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A Statistical Analysis of the Achievements of Students who Enrolled in a Remedial Mathematics Course Offered at the University of Omaha

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A STATISTICAL ANALYSIS OF THE ACHIEVEMENTS OF STUDENTS WHO ENROLLED IN A REMEDIAL MATHEMATICS COURSE OFFERED AT THE UNIVERSITY OF OMAHA

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D. C. B.

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CHAPTER I

NATURE OF THE STUDY

During the past three years the mathematics department of the University of Omaha has offered a course in improving basic mathematical skills. The course is open to any student who feels he needs some additional work in mathematics before he enrolls in the regular beginning college mathematics, chemistry, or accounting courses. However, most of the students who take the course do so as a result of their counselor's recommendation. If the student receives a low score on the Numerical Ability section of the Differential Aptitude Tests (one of the tests given to all incoming freshmen), he is encouraged to take the remedial mathematics course. Analysis of the class membership revealed that 80 per cent of the students were freshmen, 14 per cent were sophomores, 4 per cent were juniors, and 1 per cent were seniors. The remaining 1 per cent were either unclassified or information concerning their classification was not available.

This remedial mathematics course is listed in the university's general catalog as Mathematics 95: Improvement in Basic Mathematical Skills. The catalog description reads: "For students lacking mathematics entrance requirements, or review of arithmetic and algebra [sic]."[1] Basic content of the course consists of arithmetic including

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[1] General Catalog 1957-58--1958-59 (Bulletin of the University of Omaha, Vol. XIX, No. 2; Omaha: January, 1957), p. 95.

fractions, decimals, and percentages, and elementary algebra up to and including simple linear equations. Classes meet five hours per week; the course grants two semester hours credit when successfully completed. Samples of some of the tests given in the course are included in Appendix B of this thesis.

I. THE PROBLEM

Statement of the problem. The primary purpose of the study was to discover the effect Mathematics 95 (a remedial course in mathematics offered at the University of Omaha) had upon the achievement of students who completed the course and then went into the regular beginning college courses in mathematics, chemistry, and accounting. A second purpose was to study the Mathematics 95 course itself in an attempt to see if factors such as age, sex, and marital status were related to the achievement of the students. The study of the Mathematics 95 course itself was done first as a preliminary to the primary purpose of the study.

Importance of the study. The course in Mathematics 95 was an experimental attempt to meet the need of providing something in the line of special aid for students entering the University of Omaha without adequate ability in the mathematical skills. University officials wanted to know what success the course was having in preparing students for the regular beginning college courses in mathematics, chemistry, and accounting. The instructor of the course desired information

concerning the effectiveness of the course in improving basic mathematical skills and the nature of the performance of the students within the course itself. This study was conducted for the purpose of providing such information.

Basic Principles. The study was constructed on the null hypothesis that students who completed the Mathematics 95 course and then went into the regular beginning college courses in mathematics, chemistry, and accounting would receive grades in these courses which would not differ from the grades received by students who had similar raw scores on the Numerical Ability section of the Differential Aptitude Tests but had not taken Mathematics 95. An alternative hypothesis was that the grades of the Mathematics 95 students would differ from the grades of the non-Mathematics 95 students. In dealing with the data collected, some basic assumptions were made. It was assumed that the Numerical Ability test was properly administered in all cases so that comparison of scores achieved before and after completion of Mathematics 95 would yield a measure of learning which would be as nearly objective and accurate as possible. It was also assumed that although several instructors were involved, instruction given in all classes of a particular subject would be so similar that the achievement of students from different classes could be compared objectively. This assumption was made so that comparisons of the achievement of students in the experimental group could be made with the achievement of students in a control group without requiring the experimental student and the

control student with whom he was being compared to be in the same class. It would have been almost impossible to find a control student for the experimental students without allowing this mixing of the classes.

II. DEFINITIONS OF TERMS USED

Mathematics 95 student. A Mathematics 95 student was one who had completed the course in remedial mathematics and had received a final grade of A, B, C, D, or F. Students who received final grades of Incomplete, Condition, or Withdrawn were not considered in this study.

Regular beginning college course. The first course offered a beginning student in a particular department of the University of Omaha was called a regular beginning college course. This study dealt with such courses in the mathematics, chemistry, and accounting departments.

Mathematics 111A. Mathematics 111A is the regular beginning college course in the mathematics department. It is the first course in algebra and is followed by Mathematics 111B, College Algebra. The general catalog description reads: "Topics from third semester algebra and from introductory college algebra. Prerequisite: One year each of high school algebra and geometry or permission. Credit 3 hours."[2]

Chemistry 111. The regular beginning college courses in the chemistry department are Chemistry 111 and 112, College Chemistry:

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[2] Ibid., p. 56.

"Lecture 3 hours, laboratory 4 hours; not open to those with high school chemistry. Prerequisite: 1 year each, high school algebra and geometry. 111 prerequisite to 112. Credit 4 hours each."[3] This study dealt with Chemistry 111 only.

Accounting 101. The regular beginning college courses in the accounting department are Accounting 101 and 102, Elementary Accounting: "Theory and principles of accounting; analysis and recording of business transactions; control accounts, adjusting and closing entries, financial statements. Second semester, business vouchers; partnerships; basic corporation accounting; departmentalization; introduction to cost accounting; budgeting; analysis of financial statements. 101 prerequisite to 102, 2 hrs. lecture, 2 hrs. lab. Credit 3 hours each."[4]

Reading 97. The course referred to as Reading 97 in this thesis is listed as: "Reading Development 97, Reading Improvement: For students who need to improve their reading and study skills. Open to all University students. Credit 1 hour."[5]

Experimental group. Students who had completed Mathematics 95 and received a grade of A, B, C, D, or F were the only ones considered for inclusion in the experimental group. This group was composed of those Mathematics 95 students who had also completed at least one of the regular beginning college courses in mathematics, chemistry, or accounting after they had completed Mathematics 95 and had received grades of

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[3] Ibid., p. 40. [4] Ibid., p. 137. [5] Ibid., p. 95.

A, B, C, D, or F in the subsequent courses. If a Mathematics 95 student enrolled for one of these courses and withdrew or received a final mark of Incomplete or Condition, he was not included in the experimental group.

Control group. In order to compare the achievement of the Mathematics 95 students in the regular beginning college courses in mathematics, chemistry and accounting with the achievement of students in the same courses who had not taken Mathematics 95, a control group was set up. Selection of the controls was done on the basis of the raw score on the Numerical Ability section of the Differential Aptitude Tests. The experimental group and the control group were not matched by pairs. Instead, all members of the control group who had the same raw score were grouped together, and the mean of their grades was matched with the grade of the student in the experimental group. If two or more students in the experimental group had the same raw score, their grades were also combined and the mean was used.

Differential Aptitude Tests. The Differential Aptitude Tests are an "integrated battery of guidance tests."[6] In the words of the test authors:

> The Differential Aptitude Tests were prepared to meet the needs of counselors and students for an integrated battery of

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[6] George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, A Manual for the Differential Aptitude Tests (New York: The Psychological Corporation, 1952), p. 1.

> well-standardized tests, each of which would provide meaningful scores, readily interpretable by informed counselors and teachers, and broadly inclusive of aptitude for many significant areas.[7]

The authors summarize the meaning of "aptitude" as simply a capacity to learn a particular skill.[8] The test battery contains eight tests: Verbal Reasoning, Numerical Ability, Abstract Reasoning, Space Relations, Mechanical Reasoning, Clerical Speed and Accuracy, and Language Usage: Spelling and Sentences. Only the Numerical Ability test was used in this study.

Numerical Ability Test. In this thesis the term "Numerical Ability Test" refers to the mathematics section of the Differential Aptitude Tests battery. The authors say:

> The Numerical Ability Test is a measure of the student's ability to reason with numbers, to manipulate numerical relationships and to deal intelligently with quantitative materials. . . . Educationally it is important for prediction in such fields as mathematics, physics, chemistry, engineering, and other curricula in which quantitative thinking is essential.[9]

The study dealt with raw scores received on this test; the highest possible raw score is forty.

Freshman, Sophomore, Junior, Senior. According to the academic

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[7]George K. Bennett, Harold G. Seashore, and Alexander G. Wesman, "The Differential Aptitude Tests: An Overview," Personnel and Guidance Journal, 35:81-93, October, 1956.

[8]Bennett, Seashore, and Wesman, A Manual for the Differential Aptitude Tests, p. 2.

[9]Ibid., p. 6.

classification system used by the University of Omaha, a freshman is a student who has completed less than 27 semester hours of credit; a sophomore has completed from 27 to 57; a junior from 58 to 90; and a senior from 91 to 124.[10]

A, B, C, D, F. The University of Omaha uses a letter grading system. "Passing grades are A, B, C, and D, the last named being the lowest. F indicates failure and results in loss of credit."[10]

Achievement. Achievement was interpreted as meaning the end result of completing a particular course. The assumption was made that achievement could be measured by the final grade received for the course and by the difference in the raw scores received on the Numerical Ability test which was taken before and after completion of Mathematics 95.

Significance. As pointed out by Wallis and Roberts, it is important not to confuse the statistical usage of "significance" with the everyday usage.

> In everyday usage, "significant" means "of practical importance," or simply "important." In statistical usage, "significant" means "signifying a characteristic of the population from which the sample is drawn," regardless of whether the characteristic is important.[11]

In this thesis, "significance" will refer to the statisfical usage.

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[10] General Catalog 1957-58--1958-59, p. 27.

[11] W. Allen Wallis and Harry V. Roberts, Statistics: A New Approach (Brooklyn: Book Production Company, 1957), p. 385.

Level of significance. Jaynes defines level of significance as "a predetermined value of significance which leads to the rejection of H_o. . . . The probability of rejecting H_o when H_o is true."[12] (H_o refers to the null hypothesis.)

III. ORGANIZATION OF THE REMAINDER OF THE THESIS

Chapter II of this thesis will explain the method of procedure used in conducting the study. Chapter III will present a review of the literature dealing with similar studies. The data relating to the students' achievement in Mathematics 95 and the analysis of the data appear in Chapter IV. Chapter V contains the data relating to the achievement of the Mathematics 95 students in other mathematics, chemistry, and accounting courses and the analysis of the data. The final chapter, Chapter VI, will summarize the findings of the study and present the conclusions. A bibliography and the appendices follow the body of the study.

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[12] William E. Jaynes, "Statistical Methods" (Omaha: University of Omaha, 1958). (Mimeographed.)

CHAPTER II

METHOD OF PROCEDURE

This study was carried out in three separate but related parts. First of all an intensive search of the literature in the field was made in order to determine whether any studies of a similar nature had previously been made. Second, the data concerning the Mathematics 95 course itself were collected and analyzed. Third, the data concerning the achievement record of the Mathematics 95 students in the regular beginning college mathematics, chemistry, and accounting courses were collected and analyzed.

In dealing with the Mathematics 95 course itself, an attempt was made to determine the relationship, if any, existing between several factors and the final grade received for the course. Three of these factors were age, sex, and marital status. The difference in the raw score on the re-take of the Numerical Ability test after completion of Mathematics 95 was also tabulated with reference to the age and sex of the students. The grades received by students who took Reading 97, Reading Improvement, before taking Mathematics 95 were studied to see if any relationship existed between the two courses.

In working with the data concerning the achievement of the Mathematics 95 students in other courses, care was taken to see that they had completed Mathematics 95 before beginning the next course. Students enrolled in the courses at the same time were excluded from the experimental group. If a student was enrolled in two of the regular

beginning college courses during a particular semester, his record in both courses was included in the study. If any of the essential data for a student were not available, he was excluded from the experimental group. In this part of the study a control group was used to aid in determining the effect the Mathematics 95 course was having on future performance of students. The control group was composed of students who were enrolled in the same courses as the members of the experimental group. The control group was selected on the basis of the raw scores received on the Numerical Ability test taken by students when they enter the university. The controls were not matched with the experimental group by pairs, but rather all students who received a particular raw score were grouped together and the group was matched with the student (or students) in the experimental group who had the same raw score. This grouping was done so that more accurate comparisons of final grades could be made; instead of selecting one student from the experimental group, the mean of the grades of all possible control students was used.

Only data from the 1956-57 and 1957-58 school terms and the 1957 and 1958 summer sessions were available, so this study deals with a two-year time span. Since only 11 per cent of the Mathematics 95 students were women, and an even smaller percentage was found in the regular beginning college courses so that controls could not be found for the women, that part of the study dealing with the achievement of Mathematics 95 students in other courses was based only on men students.

CHAPTER III

REVIEW OF THE LITERATURE

Very little was found in the literature which was related to the study being conducted. Most of the material dealt with general mathematics courses rather than remedial courses. Several writers suggested what should be included in a general mathematics program and why each item should be included. Chief among these were Mires,[13] Simpson,[14] and Summerer.[15] Hildebrandt[16] also presented methods of teaching general mathematics. Brown compared two studies, one made in 1942 and one in 1947, and concluded that college general mathematics had lost ground in the number of institutions offering it for two reasons: lack of proper teaching staff in the face of increased enrollments and lack of a desirable textbook.[17]

Two very interesting reports of a study involving remedial mathematics at Brooklyn College and School of Education, New York University,

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[13]Katherine C. Mires, "General Mathematics for College Freshmen," The Mathematics Teacher, Vol. I, No. 7:513-516, November, 1957.

[14]T. M. Simpson, "Mathematics in the College General Education Program," The Mathematics Teacher, 50:155-159, February, 1957.

[15]Kenneth H. Summerer, "College Mathematics for the Non-Science, Non-Mathematics Major," School Science and Mathematics, 56:39-43, January, 1956.

[16]E. H. C. Hildebrandt, "For a Better Mathematics Program," The Mathematics Teacher, 49:89-99, February, 1956.

[17]Kenneth E. Brown, "Is General Mathematics in the College on Its Way Out?" The Mathematics Teacher, 41:154-158, April, 1948.

were found.[18, 19] The results achieved by that study appeared to be outstanding so a rather detailed explanation of the study follows.

The purpose of that study was to test one way in which an institution could meet the problem of providing freshmen students with a review program to prepare them for college mathematics courses. An experimental group of about sixty freshmen students was given approximately fourteen hours of remedial work devoted solely to the topics prerequisite to trigonometry. This remedial work was given to the students in small groups of four for one hour each week. Each student worked on only those topics in which he needed remedial help. The remedial work was given during the semester in which the trigonometry course was being studied. (The trigonometry course precedes college algebra and is taken mainly by the lower freshmen.) A control group was selected which received no remedial instruction.

At the end of the course, the experimental group had attained greater skill than the control group and greater skill than the students of the originally superior total group who received A as their final grade. The students who received remedial help also performed better than the control group and the total group in subsequent mathematics courses.

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[18] Jack Wolfe, "An Experimental Study in Remedial Teaching in College Freshman Mathematics," Journal of Experimental Education, 10:33-37, September, 1941.

[19] Jack Wolfe, "Mathematical Skills of College Freshmen in Topics Prerequisite to Trigonometry," The Mathematics Teacher, 34:164-170, April, 1941.

In concluding one of his reports of the study, the author says:

> As a result of conducting with college freshmen an experiment in remedial work in the skills prerequisite to trigonometry, the writer believes that the most efficient way, administratively and educationally, for an institution to meet the problem of review is by the introduction of a definite, specific, and individualized remedial program for the students who need it.[20]

The author includes a complete description of the plan of remedial instruction given. He also points out that it is highly possible that the students in the experimental group were scholastically superior to similar groups in other colleges. He explains:

> The students admitted to the day session of Brooklyn College are a scholastically select group, as attested by the relatively high entrance requirements and by the fact that on the Thurstone Psychological Examination the median score of the Brooklyn College entering freshmen ranked twenty-first in a descending order listing of the median scores of 323 colleges.[21]

He feels that "it is likely that the favorable results observed may not appear to the same extent, if the remedial program is administered to a group less capable of profiting from the assistance."[22]

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[20] Wolfe, "An Experimental Study in Remedial Teaching in College Freshman Mathematics," p. 36.

[21] Ibid., p. 37.

[22] Ibid.

CHAPTER IV

ANALYSIS OF STUDENTS' ACHIEVEMENT IN MATHEMATICS 95

The instructor of the Mathematics 95 course wanted some information about the achievement of the students in the course itself. This chapter will present information secured from an analysis of the data concerning the students who took the course and the grades they received. Such factors as age, sex, and marital status and their relation to final grades will be explored.

There were 228 students who received final grades for the course. Of this number, 4 students received an Incomplete so they were not included in this part of the study.

An attempt was made to determine whether men or women students received higher grades in the course and whether marital status had any effect on the grades. Analysis of the data presented in Table VIII, which appears in Appendix A, revealed that two hundred men and twenty-four women completed the course. Thirty-four of the men were married; all of the women were single. Mean grades were obtained for these three groups of students by giving numerical values to the letter grades according to this system: F = 1, D = 2, C = 3, B = 4, and A = 5. The thirty-four married men earned a mean grade of 3.08 (C); the one hundred sixty-six single men earned a mean grade of 2.78 (C-); and the twenty-four women earned a mean grade of 2.50 (C-/D+). The mean grade for the total group was 2.80 (C-). The differences between the groups were very small, but the men did slightly better than the women and the married

men did slightly better than the single men and women.

Table I shows the relationship existing between age and the final grade received in Mathematics 95. Seventeen of the students who took Mathematics 95 are not included in the table because their age was unknown, they received a final Incomplete in the course, or there were only one or two students at a particular age level. The table shows that the students who were twenty-four, twenty-five, and twenty-six years old received the highest grades. However, the groups at these age levels were smaller than most of the other groups.

The Numerical Ability section of the Differential Aptitude Tests was administered to these students before and after they took Mathematics 95. Table II shows the increase in mean raw score attained by the students on the second administration of the test. (For various reasons fifty of the students missed one or both of the testing sessions, or other essential data were not available so that they could not be included here.) The students are grouped by age and sex; there are twelve different age groups made up of ten groups of men students and seven groups of women students (three of these women's "groups" contain only one student.) Only five of the age groups contain both men and women. Analysis of these five pairs of groups reveals that at each of the five ages the men had a higher mean raw score on the Numerical Ability test taken before the course than did the women, and in four of the five age groups the men maintained this higher mean raw score on the re-take of the test after the course. However, in three of the age groups the raw scores of the women increased more than the raw scores of

TABLE I

MEAN FINAL GRADES OF STUDENTS IN MATHEMATICS 95 GROUPED BY AGE

AGE	NUMBER OF STUDENTS	MEAN FINAL GRADE
18	33	2.64
19	45	2.51
20	35	2.43
21	13	2.69
22	23	3.04
23	16	3.19
24	23	3.43
25	11	3.27
26	8	3.63
27	4	2.50

NOTE: For this table letter grades were given numerical values according to this system: F = 1, D = 2, C = 3, B = 4, A = 5.

TABLE II

MEAN NUMERICAL ABILITY RAW SCORES BEFORE AND AFTER COMPLETION OF MATHEMATICS 95 GROUPED BY AGE AND SEX

AGE	SEX	NUMBER OF STUDENTS	MEAN RAW SCORE BEFORE	MEAN RAW SCORE AFTER	AMOUNT OF INCREASE
17	F	1	9.0	13.0	4.0
18	M	23	20.7	25.7	5.0
18	F	5	10.8	21.2	10.4
19	M	29	16.4	21.9	5.5
19	F	8	13.3	20.8	7.5
20	M	21	15.1	22.6	7.5
20	F	5	12.6	18.2	5.6
21	M	10	14.4	21.1	6.7
21	F	2	8.5	12.5	4.0
22	M	16	17.9	24.5	6.6
23	M	15	16.3	23.5	7.2
23	F	1	15.0	24.0	9.0
24	M	17	16.7	26.5	9.8
25	M	9	16.7	26.1	9.4
26	M	8	15.5	25.4	9.9
27 - 33	M	7	12.6	20.6	8.0
28	F	1	22.0	30.0	8.0
Totals:	M	155	16.7	23.9	7.2
	F	23	12.4	19.8	7.4

the men. Combining all the men into one group and all the women into another bears this out, but the difference in the increase is very small. According to the national percentile rankings for twelfth grade students as given in the Differential Aptitude Tests manual these mean raw scores place these University of Omaha men at the twenty-fifth percentile before the course and the fiftieth after the course; the women place at the thirtieth percentile before and the sixtieth after. As a result of administering the test for several years, the Omaha University department of student testing has formulated its own percentiles for Omaha University freshmen. Here these men place at the twenty-third percentile before the course and the forty-ninth after; the women are at the fourteenth percentile before and the thirty-sixth after.

The University of Omaha also offers a course in reading improvement. This course, Reading 97, was taken by some of the students who took Mathematics 95. Table III shows a comparison of final grades received in Mathematics 95 by students who took Reading 97 and those who did not. The mean of the grades for each group was computed to see if the students who had taken the reading course before the mathematics course would receive higher grades in Mathematics 95 than those who had not completed the reading course first. The 132 students who took only Mathematics 95 or took Reading 97 after they had completed Mathematics 95 earned a mean grade of 2.89 (C-) in Mathematics 95. The 22 students who took Reading 97 before Mathematics 95 earned a mean grade of 2.95 (C-). The 70 students who were enrolled in the two courses at the same time earned a mean grade of 2.56 (C-).

TABLE III

COMPARISON OF FINAL GRADES RECEIVED IN MATHEMATICS 95 BY STUDENTS WHO TOOK ONLY MATHEMATICS 95 AND STUDENTS WHO TOOK BOTH MATHEMATICS 95 AND READING 97

GRADE IN MATH. 95	NUMBER OF STUDENTS WHO TOOK MATH.95 ONLY	NUMBER OF STUDENTS WHO TOOK READING 97 AFTER MATH. 95	NUMBER OF STUDENTS WHO TOOK READING 97 BEFORE MATH.95	NUMBER OF STUDENTS WHO TOOK READING 97 AND MATH.95 AT THE SAME TIME
A	7	0	2	3
B	38	1	8	12
C	32	7	3	21
D	24	3	5	20
F	20	0	4	14
Totals	123	13	22	70

CHAPTER V

ANALYSIS OF MATHEMATICS 95 STUDENTS' ACHIEVEMENT IN OTHER MATHEMATICS, CHEMISTRY, AND ACCOUNTING COURSES

The purpose of this part of the study was to determine what effect the Mathematics 95 course had upon the achievement of students who went into the regular beginning college courses in mathematics, chemistry, and accounting. This chapter contains the tables and figures presenting the data used for this part of the study, an explanation of the formula used to determine significance, and the analyses of the data collected.

A null hypothesis was formulated which stated that students who completed Mathematics 95, the experimental group, would receive grades in subsequent courses which would not differ from the grades of a control group of students who had similar raw scores on the Numerical Ability test but had not taken Mathematics 95. An alternative hypothesis was that the grades of the experimental group would differ from the grades of the control group.

The data were obtained from the permanent records of the university registrar's office: the class grade sheets and the student's registration card and permanent record folio. The final conclusions of the study were based upon a comparison of final grades received by the experimental group and by a control group.

As pointed out in Chapter II, a control group was used to measure the effect of the Mathematics 95 course on the subsequent performance of

students. This control group was not matched with the experimental group by pairs, but rather students who received the same raw score on the Numerical Ability test were grouped and the group was compared with the members of the experimental group. In most cases a member of the experimental group could have been matched with any one of several members of the control group. Rather than selecting one control from the group of possible controls (in at least two cases their final grades ranged from A to F), the mean of the grades was used as a control. In cases where two or more members of the experimental group had the same raw score, they too were grouped and the mean of their final grades was used. It was felt that this grouping would provide a more accurate method of comparing the experimental students with the control students.

Table IV presents the data in regard to the achievement of the experimental group and the control group in Mathematics 111A. Fifty-five students who completed Mathematics 95 went into and completed Mathematics 111A. (Table VIII shows 63 students who completed Mathematics 111A. For 7 of these students no beginning raw score was available, and another one received "Incomplete" as a final grade for Mathematics 95 so they could not be included in this part of the study.) Of the 55 students included in Table IV, no control students were found to match 3 of the experimental group students. For the control group, complete data for 209 students who had the same Numerical Ability raw scores as the experimental group students were found. So the achievement of 52 experimental group students was compared to the achievement of 209 control group students. Further analysis of the table shows that

TABLE IV

EXPERIMENTAL GROUP ACHIEVEMENT IN MATHEMATICS 111A COMPARED TO THAT OF THE CONTROL GROUP

DAT NUMERICAL ABILITY RAW SCORE	MATHEMATICS 111A FINAL GRADES				EXPERIMENTAL GROUP MEAN COMPARED TO CONTROL GROUP MEAN*
	EXPERIMENTAL GROUP		CONTROL GROUP		
	Mean Grade	No. of Students	Mean Grade*	No. of Students*	
4	1.0	1			
5	1.0	1			
6	---	---			
7	1.0	1			
8	1.0	1	2.0	2	- 1.0
9	1.0	2	1.0	2	0.0
10	1.0	2	3.0	1	- 2.0
11	1.0	2	2.7	3	- 1.7
12	2.0	1	1.4	5	+ .6
13	1.3	3	1.3	4	0.0
14	1.0	3	1.6	9	- .6
15	1.0	2	1.5	4	- .5
16	1.3	4	1.3	8	0.0
17	1.3	6	1.4	9	- .1
18	1.0	2	1.0	2	0.0
19	1.8	5	1.9	20	- .1
20	1.7	3	2.2	11	- .5
21	1.0	1	1.7	20	- .7
22	1.7	3	2.0	4	- .3
23	3.0	1	2.1	13	+ .9
24	1.0	1	1.8	16	- .8
25	1.0	1	2.7	12	- 1.7
26	1.5	2	2.7	13	- 1.2
27	3.0	1	2.6	17	+ .4
28	---	---	---	---	---
29	1.7	3	2.6	14	- .9
30	2.0	2	2.8	9	- .8
31	3.0	1	2.9	11	+ .1

NOTE: For this table letter grades were given numerical values according to this system: F = 1, D = 2, C = 3, B = 4, A = 5.

*Blank spaces in these columns indicate that no control students were found to match the students in the experimental group.

these students had a total of twenty-three different Numerical Ability raw scores, so twenty-three pairs of groups of students are being compared. It should be pointed out that some of these "groups" consisted of only one student.

In four of these paired groups, there was no difference between the mean grade received by the experimental group and that of the control group. In four of the paired groups, a positive difference appeared; this means that the experimental groups received better final grades in Mathematics 111A than did the control groups. In fifteen of the paired groups a negative difference is shown; the experimental groups did not do as well as the control groups.

To determine whether these differences in mean grades were significant or not, a small group test of significance was used. The computational formula, derived from McNemar's Psychological Statistics,[23] was:

$$t = \frac{\frac{\Sigma D}{n}}{\sqrt{\frac{n\Sigma D^2 - (\Sigma D)^2}{n^2(n-1)}}}$$

In this formula, "D" refers to the difference between the means of the paired groups and "n" refers to the number of paired groups. Since this test is based on a normal distribution, the distribution of the differences of the means was first examined to see if it was sufficiently normal to justify the assumption of normality in the universe. Figure 1

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[23]Quinn McNemar, Psychological Statistics (New York: John Wiley & Sons, Inc., 1949), p. 226.

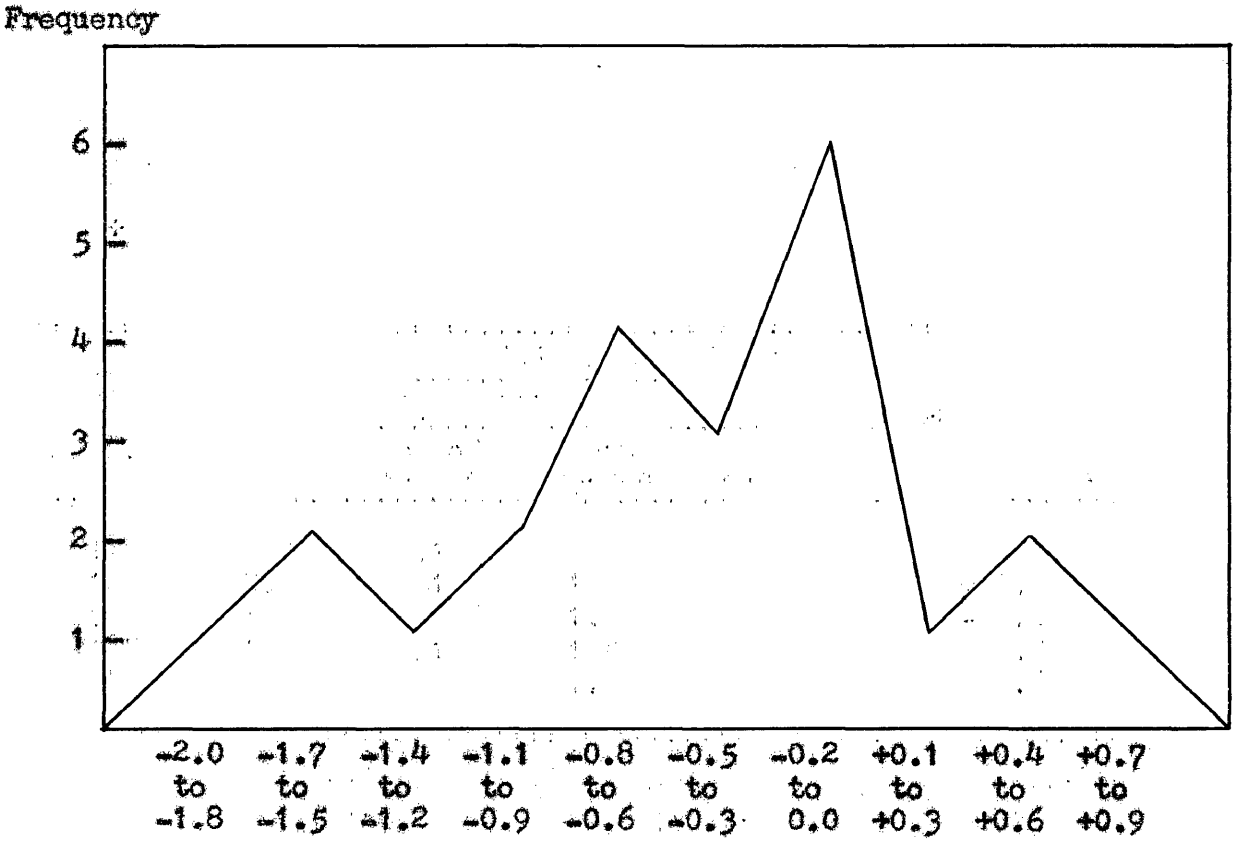

FIGURE 1

FREQUENCY OF THE DISTRIBUTION OF THE DIFFERENCES OF THE MEAN GRADES IN MATHEMATICS 111A BETWEEN THE EXPERIMENTAL GROUP AND THE CONTROL GROUP

presents the distribution of the differences and indicates that the assumption could reasonably be made. Computation yielded a t value of 3.09. When this value was referred to a t table, it was discovered that the difference between the means was significant beyond the 1 per cent level. This result led to rejection of the null hypothesis in favor of the alternative: the experimental group received lower grades than the control group.

Tables V and VI present the data in regard to the achievement of the experimental group and the control group in Chemistry 111 and Accounting 101. The experimental group consisted of only five students in Chemistry 111 and only thirteen in Accounting 101. Of the five chemistry students, no control group existed for one, and of the thirteen accounting students, four had no control group. Applying the t values obtained from the small group test of correlation to a t table revealed that the difference between the means was not significant at the 5 per cent level for either course. Therefore the null hypothesis was accepted: the grades of the two groups of students were not different.

Table VII shows an over-all comparison of achievement of the experimental group with all other students who took Mathematics 111A, Chemistry 111, and Accounting 101. This comparison was made only on the basis of the percentage of students in each group who passed the courses; Numerical Ability raw scores were not involved. Three groups are shown: the group of students who first passed Mathematics 95, the group of students who had not had Mathematics 95, and the total group.

TABLE V

EXPERIMENTAL GROUP ACHIEVEMENT IN CHEMISTRY 111 COMPARED TO THAT OF THE CONTROL GROUP

DAT NUMERICAL ABILITY RAW SCORE	CHEMISTRY 111 FINAL GRADES				EXPERIMENTAL GROUP MEAN COMPARED TO CONTROL GROUP MEAN*
	EXPERIMENTAL GROUP		CONTROL GROUP		
	Mean Grade	No. of Students	Mean Grade*	No. of Students*	
11	2.0	1			
12	2.0	1	1.0	3	+ 1.0
16	1.0	1	1.2	5	- .2
18	1.0	1	1.5	2	- .5
24	1.0	1	1.6	12	- .6

NOTE: For this table letter grades were given numerical values according to this system: F = 1, D = 2, C = 3, B = 4, A = 5.

*Blank spaces in these columns indicate that no control students were found to match the students in the experimental group.

TABLE VI

EXPERIMENTAL GROUP ACHIEVEMENT IN ACCOUNTING 101 COMPARED TO THAT OF THE CONTROL GROUP

DAT NUMERICAL ABILITY RAW SCORE	ACCOUNTING 101 FINAL GRADES				EXPERIMENTAL GROUP MEAN COMPARED TO CONTROL GROUP MEAN*
	EXPERIMENTAL GROUP		CONTROL GROUP		
	Mean Grade	No. of Students	Mean Grade*	No. of Students*	
9	1.0	1	1.0	1	0.0
10	1.0	1			
13	2.5	2	1.0	1	+ 1.5
15	3.0	1	4.0	1	- 1.0
16	3.0	1	1.7	3	+ 1.3
17	1.0	1	2.3	4	- 1.3
18	3.0	2			
22	2.5	2	1.0	1	+ 1.5
25	1.0	1			
27	1.0	1	5.0	1	- 4.0

NOTE: For this table letter grades were given numerical values according to this system: F = 1, D = 2, C = 3, B = 4, A = 5.

*Blank spaces in these columns indicate that no control students were found to match the students in the experimental group.

TABLE VII

ACHIEVEMENT OF STUDENTS WHO PASSED MATHEMATICS 95 AND THEN FINISHED OTHER COURSES COMPARED TO THE ACHIEVEMENT OF OTHER STUDENTS IN THOSE COURSES

Course	Total Number Who Finished Course*	Per cent Who Passed Course	Number of Non-Math. 95 Who Finished Course*	Per Cent of Non-Math. 95 Who Passed Course	Number of Math. 95 Who Finished Course*	Per Cent of Math. 95 Who Passed Course
Mathematics 111A	595	58.7	533	61.2	62	33.9
Chemistry 111	336	64.3	331	64.7	5	40.0
Accounting 101	130	74.0	116	76.7	14	42.9
Totals	1061	62.2	980	64.3	81	35.8

*Does not include students who withdrew or received grades of "Incomplete" or "Condition".

The experimental groups are larger than those used in Tables IV, V, and VI because data necessary for those tables were not available for a few of the students included in this table. Inspection of the table reveals that the passing rate of the experimental group was much lower in all of the courses. In Mathematics 111A only 33.9 per cent of the experimental group passed the course compared to 61.2 per cent of those who had not taken Mathematics 95 and a passing rate of 58.7 per cent for the total group. In Chemistry 111 the percentages were 40.0, 64.7, and 64.3, and in Accounting 101 they were 42.9, 76.7, and 74.0. Grouping all three courses, 35.8 per cent of the experimental group passed, and 64.3 per cent of all other students passed. The total group percentage was 62.2.

Figure 2 shows what final grades sixty-two members of the experimental group received in Mathematics 95 and in Mathematics 111A. Analysis of the table reveals that of the thirteen who received C in Mathematics 111A, two had received A in Mathematics 95, eight had received B, and three had received C. Of the eight who received D in Mathematics 111A, five had received B in Mathematics 95 and three had received C. Of the forty-one who received F in Mathematics 111A, one had received A in Mathematics 95, seventeen had received B, fifteen had received C, and eight had received D.

These data show that none of the students who had failed Mathematics 95 attempted Mathematics 111A. Three students who received A in Mathematics 95 attempted Mathematics 11A: two received C and one received F. No student received a higher grade in

Math. 95 / Math. 111A	A	B	C	D	F	Total
A						
B						
C	2	8	3			13
D		5	3			8
F	1	17	15	8		41
Total	3	30	21	8		62

FIGURE 2

COMPARISON OF GRADES OF EXPERIMENTAL GROUP STUDENTS
IN MATHEMATICS 95 AND MATHEMATICS 111A

Mathematics 111A than he had in Mathematics 95; in fact, 95 per cent received lower grades.

Figures 3 and 4 show much the same result for Chemistry 111 and Accounting 101. All the students who took Chemistry 111 after Mathematics 95 received lower grades in the chemistry course than they had in Mathematics 95. One student who had received a C in Mathematics 95 earned a B in Accounting 101. Otherwise the pattern is much the same; 64 per cent received lower grades in the accounting course than they had received in Mathematics 95. No student who had failed Mathematics 95 attempted chemistry or accounting.

Math. 95 / Chem. 111	A	B	C	D	F	Total
A						
B						
C						
D			2			2
F			2	1		3
Total			4	1		5

FIGURE 3

COMPARISON OF GRADES OF EXPERIMENTAL GROUP STUDENTS
IN MATHEMATICS 95 AND CHEMISTRY 111

Math. 95 / Acctg. 101	A	B	C	D	F	Total
A						
B			1			1
C			3			3
D		1		1		2
F	1	1	3	3		8
Total	1	2	7	4		14

FIGURE 4

COMPARISON OF GRADES OF EXPERIMENTAL GROUP STUDENTS
IN MATHEMATICS 95 AND ACCOUNTING 101

CHAPTER VI

SUMMARY AND CONCLUSIONS

I. SUMMARY

The purpose of this study, carried out at the University of Omaha, was two-fold: (1) to provide information concerning the nature of the performance of the students who had taken a remedial course in mathematics; and (2) to discover what effect the remedial course in mathematics had upon the achievement of the students who completed the course and then went into other courses in mathematics, chemistry, and accounting. A null hypothesis was formulated which stated that students who completed the remedial mathematics course and then went into the regular beginning college courses in mathematics, chemistry, and accounting would receive grades which would not differ from the grades received by students who had similar raw scores on the Numerical Ability section of the Differential Aptitude tests but had not taken the remedial course. An alternative hypothesis was that the grades of the two groups of students would be different.

An intensive search of the literature failed to uncover any studies similar to this one. The reports which were found dealt with studies concerning either general mathematics courses or remedial assistance on a highly individualized basis. One of the latter studies was reported as being of great value to the students.

The data collected for the study yielded the following findings

about the achievement of the students in the remedial mathematics course itself:

1. Men students received slightly higher final grades for the course than women students.
2. Married men received slightly higher final grades than the single men and women (no married women completed the course).
3. Students who were twenty-four, twenty-five, and twenty-six years old received higher grades than students under twenty-four.
4. On both the pre-course and post-course administrations of the Numerical Ability test the men students had higher raw scores than did the women students.
5. The women students achieved a slightly greater increase in raw score on the Numerical Ability test between the pre-course and post-course test administrations.
6. According to the national percentile rankings for twelfth grade students as given in the Differential Aptitude Tests manual the women students ranked higher than the men.
7. The men students ranked higher on percentiles prepared on Omaha University freshmen.
8. Students who completed a remedial course in reading before they took the remedial mathematics course did not receive appreciably higher grades in the mathematics course than did students who did not take the reading course.

Analysis of the data concerning the performance of the students

who completed the remedial mathematics course and then went into the regular beginning college courses in mathematics, chemistry, and accounting also yielded several discoveries:

1. The students who completed the remedial mathematics course before they enrolled in the regular beginning course in mathematics received lower grades than did a group of students of similar ability who had received no remedial assistance. This difference was significant beyond the 1 per cent level.
2. The grades of the experimental group students were no different from the grades of the control group students in the regular beginning courses in chemistry and accounting. (In both these courses the experimental group was very small.)
3. The failure rate of the students who first completed the remedial mathematics course and then went into the regular beginning courses in mathematics, chemistry, and accounting was much higher in those courses than the failure rate for all other students who were in the same courses.
4. None of the students who failed the remedial mathematics course attempted the regular beginning courses in mathematics, chemistry, or accounting.
5. Only one student received a higher grade in a regular beginning course than he had received in the remedial course. A large majority of the students who passed the remedial course received lower grades in subsequent courses.

II. CONCLUSIONS

Although the remedial course in mathematics did improve the mathematical ability of the students as measured by a re-take of the Numerical Ability test, the failure rate of these students in subsequent courses showed that the remedial course did not bring them up to a level at which they could successfully compete with other college students. Perhaps students who are low in mathematical ability when they enter college are beyond the point at which they can profit from remedial courses. The very successful remedial program reported in Chapter III of this thesis was admittedly done with students who had more ability than the students who completed the remedial course at Omaha University, and it was conducted on a highly individualized basis. It must be remembered that the students in the Omaha University course were those who had scored lowest on the Numerical Ability test.

However, the discovery that the students in the experimental group received lower grades in the regular beginning college course in mathematics than did a control group of students who had similar raw scores on the Numerical Ability test leads to the conclusion that careful consideration should be given to the continuance of the remedial program at the college level. The fact that the experimental group failed to do significantly better than the control group in chemistry and accounting lends additional support to this conclusion. The remedial course as it is now offered is not adequately preparing the students for entrance into subsequent mathematics, chemistry, and

accounting courses. The author recommends that the course be changed from the regular classroom setting with a large group of students to a plan of individualized instruction so that the instructor would see the students in very small groups. In this way the students could study only those areas of mathematics which give them trouble; they would not need to spend time on topics which they already understood.

Some reason must exist which would cause a group of students who are given special remedial help to do less well in a subsequent course than another group of students with similar test scores who receive no remedial help. There are possible explanations: (1) Being in a remedial course for a whole semester has a negative psychological influence upon the students; (2) The students develop a negative attitude toward mathematics or develop poor study habits as a result of re-studying basic concepts; (3) Some students may find it easy to do passing work in the remedial course and are over-confident in the subsequent courses; (4) Some students may find the first few weeks of Mathematics 111A relatively easy and may put off really studying until after they have missed out on some basic material and can no longer catch up; and (5) Remedial work of this nature cannot be adequately handled in a classroom situation but must be done on a highly individualized basis.

A search for the causes of the poor achievement of the experimental group students in subsequent courses could well be a topic for future study.

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APPENDIX A

BASIC DATA

TABLE VIII

DATA FOR EXPERIMENTAL GROUP

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
1	19	M	Fr.	S	23	30	7	C						
2	19	F	Fr.	S	11	27	16	D						
3	20	M	Fr.	S	18	28	10	C			F			
4	24	M	Jr.	S	12	24	12	B						
5	24	M	So.	S	10			D				C		
6	21	F	Fr.	S	8	15	7	C				B		
7	19	M	Fr.	S	27	23	-4	D			F	D		
8	22	M	Fr.	M	14	20	6	C	F					A
9	19	M	Fr.	S	22	30	8	B						
10	20	M	So.	S		25		B	F			C		
11	19	M	Fr.	S	23	19	-4	C						D
12	24	M	So.	S	18	28	10	B				A		
13	19	M	Fr.	S	14			F						
14	18	M	Fr.	S	29	31	2	B	F					
15	20	M	Fr.	S	2	9	7	D						
16	23	M	Fr.	S	22	25	3	C	C		B			
17	20	M	Fr.	S	17	17	0	D					C	
18	20	M	Fr.	S	10	27	17	C						
19	18	M	Fr.	S	20	27	7	B						
20	24	M	Fr.	S	24			F					F	
21	24	M	Fr.	S	17	14	-3	C						
22	20	M	Fr.	S	5	22	17	C						
23	24	M	Fr.	S		23		B	D					
24	19	F	Fr.	S	9	19	10	D						
25	19	M	Fr.	S	17	18	1	D	F					F
26	22	M	Fr.	S	28	25	-3	B				F		
27	19	M	Fr.	S	13			F					F	
28	19	F	Fr.	S	17	16	-1	D					D	
29	21	M	So.	S	2	12	10	F						
30	23	M	Fr.	M	10	27	17	C	F					
31	22	M	Fr.	S	4			F					F	
32	24	M	Fr.	S	10	29	19	C	F		F		D	
33	20	M	So.	S	23	27	4	B	C					

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
34	18	M	Fr.	S	21	25	4	D						F
35	21	M	Fr.	S	18	19	1	D					D	
36	19	M	Fr.	S	13			F					F	
37	32	M	Fr.	M	11	16	5	D					F	
38	20	F	So.	S	15	21	6	D						
39	22	M	Jr.	S		27		B	C					
40	22	M	Fr.	S	10			F						
41	20	M	Fr.	S	18	31	13	B					C	
42	28	M	Sp.	M		38		A						
43	20	F	Fr.	S	0	11	11	F				A		
44	22	M	Fr.	M	15	27	12	C					B	
45	19	M	Fr.	S	21	26	5	B				F		
46	18	M	Fr.	S	20	27	7	B						
47	20	M	Fr.	S	15			D						
48	19	M	Fr.	S	14	24	10	B	F				C	
49	19	M	Fr.	S	26	31	5	B						
50	18	M	Fr.	S	24	22	-2	D						
51	25	M	Fr.	S	26	31	5	B	F				A	
52	21	F	So.	S	9	10	1	F						
53	23	M	Fr.	S	5	4	-1	C					C	
54		M			6	24	18	D						
55	20	M	Fr.	S	9			F				F		
56	21	M	Fr.	S	11	26	15	C	F	D			A	
57	22	M	Fr.	M	19	31	12	B	D				B	
58	20	M	Fr.	S	7	8	1	F						
59	20	M	Fr.	S	17	32	15	C						
60	18	M	Fr.	S	30	36	6	B	C					
61	18	M	Fr.	M	27	33	6	B	C					
62	21	M	Fr.	S	17	19	2	D	F		F			
63	18	M	Fr.	S	14			F						
64	18	M	Fr.	S	17	24	7	C						
65	24	M	Fr.	S	27	25	-2	B						
66	22	M	Fr.	S	23	30	7	C						
67	25	M	Jr.	M	23	33	10	B						
68	18	M	Fr.	S	7			F						

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
69	24	M	So.	S		23		B				F		
70	23	M	Fr.	S	18	22	4	B						
71	20	M	Fr.	S	12	17	5	D				A		
72	26	M	Fr.	S	14	19	5	C					A	
73	18	F	Fr.	S	3	17	14	D						
74	18	M	Fr.	S	11			D						
75	24	M	Fr.	S	8	34	26	B	C				A	
76		M				24		D						
77	25	M	Fr.	S	20	32	12	A				A		
78	26	M	Fr.	M	20	23	3	B						
79	18	M	Fr.	S	21	18	-3	C						
80	29	M	So.	S	6	6	0	F						
81	18	M	Fr.	S	32	37	5	A						
82	18	M	Fr.	S	16	23	7	D	F					
83	19	M	Fr.	S	30	34	4	A						
84	20	M	So.	S	6			F						
85	20	M	Fr.	M	17	25	8	C						
86	20	M	Jr.	S	31	38	7	A					C	
87	23	M	Fr.	S	18	24	6	C	F	F	C		B	
88	24	M	Fr.	S	15	18	3	D					B	
89	20	F	Fr.	S	28	34	6	B						
90	21	M	Fr.	S	21			Inc.						
91	22	M	Fr.	S	30	34	4	B	F					
92	20	M	So.	S	12			F						
93	22	M	So.	S	24			F						
94	25	M	Fr.	S	25	32	7	C						
95	19	M	Fr.	S	22	27	5	D	F		D			
96	22	M	Fr.	S	16	26	10	C						
97	25	M	So.	M				B	F					
98	23	M	Fr.	M	13	20	7	B	F		D			
99	26	M	So.	M	29	35	6	A	F					
100	19	M	Fr.	S	19	30	11	C	F				A	
101	23	F	Fr.	S	15	24	9	C						
102	19	M	Fr.	S	12	26	14	C	D	D				
103	24	M	Fr.	M	[redacted]	23	4	C						

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
104	38	F	Jr.	S				Inc.						
105	21	M	Fr.	S		19		C	C					C
106	24	M	Fr.	M	15	30	15	C	F		C		B	
107	20	F	Fr.	S	10	19	9	C					A	
108	22	M	Fr.	S	0	10	10	F					A	
109	23	M	Fr.	S	31	37	6	A	C					
110	24	M	Fr.	M		31		B						
111	20	M	Fr.	S	9	20	11	D			F			
112	18	F	Fr.	S	20	30	10	C					A	
113	18	M	Fr.	S	29	30	1	B	C					B
114		M	So.		11	19	8	D						
115	23	M	Fr.	M	15	20	5	D					C	
116	22	M	Fr.	S	21	16	-5	C						
117	26	M	So.	S	28	31	3	B						
118	18	M	Fr.	S	15	19	4	F					F	
119	25	M	Fr.	M	16	30	14	B	D					
120	25	M	Fr.	M	5	14	9	C	F					F
121	21	M	Fr.	S	9	13	4	D					B	
122	19	M	Fr.	S	4			F					D	
123	18	M	Fr.	S	17	27	10	C						
124	19	F	Fr.	S	17	13	-4	D					B	
125	18	M	Fr.	S	16	28	12	F				A		
126	22	M	Fr.	S	16	25	9	C		F			C	
127	24	M	Fr.	S	20	23	3	B						
128	33	M	Fr.	S	13	23	10	C			F			A
129	23	M	Fr.	S	16	11	-5	D						
130	18	M	Fr.	S	7	21	14	D					F	
131	24	M	Fr.	S	20	26	6	B	F					
132	19	M	Fr.	S	4	10	6	D	F					
133	25	M	So.	M				F						
134	22	M	Fr.	S	17	27	10	C	F				C	
135		M	Fr.		12			F						
136	25	M	Fr.	S	13	17	4	D						

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
137	27	M	Fr.	M	0			F				B		
138	24	M	Fr.	S	24	31	7	D	F	F			B	
139	23	M	So.	M	21	35	14	C	D				C	
140	19	M	Fr.	S	12	19	7	F					F	
141	30	M	Sr.	M	16	27	11	C						
142	19	M	So.	S	19			B	C					
143	26	M	Fr.	M	0	12	12	D					X	
144	18	M	Fr.	S	18	24	6	B	F				B	
145	20	M	Fr.	S	11			Inc.	F					F
146	18	F	Fr.	S	11	22	11	C						
147	19	F	Fr.	S	10	21	11	C						
148	20	F	Fr.	S	10	6	4	D					A	
149	19	M	Fr.	S	3			F					F	
150	27	M	Fr.	M	0	16	16	D					A	
151	20	M	Fr.	S	8	6	2	D				D		
152	18	M	Fr.	S	19	19	0	D					D	
153	20	M	Fr.	S	9	11	2	D	F				A	
154	19	M	Fr.	S	15	19	4	D						
155	26	M	Fr.	S	7	30	23	B				A		
156	20	M	Fr.	S	5			F						
157	24	M	Fr.	S	22	34	12	A					A	
158	21	M	Jr.	S	19	29	10	B						
159	19	M	Fr.	S	17	23	6	C	F				F	
160	20	M	Fr.	S	19	23	4	C						
161	19	M	Fr.	S	5	5	0	F						
162	18	M	Fr.	S	20			F						
163	19	F	Fr.	S	14	25	11	C					C	
164	18	F	Fr.	S	13	22	9	C						
165	20	M	Fr.	S	22			F					F	
166	22	M	Sr.	S				B						
167	25	M	Jr.	S				D						
168	22	M	Fr.	S	17	26	9	B	F					
169	19	M	So.	S	13	28	15	B	D					

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
170	28	F	Fr.	S	22	30	8	B						
171	23	M	Fr.	S	17	27	10	C					B	
172	23	M	Fr.	S	16	17	1	C	F					
173	19	M	Fr.	S	17			F					F	
174	23	M	Fr.	S	9	35	26	B						
175	22	M	So.	S	17	24	7	C				W		
176	19	F	Fr.	S	6	10	4	D					A	
177	19	M	Fr.	S	13	11	-2	D					B	
178	20	M	So.	S	20	25	5	B	F					
179	18	M	Fr.	S	17	17	0	D					B	
180	19	M	So.	S	13	26	13	D					B	
181	19	M	Fr.	S	19	26	7	C	D			B		
182	19	F	Fr.	S	22	35	13	B					A	
183	19	M	Fr.	M	21			F					F	
184	44	M	Sr.	M		25		C						
185	18	F	Fr.	S	7	15	8	F					C	
186	24	M	Fr.	S	17	21	4	B	C				B	
187	17	F	Fr.	S	9	13	4	C						
188	24	M	Fr.	S	19	31	12	C						
189	19	M	Fr.	S	9	29	20	B	F					
190	21	M	So.	S		16		C						
191	22	M	Fr.	M	15	27	12	D						
192	20	M	So.	S	25	31	6	A				A		
193	20	M	Fr.	M	16	30	14	C	F		C			A
194	19	M	Fr.	S	13	14	1	C	F					
195	18	M	Fr.	S	14	28	14	C					A	
196	19	M	Fr.	S	9	10	1	D						
197	22	M	Fr.	S		26		A	C				A	
198	23	M	Fr.	M	19	27	8	B	F				C	
199	20	M	Fr.	S	14	17	3	F						
200	19	M	Fr.	S	14	21	7	C						
201	19	M	Fr.	S	10	18	8	D					F	
202	26	M	Fr.	M	11	31	20	B	F				C	

TABLE VIII (continued)

SUBJECT					DAT NUMERICAL ABILITY RAW SCORES			FINAL GRADES				RDG. 97 FINAL GRADE		
Case Number	Age	Sex	Class	Marital Status	Before Math. 95	After Math. 95	Change	Math. 95	Math. 111A	Chem. 111	Acctg. 101	Taken Before Math. 95	Taken With Math. 95	Taken After Math. 95
203	24	M	So.	S	14	34	20	B				B		
204	18	M	Fr.	S	26	30	4	B	D					
205	25	M	So.	S	15	25	10	B						
206	23	M	Fr.	M	14	22	8	D	F					F
207	21	M	Fr.	S	16	22	6	Inc.						W
208	20	M	Fr.	S	17			F						
209	18	M	Fr.	S	18			F					F	
210	24	M	Fr.	S				A			F			
211	20	M	So.	S	20	31	11	C	C				A	
212	22	M	Fr.	S	24	24	0	A						
213	24	M	Fr.	S	7	25	18	C	F					C
214	22	M	Jr.	M		33		B	F					
215	18	M	Fr.	S	17	18	1	D						
216	20	M	So.	S				F						
217	26	M	Fr.	M	15	22	7	C	F				B	
218	21	M	Fr.	S	10	28	18	B					C	
219								F						
220	21	M	Fr.	S	22	28	6	B	F			A		
221	18	M	Fr.	S	25	28	3	B	F		F			
222	27	M	Fr.	S	18	27	9	C					A	
223	21	M	So.	S	20	15	-5	C						
224	19	M	Fr.	S	25	24	-1	C					B	
225	27	M	So.	S	24	29	5	B						
226	22	M	Fr.	S	15	20	5	D				C		
227	19	M	Fr.	S	24	31	7	B					F	
228	19	M	Fr.	S	12	17	5	D						

*Blank spaces in these columns indicate that the data were not available.

TABLE IX

DATA FOR CONTROL GROUPS

Numerical Ability Raw Score	Mathematics 111A Final Grades	Chemistry 111 Final Grades	Accounting 101 Final Grades
0	F		CF
1			
2			
3			
4			
5			
6			F
7		D	
8	CF	FF	FF
9	FF	F	F
10	C	F	
11	CCD		D
12	DDFFF	FFF	DF
13	DFFF	C	F
14	CCDFFFFFF	F	
15	CFFF	F	B
16	CFFFFFFF	DFFFF	CFF
17	CDDFFFFFF	F	BCFF
18	FF	DF	
19	BBCCCCDDDDFFFFFFFFF	BCCDDFFFF	BCFFF
20	CCCCCCDFFFF	CC	BDDD
21	BCCDDDDDDFFFFFFFFFF	DFFFFF	D
22	CDDF	DFF	F
23	ABCCDDDFFFFFF	CCCCCDDDFFFFFF	CC
24	BBBCDFFFFFFFFFFF	CCDDDFFFFFFF	C
25	BCCCCCCCCDFF	CCDDDDDDFFF	
26	BBBCCCCCDDDFF	CCCDDFF	ACCD
27	BBBBBCCCCCDDDFFFF	BCCCCCCCCCDDDFFF	A
28	ABCCCCCCCCCCFFFF	CCCCCCCDDFF	CCD
29	ABCCCCCCDDDDFF	BCCCCDDDFF	BBCDFF
30	BCCCCCCDF	CCCCCDFFF	BC
31	BBBCCCCCDDF	CCCCCCCCDDDDFFFF	A
32	ABCCDDFFF	CCCCCCCDFFF	BC
33	BCCCCCCDF	ACCCCCCCDF	AACDD
34	BCCCCCDF	BBCCCCCCCC	AABBCC
35	BBCC	BBCCCCCCFF	C
36	BCC	BCCCCDDDFFF	A
37	B	ACCCDF	AB
38	ABBBBB	BCCCCF	AC
39	B	B	A
40	ABB	C	C

APPENDIX B

TESTS GIVEN IN MATHEMATICS 95

MATHEMATICS 95
1st Hourly Test
Sept. 20, 1957

NAME

My Number is Row_____ Seat_____

I am to work problems number _____

1. $4321 - 1234 = ?$ Perform this operation and show how you check the answer. Show your work.

2. 9876 less 6789 = ? Perform this operation and show how you check the answer. Show your work.

3. Multiply 201 by 30 and prove answer by suitable division.

4. Divide 840 by 21 and prove answer by suitable multiplication.

5. Divide 1573 by 11 and prove answer by suitable multiplication.

6. Multiply 89 by 22 and prove answer by suitable division.

7. $x + 3 = 10$ Use one of the axioms about "equals" and solve algebraically for x. Show each step.

8. $4 + x = 10$ Use one of the axioms about "equals" and solve algebraically for x. Show each step.

9. $\frac{5}{6-6}$ is 0; impossible; 5; $\frac{5}{6}$; $\frac{5}{12}$; 6.

10. $\frac{6}{7-7}$ is 7; 6; 0; $\frac{6}{7}$; $\frac{6}{14}$; impossible

11. 27 is NOT the same as; 1×27; $\frac{27}{1}$; $20 + 7$; $\frac{1}{27}$; 3×9; $\frac{54}{2}$.

12. 35 is different than; $30 + 5$; $\frac{70}{2}$; $\frac{1}{35}$; $\frac{35}{1}$; 35×1; 5×7.

13. 0×43 is; 43; 0; 430; $\frac{1}{43}$; $4 + 3$; impossible

15. 12 48 =
24 60 =
36 72 =
\+ =

Add vertically & horizontally. Show all 5 sub-answers and the final answer.

16. 95 16 =
47 12 =
80 36 =
\+ =

Add vertically & horizontally. Show all 5 sub-answers and the final answer.

17. 10 Bushels of grain cost $25
1 Bushel of grain costs _____
7 Bushels of grain cost _____
14 Bushels of grain cost _____

18. 5 Head of cattle cost $400
1 Head of cattle costs _____
4 Head of cattle cost _____
8 Head of cattle cost _____

19. 263 - 107 =
507 - 238 =
\- =

Subtract horizontally.
Add vertically.
Show all 4 sub-answers and the final answer.

20. 432 - 321 =
664 - 456 =
\- =

Subtract horizontally.
Add vertically.
Show all 4 sub-answers and the final answer.

21. 709
45a
1246

The missing figure a is _____.
Show how you obtained the answer.

22. 987
6e2
1639

The missing figure a is _____.
Show how you obtained the answer.

PLEASE CHECK 1 OF THESE (I had too little time.
(I had enough time.

THE PROBLEMS WHICH GAVE ME MOST TROUBLE WERE NUMBERS _____

Mathematics 95
Hourly Test October 11, 1957

. The average of 63.95; 63.88; 63.78 is63.89; 63.81; 63.87; 63.78.

. 0.10044 ÷ 0.372 = 27.0; 0.27; 2.70; 0.027; 0.0027.

. 4/9 x = 12 x = 18; 27; 36; 48; 30.

. 3/17 = 0.1657; 0.5671; 0.2301; 0.1765.

. 2/7 has the same value as 2/3 + 7/3 True False

. 3 cans of tomatoes for 25 cents is cheaper than 5 cans for 42 cents. True False

. (21/5 ÷ 7/10) + (25/9 ÷ 5/3) = 1 2/5; 3 3/5; 1 2/3; 2 2/3; 3 2/3.

. 1 Kilometer = 0.62 mile. There are 1.75; 1.83; 1.61; 2.53; 1.70 kilometers in 1 mile.

. 0.48 = 1/2; 2/5; 13/50; 12/25; 7/15.

. 300 Miles/hour = 440; 360; 550; 300; 220 feet/second.

. 3x + 16 = 28 x = 2; 3; 4; 2 1/2; 2 1/4.

. 3/17 ÷ 3/17 = 9/289; 5/23; 5 1/3; 0; 1.

. 100 yards is 28.1 ft; 300 inches; 287 inches; 32 feet; shorter than 100 meters

. x ÷ 0 = x; 1; 0; impossible.

. A tarpaulin is 36" wide and 5 feet 9 inches long. The area is 7/12; 11/12 1 3/4; 1 1/2; 1 11/12 square yards.

. 0.625x = 10 x = 15; 14; 8; 12; 16.

. 5(6-6) = 0; 30; 1; impossible.

. 0.3x - 2 = 1/2 x = 1/2; 2/3; 8 1/3; 2 1/3; 2 1/6.

. 3/7 x - 7 = 14 x = 56; 42; 49; 94; 21

. 1 lb. 1 oz. = 482 grams. There are 460.8; 453.6; 284.9; 384.5 grams per pound

. 5/6 - 1/5 - 1/2 = 1/5; 1/15; 2/15; 1/30; 7/30.

. 2 5/8 times a number is 42. The number is 24; 16; 18; 12; 30

. A car uses gas at rate of 1 gal./18 miles. At 31.9 cents/gallon, the cost of gas for 306 miles is $5.42; $4.51; $6.22; $4.52.

. 35 1/5 ft./sec = 25; 24; 26; 28; 30 miles/hour

. 0.375 of a number is 12. The number is 26; 30; 32; ~~40~~ 28; 42.

26. 5/6 has the same value as 5/7 + 6/7 True False

27. 600 miles/hour = 600; 440; 900; 880; 660 feet/second

28. 0.24 = 1/4; 2/5; 6/25; 1/12; 2/3.

29. 3/8 is 0.6; 0.06; 0.006 smaller than 0.381.

30. (7/10 + 2 1/5) + (25/9 x 3/5) = 2/15; 1/10; 3/5; 2/7; 1/9.

31. 1 Kilometer = 0.62 mile. There are 8516.1; 5280.7; 3200; 3273.6 feet in 1 kilometer

32. 3 cans of soup for 40 cents is cheaper than 5 cans for 66 cents True False

33. 0.1x - 3 = 1/5 x = 1/2; 1/3; 16 1/2; 32.

34. y + 0 = y; 1; 0; impossible.

35. The average of 42.80; 42.93; 42.85 is 42.86; 42.68; 42.78; 42.85.

36. 0.375x = 9 x = 15; 12; 36; 18; 24.

37. A cloth is 36" wide and 5 ft. 3 in. long. The area is 7/8; 1 1/2; 1 1/4; 1 3/8; 1 3/4 square yards.

38. 6 (5-5) = 0; 30; 1; impossible.

39. 0.04914 ÷ 0.273 = 1.8; 0.018; 18.0; 0.18; 0.0018.

40. 1 lb. 5 oz. = 595 grams. There are 453.3; 495.2; 422.8; 435.6 grams per pound.

41. 2/9 x - 4 = 8 x = 48; 54; 36; 46; 45

42. 2/19 = 0.265; 0.0256; 0.0526; 0.526

43. 4/19 ÷ 4/19 = 16/361; 4 1/2; 0; 4 1/3; 1.

44. 2/7 x = 4 x = 12; 14; 28; 13; 26.

45. 5x + 22 = 37 x= 3; 2; 4; 2 1/2; 2 1/4.

46. 4/7 - 1/3 - 1/6 = 2/21; 1/21; 5/128; 5/126.

47. 2 3/8 times a number is 38. The number is 30; 24; 16; 18; 12.

48. 1 gallon gasoline is used per 18 miles. At 32.9 cents/gal. the cost of gas for 306 mile is $4.37; $5.59; $3.47; $6.29.

49. 36 2/3 ft./sec. = 23; 24; 25; 26; 27 miles/hour.

Mathematics 95
November 7, 1957

NAME _____

1. Interest on a loan of $150.00 for 5 months at 6% per year would be. $_____

2. Divide 6 hours 22 minutes 15 seconds into 5 equal parts.
_____hours _____minutes _____seconds each

3. Express as common fractions in lowest integers.

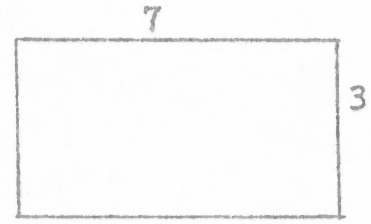
25%_____ 16-2/3%_____ 20%_____ 33-1/3%_____ 4%_____

17-1/3% _____ 12-1/2%_____ 87-1/2%_____ 6-2/3%_____ 66-2/3%_____

4. Kerosene weighs 5/6 as much as water. If kerosene weighs 6.58 pounds/gallon, how much does water weigh? _____pounds/gallon

5. $x + 7 = 14$ $x =$ _____ $1/2x + 7 = 14$ $x =$ _____ $x/2 - 7 = 14$ $x =$ _____ $x/2 - 14 = 7$ $x =$ _____

6.



Given a rectangle 7 units in length, 3 units wide.
Length of diagonal = _____
Prepare and show your own table of numbers and squares and show your work in deriving the diagonal.

7. Cinder blocks measure 12" x 9" x 8". How many blocks would be needed to build a retaining wall 20 foot long, 1 foot thick, 4 foot high? _____blocks

8. $4.25 is 17% of what sum? _____

9. A wheel of a bicycle has a diameter of 30 inches. How many revolutions per second does the wheel make at 20 miles/hour. _____
How many revolutions does the wheel make in going 100 feet. _____

10. A wholesale house gives successive discounts of 10% and 5% on a bill of goods amounting to $2500. What is the net cost? $_____
What would the next cost be at a flat discount of 15%? $_____

over

11. A rectangular playing field is 100 yards long and 50 yards wide. How many times around the field = 1 mile? _____ times

12. An electric meter reads 49635 kilowatt-hours and a month later 50624 kilowatt-hours. At 3-1/4¢ per kilowatt hour, what is the power cost? $_____

MATHEMATICS 95
TEST DECEMBER 6, 1957

_____
NAME

1. Community Chest contribution in a factory is on the same proportionate basis throughout. A worker who makes $60/week contributes $2. What amounts are contributed by those who make $56/week _____ and $80/week _____.

2. Cement blocks measure 9"x12"x4". How many are there in a uniform rectangular stack 3 ft. wide, 4 ft. high, 30 inches long.

3. $a^5 . a^6$ = _____ $(a^3)1/3$ = _____ $(a^3)^2$ = _____

$(\sqrt{a})^2$ = _____ $(a^2)^3$ = _____ $a^{-2} . a^3$ = _____

$(a^3/2)^{2/3}$ = _____ $a^{-3} . a^2$ = _____ $a . a^{-4}$ = _____

4. One number is 30% of another. Their difference = 14. The numbers are _____ and _____.

5. A tank holds 50 gallons more than three times the capacity of another tank; together they hold 350 gallons. The capacity of each tank is _____ and _____.

6. $(x - 2y)(4x + 5y)$ = _____
Show work here.

Divide product by either factor.
Show work here.

7. 20% of a number = 13.5. The entire number is _____.

8. $y - 3(2y + 2) \div (6y + 3)$ = _____.
If $y = 3$, the numerical value of the answer is _____.

9. $(5/7 + 1/5 - 1/2) \div (13/16 \div 5/8)$ = _____.

10. Hypotenuse of a right triangle = 12. One side = 6. The third side = _____.
(One decimal place)

11. A team scores 90 points. This is 40% less than they scored in previous game. Their previous score was _____.

12. A model engine is built on a scale 1:50. The model is 1 ft. 8 inches long. The real engine is how long _____.

Mathematics 95
Test January 17, 1958

Name _____

1. Capacity of one tank is 50 gallons less than twice that of another tank. Together they hold 400 gallons. The tank capacities are _____ and _____.

2. Father is 4 times as old as step son; and in 10 years he will be twice as old. Their present ages are _____ and _____.

3. Factor: $x^2 - 4x + 4 =$ _____

$25c^2y^2 - 16a^2b^2 =$ _____

$2x^2 - x - 15 =$ _____

4. Multiply 3 hours 16 minutes 21 seconds by 5 _____.

5. Divide $15x^2 - 14xy - 8y^2$ by $3x - 4y$ _____.

6. One side of a right triangle is 3 ft. and the hypotenuse is 6 1/2 ft. The other side is _____.

7. $4 is 21% of what sum? _____.

8. (a) The difference between 2 game scores is 20 points. The sum of the 2 scores is 140 points. The scores are _____ and _____.

(b) Rewrite this problem as one which states one score as a percentage of the other and show your solution.

9. Multiply $(3x - 2y + 8)$ by $(x - 7)$ _____.

10. What is net cost of a bill of $1700 with successive discounts of 15% and 5% _____.

What is net cost at a flat discount of 20% _____.

MATHEMATICS 95
FINAL EXAMINATION

January 24, 1958

INCOME TAX in a certain income bracket is at the rate of $800 plus 22% of the excess over $4000. If taxable income is $5382.97, income tax = _____

Show the decimal point plainly in your answers.

468.75/37.5 =
4.6875/0.375 =
46875/375 =
468.75/375 =
46875/37.5 =

46875/3.75 =
0.46875/375 =
4.6875/3.75 =
46.875/0.375 =
4.6875/0.0375 =

A 5" x 7" pictire is enlarged so that the 5" side becomes $7\frac{1}{2}$". The 7" side becomes _____".

A mile is run in 4 minutes flat.
This is at the rate of _____ miles/hr.
This is at the rate of _____ feet/second
This is at the rate of _____ yards/minute

3 1/7+2/21+1/3 = _____

A car goes 306 miles on 17 gallons of gasoline. This is at the rate of _____ miles/gallon.
At 32.9 cents/gallon, this trip costs _____ for gasoline.

6/13 x 26/12 x 1/3 x 9/36 = _____
This answer in decimal form is _____
This answer as a % is _____

The net cost of a bill of $1200 with successive discounts of 20% and 10% is _____.
The net cost at a flat discount of 30% would be _____.

4/9 of a number = 8.
1/2 of this number = _____.
1/3 of this number = _____.

Bricks measure 8" x 4" x 2". How many are there in a uniform rectangular stack which is 7 feet long, 5 feet wide, and 32 inches high? _____

An electric meter reads 54723 kilowatt-hours at the beginning of a month, and 58001 kilowatt-hours at the end of the month. Electric power costs 3¢ per KWH for the first 1000, and $2\frac{1}{2}$¢ per KWH thereafter. The power bill is _____.

The interest on a loan of $350 at 6% per year is _____ for 3 months; _____ for 5 months.
A dictionary has a picture of a hawk with a ception 1/12. This means the scale is 1:12.
The picture measures $1\frac{1}{2}$" in length. The length of the hawk is _____.

75% of 48 = _____
66 2/3% of 24 = _____
20% of 60 = _____
150% of 12 = _____

0.3% of 27 =
$37\frac{1}{2}$% of 80 =
0.24% of 12 =
$12\frac{1}{2}$% of 40 =

15. One circle has a radius of 2 feet. A second circle has a radius of 3 feet. $\pi = 3.14$.

a. Circumference of first circle = _____
b. Area of 1st circle = _____ square feet.
c. Circumference of 2d circle = _____
d. Area of 2d circle = _____ square feet.
e. Diameter of 1st circle = _____
f. Diameter of 2d circle = _____
g. Ratio of area of 1st to second circle = _____.
h. Ratio of area of 2d circle to 1st = _____
i. A square whose perimeter equals circumference of the first circle would have one side = _____.
j. A square whose perimeter equals circumference of the second circle would have one side = _____.
k. A square whose area equals that of 1st circle would have one side = _____.
l. A square whose area equals that of 2d circle would have one side = _____.

(One decimal place only for all above)

16. Factor

$8x^2 - 8x - 6 = (\quad)(\quad)$
$15x^2 - 12x - 3 = (\quad)(\quad)$
$9x^2 + 12x + 4 = (\quad)(\quad)$
$4x^2 - 9y^2 = (\quad)(\quad)$

17. _____ father is 4 times as old as his son. Five years from now he will be 3 times as old as his son is then. The father is now _____ years old and his son is now _____ years old.

18. Simplify:

$3K/2 - 2/3K =$ _____.
$3K/2 \times 2/3K =$ _____.
$3K/2 + 2/3K =$ _____.
$3K/2 \div 2/3K =$ _____.

19. Simplify:

$3a - 5(2a+2) =$ _____.
$2a+2a(a-2) =$ _____.
$(4x+6y) - 3(2x-2y) =$ _____
$(3y-4x)+(5x-4y) =$ _____

20. a. Multiply $3x+2y+5$ by $x-3$ _____

If $x = 1$, and $y = 2$,

b. $3x+2y+5 =$ _____
c. $x - 3 =$ _____
d. The numbers you get in (b) and (c) multiplied together = _____.
e. Rewrite your answer for (a) here with $x = 1$ and $y = 2$ substituted for each x and each y _____. Combine all these numbers into one final number _____.
f. This number should be the same as _____.