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The study compated two methods of teaching the use of the log-log slide rule in engineering courses, a straight lecture method or a lecture-laboratory method. The lecture method consisted of two separate hours a week with class discussion and demonstration by the instructor. The lecture-laboratory method comprised one hour of lecture and demonstration and one hour of laboratory work, during which the students solved problems with individual help from the instructor. To test the assumption that the laboratory method would be superior, an experiment was set up for 171 students in two groups. The equality of the two groups was determined by the Cooperative Mathematics Pre-test for College Students and the final examination was considered valid for deciding which method was better. Provision was made for control of three variables, namely, differences (1) in ability between day and night students, (2) in initial ability of the groups, and (3) caused by improved teaching. Seven day and six night classes were tested in such a way that a fall and a spring semester were taught by each method. The same instructor taught one group of 94 by the lecture method and another group of 77 by the lecture-laboratory method. The first group had a final examination score of 62.0; the latter group had a final score of 70.1. The t-test yielded a value of 2.85, a significant difference in favor of the lecture-laboratory method of teaching. (HH)

A COMPARISON OF TWO METHODS OF TEACHING AN ENGINEERING SLIDE RULE COURSE

A Project

Presented to

Dr. Gerald W. Brown

Division of Education

Los Angeles State College

In Partial Fulfillment

of the Requirements for the Degree

Master of Arts in Education

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by

Robert Oscar Maier

June 1957

This project report has been prepared under the direction of Dr. Gerald W. Brown, and has been presented to and accepted by the Division of Education, Los Angeles State College.

[illegible]

G. W. Brown

June 1957

CONTENTS

CHAPTER I

NATURE AND BACKGROUNDS OF THE STUDY

THE PROBLEM

The specific question to be answered in this study is, which method of teaching the Engineering Slide Rule course yields greater learning, a combined lecture-laboratory method or a straight lecture method? This study grew out of a concern for methods employed by teachers in developing skill in using the log-log slide rule.[1] The ability to use a log-log slide rule effectively depends upon the possession of certain mathematical understandings, skills in handling various problems, and considerable practice in its use. Thus, the teaching of a course in the use of the log-log slide rule becomes methodologically complex.

Science has used the laboratory method for years with apparent success. The assumption was made in this study that the mathematics teaching-learning situation resembles science to the degree that the laboratory method would function as well for the queen of the sciences as it would for regular science courses. To test this assumption an experimental design was set up, whereby the slide rule course would be taught to two equivalent groups. One group would be taught by the traditional lecture-discussion

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[1]A log-log slide rule is a special slide rule commonly used by engineers.

method, while the other group would be taught by the lecture-laboratory method.

BACKGROUND OF THE STUDY

The research related to teaching the use of the log-log slide rule is extremely meager. In "A Survey of Research in the Teaching of Secondary Algebra" by F. L. Wren appearing in the Journal of Educational Research, (12:606) it is pointed out that one of the most highly recommended techniques of teacher-pupil communication is the laboratory method.

NEED FOR THE STUDY

During the past two years, the writer has been teaching the Engineering Slide Rule course at El Camino College. The catalog description of this course has been: (13:130)

> MATHEMATICS 40 - Engineering Slide Rule - 1 unit
> Semester
>
> Lecture 1 hour, laboratory 1 hour
> Prerequisite: Mathematics C[2]
>
> This course teaches the operation and use of all scales of the log-log slide rule commonly used by engineers. The slide rule is applied to perform accurately and rapidly the numerical work encountered in physics, chemistry, engineering, and mathematics. Emphasis is placed on the engineering approach to significant figures, unit analysis, and estimation of numerical results. The course includes multiplication and division, direct and inverse proportions, trigonometric functions and equations, squares, cubes, square and cube roots, solution of triangles and other engineering geometry, natural logarithms and the use of the log-log scales for determining non-integral roots and powers and solving exponential equations.

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[2]Mathematics C is the equivalent of Plane Trigonometry.

It is pointed out that, although the El Camino College catalog description of the Engineering Slide Rule course states that the course involves one hour of lecture and one hour of laboratory, the course was being taught by the straight lecture method in September of 1955. Further inquiry revealed that the method of instruction was left up to the individual instructor. Prior to September, 1955, other instructors had taught the course using either the lecture-laboratory method or a straight lecture method. Discussions with these instructors revealed no real justification for either of the two methods used. From classroom observations it was apparent that many students were not gaining the needed insights through listening to the lecture and observing the instructor's techniques. Therefore, the question arose, would a system of teaching the Engineering Slide Rule course, involving laboratory activities yield greater learning for the student than the straight lecture approach?

DEFINITION OF THE PROBLEM

The problem of this study can be conveniently broken down to the following two questions:

1. Which method of teaching the Engineering Slide Rule course yields greater gains to the students, the straight lecture method or the lecture-laboratory method?

2. What are the unique differences between the straight lecture method and the lecture-laboratory method in teaching the Engineering Slide Rule course?

The following information is needed to answer these two questions: data indicating the mathematical ability of the two groups prior to and at the completion of taking the Engineering Slide Rule course; an explanation of the two methods studied.

DESCRIPTION OF THE POPULATION

El Camino College is a Junior College District embracing Centinela Valley Union High School District, El Segundo Unified School District, Inglewood Unified School District, South Bay Union High School District, and Torrance Unified School District. Since the beginning of El Camino College, the population of the District has grown rapidly. The District's estimated population for 1952 was 225,000.

In 1947 El Camino College opened with 1100 students. By 1955 it had grown to 6700 students, and presently has an enrollment of over 8000. It has offered both terminal trade courses and basic lower division work suitable for transfer to a four-year college. Students have been drawn almost equally by these two curricula.

El Camino College records indicate the majority of the students involved in this study were pre-engineering students who planned to transfer to four-year courses. The balance of the students were either working in or

interested in some phase of engineering. The ages of the students varied from 17 to 50 years.

Of the 171 students involved in the study, 170 were men, which reflects the nature of the course content. Job opportunities have been plentiful for individuals with the most fundamental mathematical background. Therefore, seventy-four per cent of the students were working either full or part time.

A typical student involved in this study was a male pre-engineering student, intending to transfer to a four-year course. He worked part time in some phase of engineering, probably connected with the aircraft industry.

CHAPTER II

METHODS OF THE STUDY

THE METHODS TO BE COMPARED

The main question involved is which method of teaching the Engineering Slide Rule course yields greater gains to the student, the straight lecture method or the lecture-laboratory method? Following is a detailed description of the two methods of instruction.

The straight lecture method of instruction consisted of two hours per week, meeting for one hour per day on two days per week. Class time was devoted to lecture accompanied by demonstration. The demonstrations were done with a large demonstration model log-log slide rule. The students followed the demonstration by going through the same operations on their own slide rules. With this method of instruction, some time is taken for class discussion of different methods of doing some operations, and the students solve assigned problems outside of class.

The lecture-laboratory method of instruction consisted of one hour per week of lecture and demonstration, and one hour per week of laboratory. The classes met on two days per week for one hour each day. When this method is used, the first hour is a lecture and demonstration, similar to the method described above. The second hour is the laboratory hour, in which the students individually solve

problems on the slide rule, with individual help from the instructor. The laboratory assignments are such that the students must solve some of the assigned problems outside of class.

DESIGN OF THE STUDY

The design of the study involved two groups of students. One group of students was taught by using the lecture-laboratory method. The other group of students was taught by using the straight lecture method. In order to obtain sufficient data for the study, it was necessary to collect evidence over a two-year period. The two-year period included day classes and night classes in both Spring and Fall semesters. Thus, to avoid confusion for students transferring from one Engineering Slide Rule class to another, all sections of the course in any given semester were taught by the same method. It was further decided to teach one Fall and one Spring semester by each method because the Spring semester is generally one or two weeks longer than the Fall semester. This obviously provides two groups for comparison, with Fall and Spring semester students in each group.

For this comparison to have any validity it is necessary that the two groups of students involved have equal initial mathematical abilities. The method of determining the students' mathematical abilities will be explained later in this chapter.

It is assumed that the final examination is sufficiently broad and detailed to collect evidence relative to the realization of the major course objectives. These objectives relate directly to competence in slide rule manipulation and operation. Thus the effectiveness of the method of instruction used can be measured by the students' achievement on the final examination. Therefore, when the two groups are initially equal, a comparison of the mean final examination scores should show whether or not either of the two methods is superior. As described herein, the design provided for these two comparisons.

FORMS USED

The preliminary test to determine mathematical ability was the "Cooperative Mathematics Pre-Test for College Students". (See Appendix D) A five point classification system was used to match the two groups. (See Appendix E)

The final examination forms used were constructed to include all operations and uses of the log-log slide rule taught in the Engineering Slide Rule course. Therefore, the assumption that this test measures the effectiveness of the instructional method is justified. Two equivalent forms of fifty questions each were used. These examinations were given to both groups in an identical manner. The examination forms were randomly distributed among the students in a pattern in which a student having a form A test is surrounded by students with form B tests, and vice versa. Copies of the two forms are included in Appendix C.

CONTROL OF VARIABLES

Several variables were involved in the study. An attempt was made to control them. These were:

1. Differences in mathematical abilities between night and day students.
2. Differences in the initial mathematical abilities of the groups studied.
3. Differences due to improved instruction.

The difference between initial mathematical abilities of night and day students was reconciled by statistically analyzing their placement test results at El Camino College.[1] The mean placements and the variances of the night and day students were computed. The t test (2:105) for difference of means indicated that there was no significant difference in the abilities of the night and day students, although, as will be shown, there were significant differences in achievement. (See Appendix A)

Student ability differences between the straight lecture classes and the lecture-laboratory classes were controlled by statistically comparing the mathematical ability of the students involved, as measured by the El Camino College placement resulting from the "Cooperative Mathematics Test for College Students." The mean placement of the students in the groups under consideration was shown to be such that there was no significant difference between the two groups.[2]

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[1]Based on "Cooperative Mathematics Test for College Students." (See Appendices D and E)

[2]See Appendix B

The third variable mentioned, that of differences due to improved instruction, was controlled by the method of grouping the students. The method of grouping the students was to teach all classes in any one semester by the same method. This was done in the following manner: Fall 1955 - straight lecture; Spring 1956 - lecture-laboratory; Fall 1956 - lecture-laboratory; Spring 1957 - straight lecture. This order of using the two methods yields a Fall and a Spring semester taught by each of the methods under consideration. It also provides a straight lecture method first and last, and a lecture-laboratory method second and third; therefore any improvement in instruction should be evident in both methods.

Thirteen classes were tested, seven day and six night. Every effort was made to keep instruction consistent in all classes.

CHAPTER III

EXPERIMENTAL PROCEDURES

QUESTIONS TO BE ANSWERED

In Chapter I the following questions were posed:

1. Which method of teaching the Engineering Slide Rule course yields greater gains to the students, the straight lecture method or the lecture-laboratory method?
2. What are the unique differences between the straight lecture method and the lecture-laboratory method in teaching the Engineering Slide Rule course?

Breaking the first question down for analysis, the following sub-questions must be answered:

1. Were the two groups equal in initial mathematical ability?
2. How were gains measured and how was the difference in gains of the two groups determined?
3. Was there a difference in gains shown by the results of the tests used to determine gains?
4. Was the difference in gains between the two methods (groups) statistically significant?

UNIQUE DIFFERENCES BETWEEN THE TWO METHODS

The teaching conditions were identical for both groups in that the same classrooms and equipment were used. The main difference in the two methods was the utilization of the time allotted to the classes. The difference between

night and day students was reconciled, as was any difference due to improved instruction. The groups were shown to be equal in initial mathematical ability.

INITIAL MATHEMATICAL ABILITY OF THE TWO GROUPS

The distributions of the abilities of the two groups, along with the calculations of their means and standard deviations are shown in Appendix B. The results of these calculations reveal a mean ability score of 3.80 for the straight lecture classes, and a mean ability score of 3.77 for the lecture-laboratory classes. The standard deviations for the straight lecture classes and the lecture-laboratory classes were 1.34 and 1.27, respectively. The critical value for t at the 95 per cent confidence level is 2.00, and the value arrived at in this comparison was only .15. Therefore, no significant difference was found to exist between the two groups.

HOW GAINS AND DIFFERENCES IN GAINS WERE DETERMINED

Straight Lecture Group Gains

The chart on the following page shows the gains of the straight lecture students, in terms of their final examination scores. These data have been classified into ten intervals with ten-unit increments for statistical analysis. A short method of computing the mean, [illegible] variability, [illegible], was used. (5:9)

[illegible] $X = cd + x_0$,

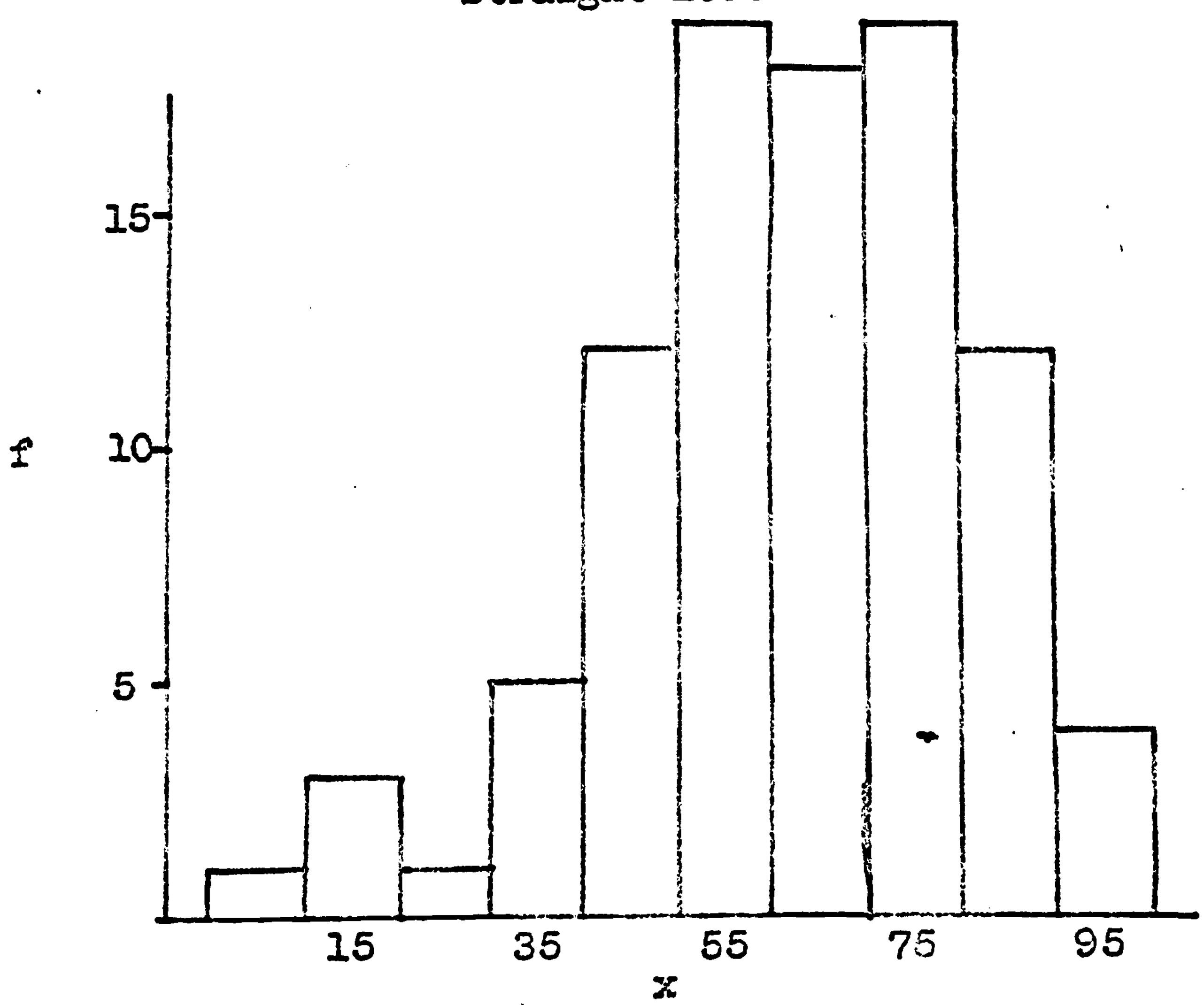
[illegible] 10, and x_0

Distribution of Final Examination Scores
for
Straight Lecture Students

x	f	u	uf	u^2	u^2f
95	4	3	12	9	36
85	12	2	24	4	48
75	19	1	19	1	19
65	18	0	0	0	0
55	19	-1	-19	1	19
45	12	-2	-24	4	48
35	5	-3	-15	9	45
25	1	-4	- 4	16	16
15	3	-5	-15	25	75
5	1	-6	- 6	36	36
	94		-28		342

$\bar{x} = 62.0$, $s = 18.8$, and $n = 94$.

Histogram of Final Examination Scores
for
Straight Lecture Students



is the class mark of the median score, namely 65.0. In this formula, $\bar{u} = \sum uf \div n$. The value of s was computed by using the formula:

$$s = c\sqrt{\frac{\sum u^2 f}{n} - \bar{u}^2}$$

The mean final examination score obtained from this group of 94 students is 62.0, and the standard deviation is 18.8. Theoretically, in a normal population, about 68 per cent of the data should be contained in the interval from $(\bar{x} - s)$ to $(\bar{x} + s)$, and about 95 per cent should be included in the interval from $(\bar{x} - 2s)$ to $(\bar{x} + 2s)$. (5:13) The histogram shows that in the straight lecture group 66 out of 94, or 70 per cent were in the 68 per cent interval, and 90 out of 94, or 96 per cent were in the 95 per cent interval. Therefore, it is justifiable to consider this group a normal population.

Lecture-Laboratory Group Gains

The chart on the following page shows the gains of the lecture-laboratory students in terms of their final examination scores. These data have been classified and analyzed in the same manner as the preceding data.

Calculations based on the distribution reveal a mean final examination score for the lecture-laboratory group of 70.1, and a standard deviation of 18.3, for a population of 77.

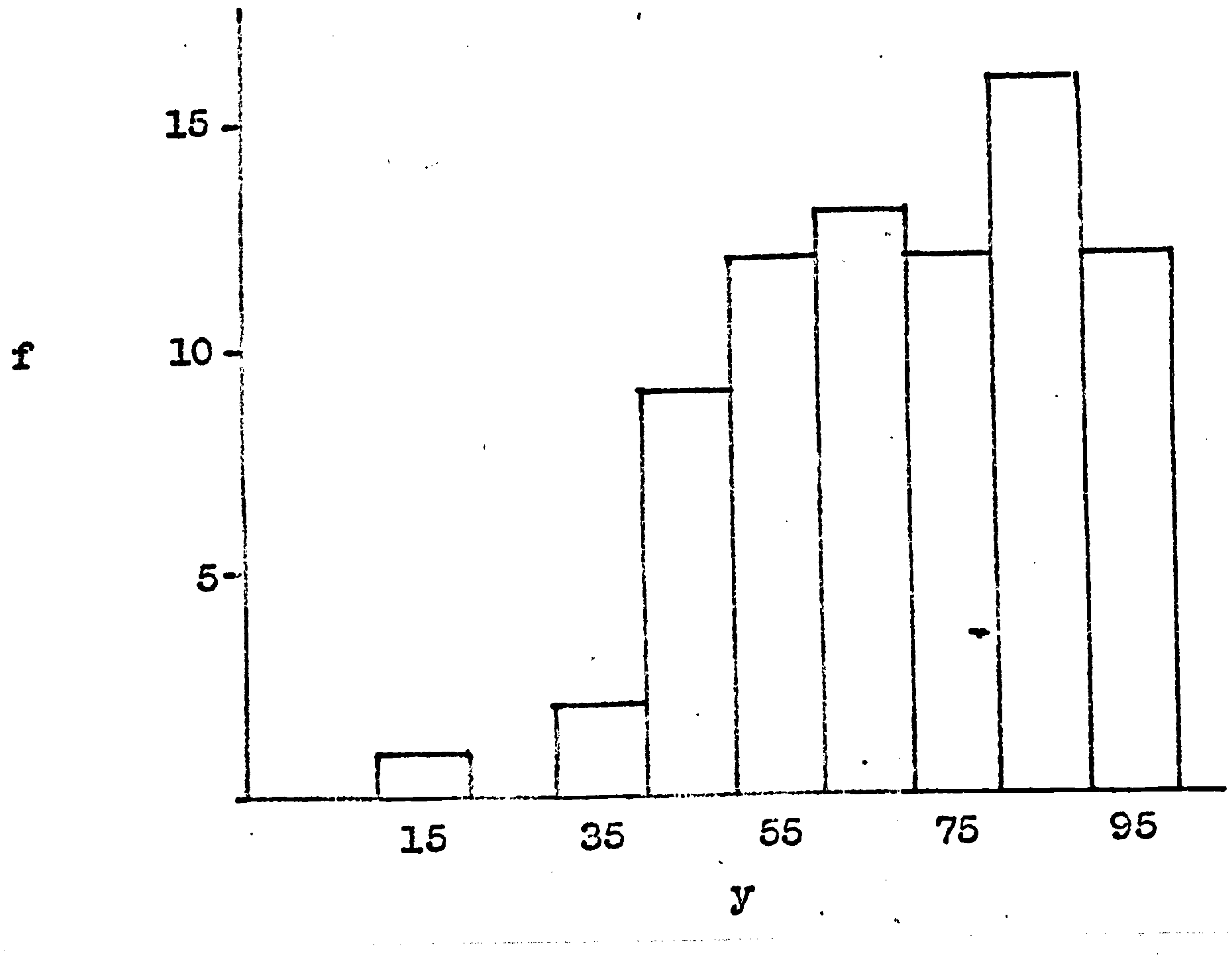
The histogram on the following page shows that 48 out of 77, or 62.4 per cent of the group fell in the

Distribution of Final Examination Scores
for
Lecture-Laboratory Students

y	f	u	uf	u^2	u^2f
95	12	2	24	4	48
85	16	1	16	1	16
75	12	0	0	0	0
65	13	-1	-13	1	13
55	12	-2	-24	4	48
45	9	-3	-27	9	81
35	2	-4	- 8	16	32
25	0	-5	0	25	0
15	1	-6	- 6	36	36
5	0	-7	0	49	0
	77		-38		274

$\bar{y} = 70.1$, $s = 18.2$, and $n = 77$.

Histogram of Final Examination Scores
for
Lecture-Laboratory Students



68 per cent interval, and 75 out of 77, or 97.4 per cent fell in the 95 per cent interval. Therefore, this group may also be considered a normal population.

Determination of Difference in Gains

The t test has been used to show whether a significant difference in the gains made by the two groups exists. The formula for t is:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{s_x^2}{n_x} - \frac{s_y^2}{n_y}}}$$

In this t test it is not necessary to consider the number of degrees of freedom since groups larger than 50 are involved. It is only necessary to show that the value of t is less than 2.00 to indicate no significant difference, or greater than 2.00 to show that there is a significant difference at the 95 per cent level. From page 13, the values of $\bar{x}$, s_x, and n_x are shown to be 62.0, 18.8, and 94 respectively. On page 15 the values of $\bar{y}$, s_y, and n_y are shown to be 70.1, 18.3, and 77 respectively. Using these values to calculate t, it is found that t = 2.85, showing that there is a significant difference in the gains made by the students in the two groups.

SUMMARY OF THE FINDINGS

Two groups of students, totalling 171 students from the Engineering Slide Rule course at El Camino College were taught by the same instructor. One group of 94

students was taught by the traditional lecture method, while the other group of 77 students was taught by the lecture-laboratory method. The groups were found to be equal in mathematical ability at the outset. At the termination of the instruction, the group taught by the lecture-laboratory method, consisting of 77 students had a mean final examination score of 70.1; while the group taught by the straight lecture method, consisting of 94 students had a mean final examination score of 62.0. The t test yielded a value of 2.85, indicating that a significant difference in mean final examination scores does exist, with the lecture-laboratory group scoring higher than the straight lecture group.

CHAPTER IV

IMPLICATIONS OF THIS STUDY

AND

NEED FOR FURTHER RESEARCH

IMPLICATIONS

The data in this study indicates that for this instructor teaching the Engineering Slide Rule course, the lecture-laboratory method yields greater gains for the student than does the straight lecture method. There is no reason to doubt that similar results would be realized by other instructors. Thus the implication is evident that the Engineering Slide Rule course at El Camino College should be taught by the lecture-laboratory method. The gains considered here are restricted to those which are evaluated by the final examination. The concession is made that gains in areas other than those measured by the final examination are possible. No attempt was made to evaluate gains in these other areas.

NEED FOR FURTHER RESEARCH

This study was undertaken in an area where motivation was high, inasmuch as advanced employment opportunities were readily available and apparent. A similar study should be undertaken with similar groups, but where this motivation is not so evident.

This study evaluated the mathematical objectives of the Engineering Slide Rule course. A more complete evaluation involving setting up objectives, and collecting evidence on the total problem needs to be done. Such an evaluation would throw further light on the superiority, or lack of it, of the lecture-laboratory method.

APPENDICES

APPENDIX A

COMPARISON OF NIGHT vs DAY STUDENTS

Ability Comparison

Distribution of Mathematics Placement Test Results
for
Night Students

Placement[1]	x	f	xf	x^2	x^2f
1	5	24	120	25	600
D/1	4	10	40	16	160
D	3	16	48	9	144
A/D	2	3	6	4	12
A	1	2	2	1	2
		55	216		1018

$\bar{x} = 3.93$, $s = 1.76$, and $n = 55$.

Distribution of Mathematics Placement Test Results
for
Day Students

Placement	y	f	yf	y^2	y^2f
1	5	49	245	25	1225
D/1	4	22	88	16	352
D	3	28	84	9	252
A/D	2	2	4	4	8
A	1	15	15	1	15
		116	436		1852

$\bar{y} = 3.76$, $s = 1.38$, and $n = 116$.

In comparing the above distributions, the value calculated for t was .65. Since this value is less than 2.00, there is no significant difference between the night and day students' abilities.

---

[1]The method of placement is explained in Appendix E.

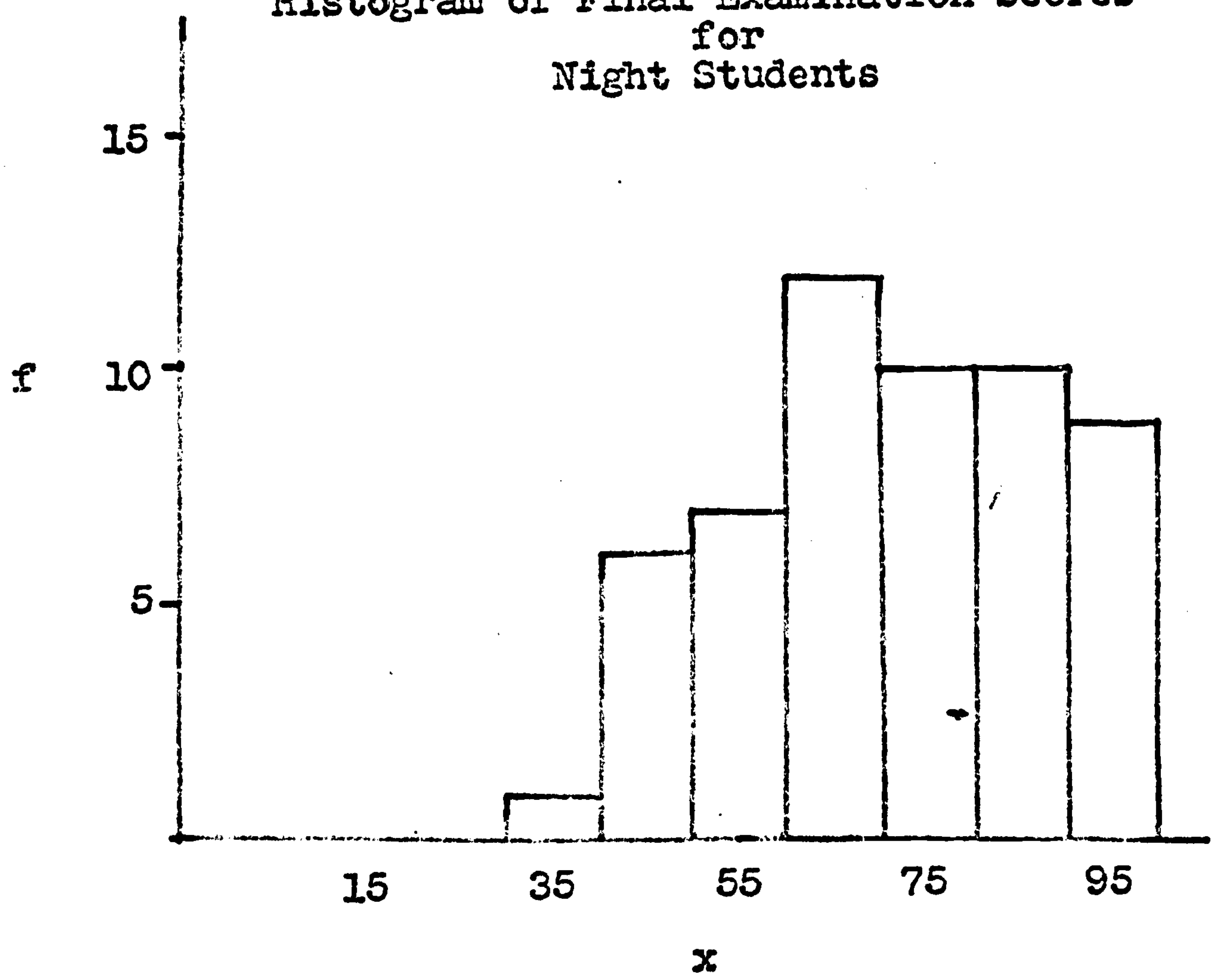
Achievement Comparison

Distribution of Final Examination Scores for Night Students

x	f	u	uf	u^2	u^2f
95	9	2	18	4	36
85	10	1	10	1	10
75	10	0	0	0	0
65	12	-1	-12	1	12
55	7	-2	-14	4	28
45	6	-3	-18	9	54
35	1	-4	- 4	16	16
25	0	-5	0	25	0
15	0	-6	0	36	0
5	0	-7	0	49	0
	55		-20		156

$\bar{x} = 71.4$, $s = 16.5$, and $n = 55$.

Histogram of Final Examination Scores for Night Students

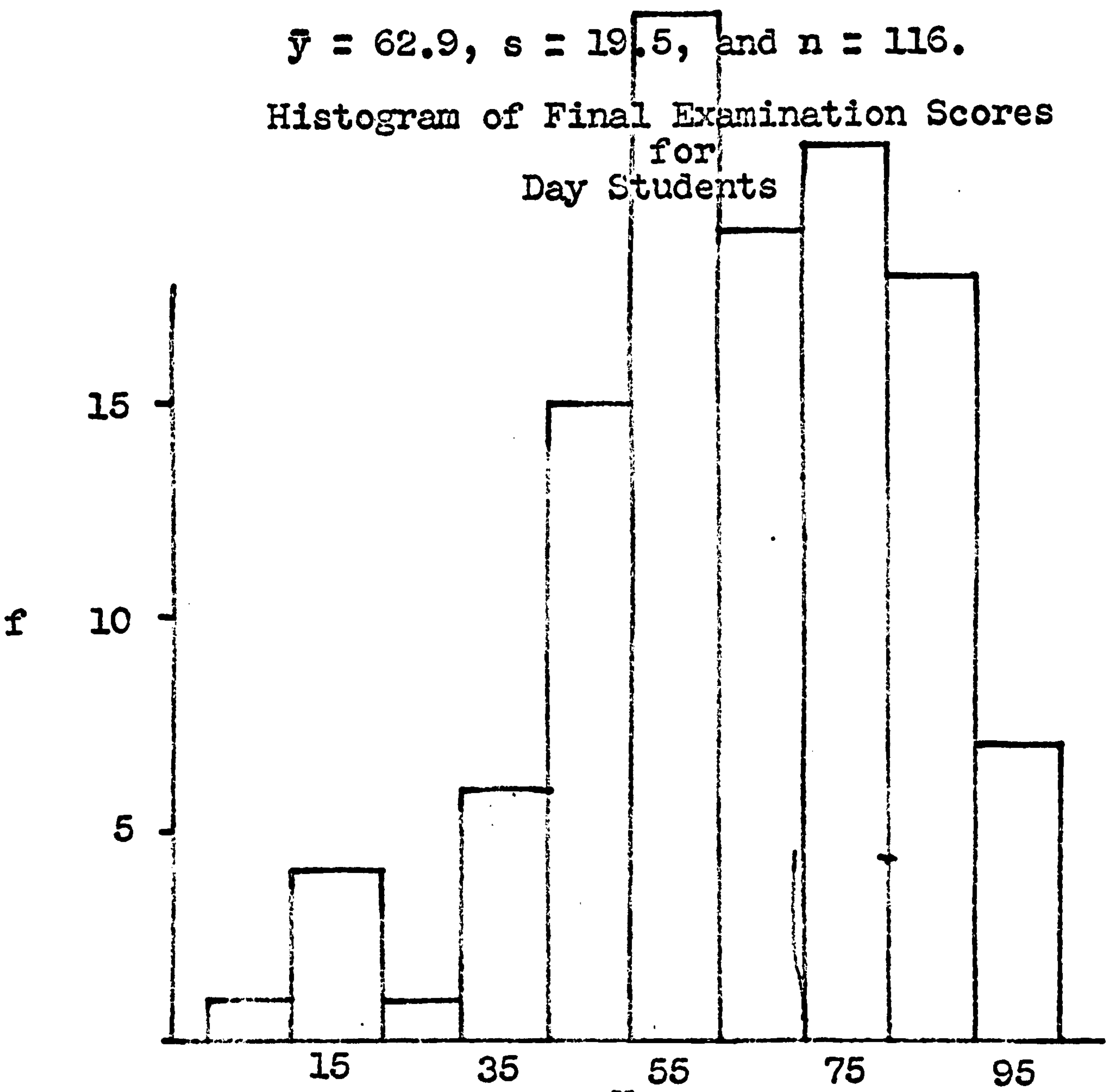


Distribution of Final Examination Scores
for
Day Students

y	f	u	uf	u^2	u^2f
95	7	3	21	9	63
85	18	2	36	4	72
75	21	1	21	1	21
65	19	0	0	0	0
55	24	-1	-24	1	24
45	15	-2	-30	4	60
35	6	-3	-18	9	54
25	1	-4	- 4	16	16
15	4	-5	-20	25	100
5	1	-6	- 6	36	36
	116		-24		446

$\bar{y} = 62.9$, $s = 19.5$, and $n = 116$.

Histogram of Final Examination Scores
for
Day Students



In comparing the achievement of the night students with the achievement of the day students, the value calculated for t was 2.96. This indicates that there is a significant difference in the achievement of these two groups. This apparent discrepancy in achievement is partially explained by the fact that 35 out of 55, or 63.7 per cent of the night students were in lecture-laboratory classes, while 42 out of 116, or 36.2 per cent of the day students were in lecture-laboratory classes. Therefore, this result only bears out the fact that the lecture-laboratory method yields greater gains to the students.

APPENDIX B

COMPARISON OF ABILITIES

STRAIGHT LECTURE GROUP vs LECTURE-LABORATORY GROUP

Distribution of Mathematics Placement Test Results for Straight Lecture Classes

Placement[1]	x	f	xf	x^2	x^2f
1	5	40	200	25	1000
D/1	4	21	84	16	336
D	3	22	66	9	198
A/D	2	2	4	4	8
A	1	11	11	1	11
		96	365		1553

$\bar{x} = 3.80$, $s = 1.34$, and $n = 96$.

Distribution of Mathematics Placement Test Results for Lecture-Laboratory Classes

Placement	y	f	yf	y^2	y^2f
1	5	32	160	25	800
D/1	4	12	48	16	192
D	3	23	69	9	207
A/D	2	3	6	4	12
A	1	7	7	1	7
		77	290		1218

$\bar{y} = 3.77$, $s = 1.27$, and $n = 77$.

In comparing the above distributions, the value calculated for t was .15. Since this value is less than 2.00 there is no significant difference here.

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[1]The method of placement is explained in Appendix E.

APPENDIX C

FINAL EXAMINATION FORMS USED

EL CAMINO COLLEGE
MATHEMATICS 40
FINAL EXAMINATION # ____

PROBLEMS

1. 7.26×34.7

2. $(44.5)(.00192)(36 \times 10^{-3})$

3. $\dfrac{388 \times 2.76 \times .836}{13.4 \times 860 \times 10}$

4. $\dfrac{(25)(72)}{4}$

5. $\dfrac{15.7 \times 160}{2.80}$

6. $(.057)(6150)(15.7)$

7. $1950 \times .0034 \times 62.5 \times 2.13 \times 220$

8. $\dfrac{4.8\pi}{379}$

9. $\dfrac{317\pi}{82.5}$

10. $\dfrac{607}{.203 \times .663}$

ANSWERS

1 ____

2 ____

3 ____

4 ____

5 ____

6 ____

7 ____

8 ____

9 ____

10 ____

11. $38.242(.99904)$

12. $\dfrac{56.340}{\sqrt{.9948}}$

13. SIN $18.1°$

14. TAN $18.1°$

15. SIN $3.14°$

16. TAN $3.29°$

17. COT $85.8°$

18. SIN $168°$

19. 10.9 COS $125°$

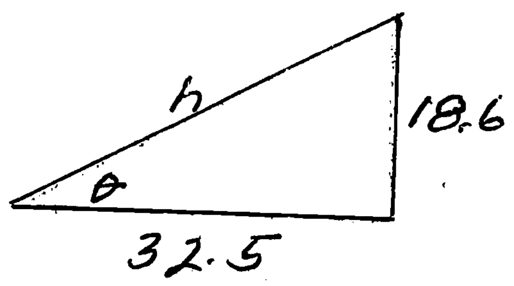
20. 11.6 COS $137°$

11	
12	
13	
14	
15	
16	
17	
18	
19	
20	

1. $\dfrac{34.7 \cos 12^\circ}{\sin 46^\circ}$

2. $\cos(-5^\circ)$

3. FIND h



4. FIND θ

5. $38 \tan 58^\circ \sin 22.6^\circ$

6. $42 \tan 69^\circ \sin 24.2^\circ$

7. $57 + j\,48$

8. $36 - j\,47$

GIVE POLAR FORM

9. CONVERT $42'$ TO RADIANS

0. CONVERT $21''$ TO RADIANS

21 __________

22 __________

23 __________

24 __________

25 __________

26 __________

27 __________

28 __________

29 __________

30 __________

$1:1041 = 72:x$

P VARIES DIRECTLY AS T.

$P = 137$ WHEN $T = 230$

$P = ?$ WHEN $T = 187$

$$\frac{\sqrt{87.9}}{\sqrt{361}}$$

$$\frac{(28.5)^2}{(14.4)(7.23)}$$

$$\sqrt{.0147}$$

$$(.0147)^2$$

$$(\sqrt[3]{12.4})(\sqrt{163})$$

$$(.124)^3$$

$$\log_{10}(7.08 \times 10^{-6})$$

$$10^{\log_{10}(1.643)}$$

31 ____

32 ____

33 ____

34 ____

35 ____

36 ____

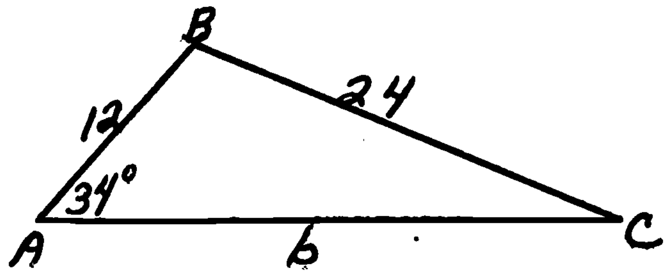
37 ____

38 ____

39 ____

40 ____

41. ANTILOG (-2.359)	41
42. $(471)^{.472}$	42
43. $(1.052)^{-18.4}$	43
44. $pH = 5.000$; $[H^+] = ?$	44
45. $[H^+] = 1.47 \times 10^{-11}$; $pH = ?$	45
46. $e^{3.92}$	46
47. $\log_e (2.371)$	47
48. $e^x = .942$; FIND x	48
49. FIND C	49
50. FIND b	50



EL CAMINO COLLEGE
MATHEMATICS 40
FINAL EXAMINATION #____

B

PROBLEMS	ANSWERS
1. 7.62×37.4	1 ____
2. $(45.4)(.00129)(36 \times 10^{-3})$	2 ____
3. $\dfrac{388 \times 2.67 \times .638}{13.4 \times 860 \times 10}$	3 ____
4. $\dfrac{(25)(72)}{4}$	4 ____
5. $\dfrac{17.5 \times 160}{2.80}$	5 ____
6. $(.057)(6150)(15.7)$	6 ____
7. $1950 \times .0034 \times 62.5 \times 2.13 \times 220$	7 ____
8. $\dfrac{379\pi}{4.8}$	8 ____
9. $\dfrac{(82.5)(\pi)}{317}$	9 ____
10. $\dfrac{.663}{.203 \times 607}$	10 ____

11. $38.224(.99904)$

12. $\dfrac{56.340}{\sqrt{.9984}}$

13. SIN $3.41°$

14. TAN $3.92°$

15. SIN $18.1°$

16. TAN $18.1°$

17. SIN $186°$

18. COT $85.2°$

19. 10.9 COS $125°$

20. 11.6 COS $137°$

11. ________

12. ________

13. ________

14. ________

15. ________

16. ________

17. ________

18. ________

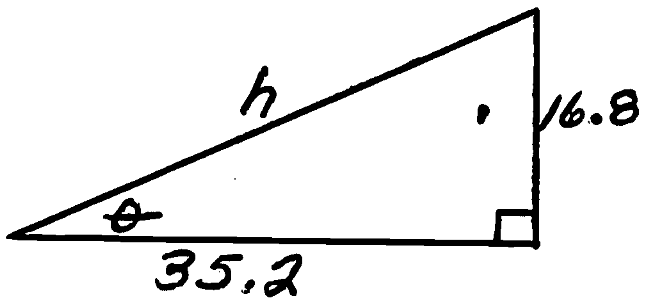
19. ________

20. ________

21. $\dfrac{37.4 \sin 46^\circ}{\cos 12^\circ}$ 21 ________

22. $\cos(-5^\circ)$ 22 ________

23. FIND h 23 ________



24. FIND θ 24 ________

25. $38 \tan 69^\circ \sin 22.6^\circ$ 25 ________

26. $42 \tan 58^\circ \sin 24.2^\circ$ 26 ________

27. $57 + j37$ 27 ________

GIVE POLAR FORM

28. $36 - j48$ 28 ________

29. CONVERT $21'$ TO RADIANS 29 ________

30. CONVERT $42''$ TO RADIANS 30 ________

$x : 72 = 1041 : 1$

P VARIES DIRECTLY AS T

$P = 137$ WHEN $T = 230$

$P = ?$ WHEN $T = 187$

$$\frac{\sqrt{89.7}}{\sqrt{361}}$$

$$\frac{(28.5)^2}{(14.4)(7.23)}$$

$$\sqrt{.0174}$$

$$(.0174)^2$$

$$(\sqrt[3]{12.4})(\sqrt{163})$$

$$(.142)^3$$

$$10^{\log_{10}(6.134)}$$

$$\log_{10}(8.07 \times 10^{-4})$$

31 ____

32 ____

33 ____

34 ____

35 ____

36 ____

37 ____

38 ____

39 ____

40 ____

41. ANTILOG (-2.539)

42. $(471)^{.472}$

43. $(1.052)^{-18.4}$

44. $pH = 6.000$; $[H^+] = ?$

45. $[H^+] = 1.47 \times 10^{-11}$; $pH = ?$

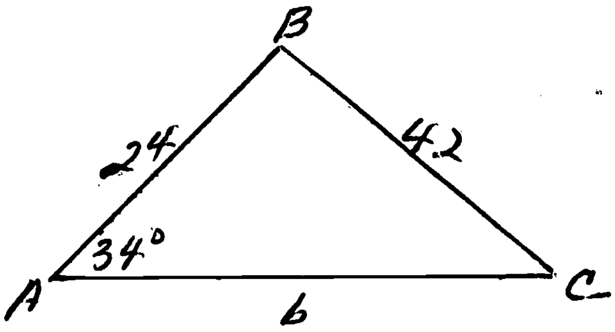
46. $e^{.392}$

47. $\log_e (2.371)$

48. $e^x = .492$; FIND x

49. FIND b

50. FIND C



41

42

43

44

45

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47

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49

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APPENDIX D

PRELIMINARY MATHEMATICAL ABILITY TEST

For determining the ability of each individual in the groups studied, the El Camino College placement of the individuals in the Mathematics course sequence was used. The El Camino College placement is based on the results of the standardized test shown in this appendix and other factors.[1] The standardized test used was the "Cooperative Mathematics Pre-Test for College Students" published by the American Council on Education.

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[1] See Appendix E.

AMERICAN COUNCIL ON EDUCATION

COOPERATIVE MATHEMATICS PRE-TEST FOR COLLEGE STUDENTS

FORM Y

(An adaptation of materials from Experimental Forms A and B)

by

THE COMMITTEE ON TESTS OF THE MATHEMATICAL ASSOCIATION OF AMERICA

with the editorial assistance of

PAUL J. BURKE, Graduate Record Office; T. FREEMAN COPE, Queens College; and BERNICE ORSHANSKY, Cooperative Test Service

Please print:

Name..Date..

Class: Fr. So. Jr. Sr. (encircle one) Age.............Yrs. ....Mos. Date of Birth..................................

School...City...Sex.........................

Classification: Liberal Arts..........................Engineering..........................Pre-Professional.......................... (check one)

Title of the mathematics course you are now taking....................................Instructor...................................

Number of **years** you will have studied the following by the end of the present semester or quarter: (Count a semester as $\frac{1}{2}$ year, a quarter as $\frac{1}{3}$ year.)

	Elementary Algebra	Intermediate Algebra	Plane Geometry	Solid Geometry	Trigonometry	Other Mathematics Courses (list)
In high school						
In college						

General Directions: Do not turn this page until the examiner tells you to do so. This examination requires 40 minutes of working time. The directions are printed at the beginning of the test. Read them carefully, and proceed at once to answer the questions. DO NOT SPEND TOO MUCH TIME ON ANY ONE ITEM. ANSWER THE EASIER QUESTIONS FIRST; then return to the harder ones if you have time. No questions may be asked after the examination has begun.

You may answer questions even when you are not perfectly sure that your answers are correct, but you should avoid **wild** guessing, since wrong answers will result in a subtraction from the number of your correct answers.

Minutes	Score	Percentile
40		

Directions: Each problem below is followed by five choices, only one of which is the correct answer. By working each problem, find the correct answer and put its **number** in the parentheses at the right.

1. $.5 + .06 + .3$ equals
1–1 .806
1–2 .86
1–3 .59
1–4 .563
1–5 .14 . . . . 1( )

2. How many twelfths are equivalent to $\frac{1}{2} + \frac{3}{4}$?
2–1 15
2–2 10
2–3 9
2–4 8
2–5 5 . . . . 2( )

3. How much money must be placed at 3 per cent simple interest for one year in order to earn $12?
3–1 $300
3–2 $360
3–3 $400
3–4 $840
3–5 $1,200 . . . . 3( )

4. $\frac{1}{2} - \frac{1}{10}$ equals
4–1 $\frac{1}{20}$
4–2 $\frac{1}{8}$
4–3 $\frac{1}{5}$
4–4 $\frac{2}{5}$
4–5 $\frac{4}{5}$ . . . . 4( )

5. The law of the lever can be expressed by the equation $EA = rs$. What is the value of s when $r = 20$, $E = 40$, and $A = 10$?
5–1 20
5–2 2
5–3 40
5–4 4
5–5 15 . . . . . . 5( )

6. What fraction, in lowest terms, is equivalent to .35?
6–1 $\frac{3}{50}$
6–2 $\frac{7}{20}$
6–3 $\frac{3}{10}$
6–4 $\frac{2}{7}$
6–5 $\frac{3}{5}$ . . . . 6( )

7. The kinetic energy E of a particle is equal to half the product of its mass m and the square of its velocity v. Written as a formula, this statement is
7–1 $E = \frac{1}{2}mv^2$
7–2 $\frac{E}{2} = mv^2$
7–3 $E = \frac{1}{2}(m + v)^2$
7–4 $\frac{E}{2} = m + v^2$
7–5 $E = \frac{m}{2v^2}$ . . . . 7( )

8. $x^3 \cdot x^5$ equals
8–1 x^8
8–2 x^{15}
8–3 x^{30}
8–4 $15x$
8–5 $15x^2$ . . . . . 8( )

9. $p + r(3p)$ equals
9–1 $4p + r$
9–2 $3p^2 + 3rp$
9–3 $p + 3rp$
9–4 $4p + 3r$
9–5 $p + 3r + rp$ . . 9( )

10. What is the value of x in the equation $3x - 5 = 8x + 10$?
10–1 0
10–2 2
10–3 3
10–4 −2
10–5 −3 . . . . . . 10( )

x	0	1	2	3	4
y	1	3	5	7	9

11. The relation between x and y from which corresponding values of x and y in the above table can be derived may be stated as
11–1 $y = 2x + 1$
11–2 $y = x + 5$
11–3 $y = 1 - xy$
11–4 $y = xy + 1$
11–5 $y = x + 1$ . . 11( )

12. If y varies directly as x, and $y = 20$ when $x = 4$, what does y equal when $x = 20$?
12–1 100
12–2 80
12–3 36
12–4 4
12–5 24 . . . . . 12( )

13. In the formula $C = \frac{E}{R + r}$, what is the value of R when $C = 3$, $E = 21$, and $r = 3$?
13–1 10
13–2 7
13–3 6
13–4 4
13–5 $2\frac{1}{3}$ . . . . . 13( )

14. If $x = 2y$ and $y \neq 0$, the fraction $\frac{3x + 4y}{9x - 4y}$ is equivalent to
14–1 $-\frac{1}{3}y$
14–2 $-\frac{1}{3}$
14–3 $\frac{1}{3}$
14–4 $\frac{5}{9}$
14–5 $\frac{5}{7}$ . . . . . 14( )

15. $(2m^2 + 3m + 1)(3m - 1)$ equals
15–1 $6m^3 + 9m^2 + 6m - 1$
15–2 $6m^2 + 9m - 1$
15–3 $6m^3 + 7m^2 - 1$
15–4 $6m^3 + 3m - 1$
15–5 $6m^2 - 1$ . . . 15( )

16. After simplification, $\frac{q^2 - 9}{q^2 - 8q + 15}$ reduces to
16–1 $\frac{q - 3}{q - 5}$
16–2 $\frac{q - 3}{q + 5}$
16–3 $\frac{q + 3}{q - 5}$
16–4 $\frac{-9}{-8q + 15}$
16–5 $\frac{1}{-8q + 6}$ . . 16( )

Go on to the next page.

17. The volume V of a right circular cone is equal to the product of the altitude, the square of the radius of the base, and one-third of π. Using h for the altitude and r for the radius of the base, a formula for V is given by

17–1 $V = \frac{\pi}{3}(h + r^2)$

17–2 $V = \frac{\pi}{3}h + r^2$

17–3 $V = \frac{\pi}{3}(h + r)^2$

17–4 $V = \frac{\pi}{3}rh^2$

17–5 $V = \frac{\pi}{3}hr^2$ . . . 17(   )

18. $(6x^2 + 11xy - 10y^2)$ divided by $(2x + 5y)$ equals

18–1 $3x + \frac{11y}{2} - \frac{11x}{5} - 2y$

18–2 $3x + \frac{11y}{2} + \frac{11x}{5} - 2y$

18–3 $3x + \frac{11xy}{10} - 2y$

18–4 $3x^2 - 2y^2$

18–5 $3x - 2y$ . . . 18(   )

19. The sum of the angles of a triangle is 180 degrees. If the two *larger* angles of the triangle are equal, and the difference between one of them and the third angle is 30 degrees, how many degrees are there in the third angle?

19–1 25
19–2 40
19–3 50
19–4 55
19–5 75 . . . . . 19(   )

20. If the sum of the two dimensions of a rectangle is 17, and the area of the rectangle is 72, one of the dimensions is

20–1 $6\frac{1}{2}$
20–2 12
20–3 3
20–4 4
20–5 8 . . . . . 20(   )

21. What is the value of $8^{\frac{2}{3}}$?

21–1 $5\frac{1}{3}$

21–2 $7\frac{1}{3}$

21–3 $21\frac{1}{3}$

21–4 4
21–5 12 . . . . . . 21(   )

22. After simplification, $\frac{3 + x}{x} - \frac{x + y}{y}$ reduces to

22–1 $\frac{3 - x}{x - y}$

22–2 $\frac{3y - x}{x + y}$

22–3 $\frac{3y - x^2}{xy}$

22–4 $\frac{3 - x + 2xy}{xy}$

22–5 $\frac{4x - xy}{x + y}$ . . . 22(   )

23. $b(-a) - (a - b)$ equals

23–1 $b - ab - a$
23–2 $-b - ab - a$
23–3 $-b + ab + a$
23–4 $2b - 2a$
23–5 0 . . . . 23(   )

24. If $ab = \frac{3}{2}$ and $ac = \frac{5}{2}$, what does $\frac{b}{c}$ equal?

24–1 $\frac{15}{4}$

24–2 2

24–3 $\frac{3}{5}$

24–4 $\frac{1}{2}$

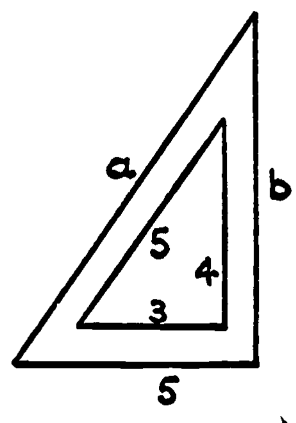
24–5 $\frac{4}{15}$ . . . . . . 24(   )

25. $\frac{(x^5)^2}{x}$ equals

25–1 10
25–2 25
25–3 x^6
25–4 x^9
25–5 x^{24} . . . . . . 25(   )

26. $(\sqrt{a + x} + \sqrt{x})(\sqrt{a + x} - \sqrt{x})$ equals

26–1 $a + x$
26–2 $a - x$
26–3 x
26–4 a
26–5 $a + \sqrt{ax} + x$. 26(   )



27. The two triangles shown above are similar. What is the length of side b?

27–1 6
27–2 7

27–3 $3\frac{3}{4}$

27–4 $6\frac{2}{3}$

27–5 $8\frac{1}{3}$ . . . . . 27(   )

28. If the perimeter of an equilateral triangle with side x is equal to the perimeter of a square with side s, what does x equal in terms of s?

28–1 $x = \sqrt{s}$

28–2 $x = \frac{4s}{3}$

28–3 $x = \frac{9s}{16}$

28–4 $x = \frac{s}{12}$

28–5 $x = s - 1$ . . 28(   )

29. $3\sqrt{3} + 4\sqrt{12}$ equals

29–1 $7\sqrt{3}$
29–2 $7\sqrt{15}$
29–3 $9\sqrt{3}$
29–4 $11\sqrt{3}$
29–5 $19\sqrt{3}$ . . . . 29(   )

Go on to the next page.

30. If $\frac{pq + x}{12} = R$, then p equals

30–1 $\frac{12R - x}{q}$

30–2 $\frac{12R}{q + x}$

30–3 $12R - (q + x)$

30–4 $\frac{12R}{x} - q$

30–5 $\frac{R(12 - x)}{q}$ . . .30( )

31. What is the value of y in the simultaneous equations $\left\{\begin{array}{l} 5x - y = -15 \\ x + 3y = 13 \end{array}\right\}$?

31–1 -20
31–2 2
31–3 -7
31–4 $3\frac{2}{3}$
31–5 5 . . . . .31( )

32. If a square root of $(x^2 + ax + b)$ is $(x - 4)$, what is the value of b?

32–1 16
32–2 2
32–3 8
32–4 -2
32–5 -8 . . . . . .32( )

33. If the numerical value of the volume of a cube is 64, what is the numerical value of the area of one of its faces?

33–1 8
33–2 $10\frac{2}{3}$
33–3 16
33–4 $21\frac{1}{3}$
33–5 32 . . . . . .33( )

34. If the hypotenuse of a right triangle is 24 feet, and one leg is half the hypotenuse, how long is the other leg?

34–1 6 feet
34–2 12 feet
34–3 $2\sqrt{3}$ feet
34–4 $6\sqrt{2}$ feet
34–5 $12\sqrt{3}$ feet . . 34( )

35. If a train runs M miles in 5 hours, how many miles will it run in K hours at the same rate?

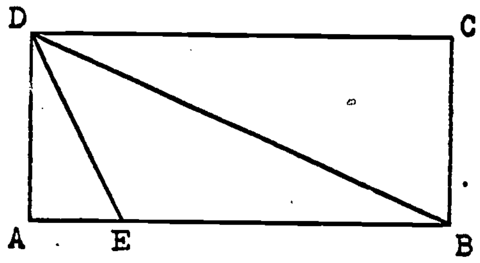
35–1 $\frac{K}{5M}$

35–2 $\frac{5M}{K}$

35–3 $\frac{5K}{M}$

35–4 $\frac{M}{5K}$

35–5 $\frac{KM}{5}$ . . . . .35( )



36. In rectangle $ABCD$, $AD = 4$, and line DE divides AB into segments $AE = 2$ and $EB = 7$. What is the area of the triangle DEB?

36–1 8
36–2 14
36–3 18
36–4 28
36–5 $2\sqrt{97}$ . . . . .36( )

37. After simplification, $\sqrt[5]{1215}$ reduces to

37–1 $15\sqrt[5]{3}$
37–2 $3\sqrt[5]{5}$
37–3 $5\sqrt[5]{3}$
37–4 $\sqrt[5]{15}$
37–5 $3\sqrt[5]{15}$ . . . . .37( )

38. $\log \frac{xy}{m}$ equals

38–1 $\log (x + y - m)$
38–2 $\log (x + y) + \log m$
38–3 $\log x + \log y - \log m$
38–4 $\frac{\log x \log y}{\log m}$
38–5 $\frac{\log (x + y)}{\log m}$. 38( )

39. If the roots of the equation $3x^2 - 5x - 2 = 0$ are added together, the sum is

39–1 1
39–2 $1\frac{2}{3}$
39–3 -3
39–4 $-2\frac{1}{3}$
39–5 -1 . . . . . .39( )

40. If the numerical values of the circumference and area of a circle are equal, what is the radius of the circle?

40–1 1
40–2 2
40–3 $\frac{1}{2}$
40–4 $\frac{1}{4}$
40–5 π . . . . . . .40( )

Number wrong	0–2	3–6	7–10	11–14	15–18	19–22	23–26	27–30	31–+
Amount to be subtracted	0	1	2	3	4	5	6	7	8

Number right________

Subtract________
(See table above)

Raw Score = Difference________

APPENDIX E

PRELIMINARY PLACEMENT CLASSIFICATION

There are three Algebra courses offered at El Camino College. They are: Mathematics A - Basic Algebra, Mathematics D - Intermediate Algebra, and Mathematics 1 - College Algebra. All entering full time students enrolling in any Mathematics course higher than Mathematics A are required to take the "Cooperative Mathematics Pre-Test for College Students." According to W. R. Peterson, (9:8) the following criteria were recommended for use in placement of the students in the Mathematics curriculum.

> 1 to 1½ years of high school algebra and Raw Score of 14 or higher----Math D.
>
> 1 to 1½ years of high school algebra and Raw Score of less than 14---check grades in high school algebra. A and B grades, Math D; C and D grades, Math A.
>
> 2 years of high school algebra and Raw Score of 24 or higher--Math 1.
>
> 2 years of high school algebra and Raw Score of less than 24--check high school algebra grades. A and B grades, Math 1; C and D grades, Math D.

Using the above criteria, the students in this study were placed in one of five categories: Math 1, Math D or 1, Math D, Math A or D, and Math A. For purposes of analysis these categories were assigned numbers in the following manner: Math 1 - 5, Math D/1 - 4, Math D - 3, Math A/D - 2, and Math A - 1.

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