. 30
D. 31

31. In this figure, angle A has the same measure as angle B, and segments AB and CD are parallel. You can therefore be sure that

A. segments AD and BC are parallel
B. angles B and D have the same measure
C. segments AD and BC have the same length
D. angles A and D have the same measure



32. How many of these figures have AT LEAST two sides of equal length?

A. Exactly one
B. Exactly two
C. Exactly three
D. Exactly four

MATHEMATICS: COMPUTATION

Directions: This is a test to see how well you can work with numbers. Work each problem. Then look to see if your answer is one of the choices given. If your answer is one of the choices, blacken the space for that answer on your answer sheet. If the correct answer is not given, blacken space E for "None of these." Here is an example:

S1. 15
14
+ 16

A. 35
B. 44
C. 54
D. 55
E. None of these

The correct answer is 45. Because 45 is not listed as one of the choices, you should blacken space E, "None of these," for question S1 in the Computation section of your answer sheet.

Remember to blacken only *one* space for each question. Make sure you blacken the correct space for your answer. Work the problems on the scratch paper you were given; do not mark the booklet.

When you are told to begin, work until time is called or until you come to the words STOP HERE.

1. 875
− 243

A. 532
B. 632
C. 642
D. 1118
E. None of these

2. 2001
− 874

A. 2875
B. 1237
C. 1137
D. 1127
E. None of these

3. 38
473
+ 527

A. 928
B. 1028
C. 1048
D. 1622
E. None of these

4. $7\overline{)4977}$

A. 711
B. 725 R2
C. 768 R1
D. 853 R6
E. None of these

5. 332
− 89

A 253
B. 257
C. 357
D. 421
E. None of these

6. $8\overline{)487.2}$

A. 609
B. 60.9
C. 6.9
D. 6.09
E. None of these

7. 907
× 8

A. 56
B. 901
C. 7256
D. 7263
E. None of these

8. $5\overline{)53}$

A. 106 R3
B. 106
C. 10 R8
D. 10 R3
E. None of these

25. $\begin{array}{r} 603 \\ \times\ 70 \\ \hline \end{array}$

A. 673
B. 42,210
C. 42,813
D. 420,210
E. None of these

26. $\frac{7}{8} - \frac{3}{4} =$

A. 1
B. $\frac{10}{12}$
C. $\frac{4}{8}$
D. $\frac{1}{8}$
E. None of these

27. 4 is 10 percent of what number?

A. 400
B. 40
C. $\frac{4}{10}$
D. .4
E. None of these

28. $17\overline{)5134}$

A. 32
B. 212
C. 302
D. 2102
E. None of these

29. $\frac{2}{5} + \frac{1}{2} =$

A. $\frac{7}{5}$
B. $\frac{5}{4}$
C. $\frac{3}{7}$
D. $\frac{2}{10}$
E. None of these

30. $1\frac{2}{5} \times \frac{1}{3} =$

A. $4\frac{1}{5}$
B. $2\frac{1}{7}$
C. $1\frac{11}{15}$
D. $1\frac{2}{15}$
E. None of these

31. $\frac{1}{4} + \frac{5}{8} =$

A. $\frac{7}{8}$
B. $\frac{6}{8}$
C. $\frac{6}{12}$
D $\frac{4}{8}$
E. None of these

32. $\frac{2}{3} - \frac{5}{8} =$

A. $\frac{1}{24}$
B. $\frac{5}{12}$
C. $\frac{3}{5}$
D. $1\frac{17}{24}$
E. None of these

33. $\frac{3}{8} \div \frac{1}{8} =$

A. $\frac{3}{64}$
B. $\frac{3}{16}$
C. $\frac{4}{8}$
D. 3
E. None of these

34. $\begin{array}{r} 74.6 \\ \times\ 8.5 \\ \hline \end{array}$

A. 6341.0
B. 634.10
C. 623.10
D. 96.98
E. None of these

35. $2\frac{5}{8} + 3\frac{3}{4} =$

A. $6\frac{3}{8}$
B. $5\frac{11}{16}$
C. $5\frac{8}{12}$
D. $5\frac{3}{8}$
E. None of these

36. $\frac{11}{100} + \frac{13}{100} + \frac{7}{10} =$

A. .94
B. .094
C. .31
D. .031
E. None of these

37. $\begin{array}{r} 74 \\ \times\ 46 \\ \hline \end{array}$

A. 120
B. 3284
C. 3304
D. 3404
E. None of these

38. $6 \div 3\frac{3}{5} =$

A. $\frac{3}{5}$
B. $1\frac{2}{3}$
C. $9\frac{3}{5}$
D. $21\frac{3}{5}$
E. None of these

APPENDIX C

APPENDIX D

ANSWER SHEET FOR "USING THE RULER" BOOKLET

NAME_____

PERIOD_____

Directions: Read the booklet and answer each question on this answer sheet. Do not write in the booklet.

1._____

2._____

3._____

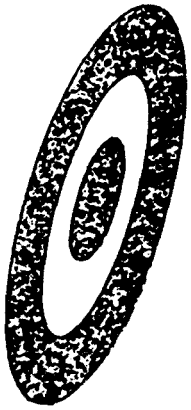
4. A. B. C. D.

5. A. B. C. D.

6. A. B. C.. D.

7. A B

8.



9._____

10._____

11._____

12. A. B. C. D.

13._____

_____

14._____

_____

15._____
1. 2 3 4 5 6 7 8

16._____

17._____
1 2 3 4 5 6 7 8

18._____

19._____
1 2 3 4 5 6 7 8

20._____