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An Experimental Study On The Effect Of Highly-Directed Versus Non-Directed Homework Assignments On Student Achievement

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This dissertation, directed and approved by the candidate's committee, has been accepted by the Graduate Committee of The University of New Mexico in partial fulfillment of the requirements for the degree of Doctor of Education (Curriculum and Instruction)

AN EXPERIMENTAL STUDY ON THE EFFECT OF HIGHLY-DIRECTED VERSUS NON-DIRECTED HOMEWORK ASSIGNMENTS ON STUDENT ACHIEVEMENT

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DISSERTATION

Submitted in Partial Fulfillment of the
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Doctor of Education
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Albuquerque, New Mexico
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ABSTRACT OF DISSERTATION

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The University of New Mexico, 1969

Description

The study was conducted at Northern Arizona University during the fall semester of 1968. It involved a total of six instructors, all full time members of the mathematics faculty, and 304 students; 203 in 6 classes of general mathematics and 101 in 6 classes of college algebra.

The directed homework classes received assignments that were taken up at the next class meeting, graded, scored, recorded, and returned. The non-directed classes received the same assignments, but the homework was not taken up. There were lectures and discussion in both groups prior to assigning homework and after it was turned in.

Objectives

The primary objective of the research was to determine whether student achievement, as measured by adjusted post-test means, was affected by their membership in directed or non-directed homework groups. A second objective was to determine whether student achievement was affected by membership in different instructor groups.

The basic comparison was between adjusted post-test means of the two homework groups and of the instructor groups. Interaction between homework and instructor and the criterion (post-test) was also examined.

<u>Procedure</u>

Students were administered a pre-test on the first day of classes. This test served as the covariate for the unit tests and the final examination.

There were five unit tests in general mathematics and four in college algebra; both courses had a final examination as well. Before study of a unit was begun, instructors were given a set of objectives for the unit, which served as guides for test construction. Analysis of covariance was the statistical method used for analysis of data.

<u>Conclusions</u>

(1) Students taught under the directed and non-directed groups did not differ significantly in their achievement, as measured by their post-test scores, on any of the unit tests or the final examination. This applies to both general mathematics and college algebra.

(2) General mathematics students taught under different instructors did differ significantly in their achievement on some unit tests but not on others. The achievements did differ significantly on all four unit tests

in college algebra. There was no significant difference in achievement on the final examinations in either general mathematics or college algebra.

(3) No significant interaction occurred in any of the unit tests or final examination for general mathematics. One test in college algebra produced significant interaction; the final examination did not produce significant interaction.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER I

STATEMENT OF THE PROBLEM

Introduction

The emphasis for this study was basically on improvement of instruction in mathematics. The scope of the problem that was investigated was limited to the effective use of homework in certain college mathematics classes. These will be listed later in this chapter.

There has been some research on homework but it has resulted in generation of opinions and not much more. It has also been more in the nature of strictly homework versus no homework.[8] These past studies generally conceded that homework serves a useful purpose if properly administered as a learning aid and not as a punitive or busy work device. Finally, practically all the research has been conducted at elementary and secondary school levels with very little research on homework at the college level.

The Purpose of the Study

The study was conducted at Northern Arizona University, Flagstaff, Arizona, during the fall semester of the academic year 1968-69. Its purpose was to compare the effects of closely directed homework assignment with non-directed homework assignment in mathematics instruction in college algebra and general mathematics.

The Need for the Study

In a general way the need for such a study rests on the constant necessity for study of the binary relation between the methods a teacher employs and those behaviors (learning) of the student which are related to the method.[2]

The National Committee on Mathematical Requirements as early as 1921 made the following more specific recommendations concerning the aims of mathematical instruction:[7] (1) practical--the usefulness of a fact, method or process of mathematics in the everyday world, (2) disciplinary--the training of certain intellectual skills such as analysis of complex problems into simpler parts, recognition of logical relations between interdependent figures and discovery and statement of a general law, and (3) cultural--the aesthetic satisfaction accruing from an understanding of logical structure, precision of statement, and the power of mathematics (on the verge of attaching mysticism to mathematics).

Implementation of learning through improved instruction in mathematics insofar as it is concerned with directed or non-directed homework was the overall objective of the research. More specifically, is there a significant contribution to student achievement in college algebra and college general mathematics as a result of homework being assigned regularly and systematically accompanied by discussion as needed, as opposed to non-directed assignment of homework, also with discussion?

In the nature of general objectives, consider that in nearly any conventional mathematics classroom the teacher is expected to perform two functions, according to Butler and Wren.[1] First, he must do "developmental teaching" and, second, he must teach for "assimilation." Developmental teaching refers to the presentation and illustration of new ideas. Assimilation refers to the student's mastery of the skills and concepts presented in the developmental function of the teaching process. Homework is instrumental in the assimilation function so that this study has an objective of attempting to clarify and strengthen the assimilation function. Developmental function improvement will also be an objective since the homework must at times concern itself with introduction to and acquaintance with new ideas, particularly if there is concern for individualizing homework.

Finally, a pedagogical theory for mathematics in essence, according to Gage, consists of "a set of proposals or recommendations together with a justification of them."[2] The objectives of this study were very closely connected to this justification aspect since justification, according to Gage, is based on three bodies of knowledge or belief: (1) a matrix of contingent generalizations about the state of affairs in society, such as how students learn, how student behavior and teacher action correlate, and what subject matter can be learned by students of varying degrees of maturity, (2) the value matrix which primarily concerns itself with the function of formal education, and mathematics specifically, relative to the rights and obligations of man and society, and (3) the nature of mathematics. The role of this knowledge or belief is probably implicit, though quite significant, in shaping recommendations, particularly concerning what should be taught and how it should be taught.[2]

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CHAPTER II

REVIEW OF THE LITERATURE, DELIMITATIONS, DEFINITIONS, AND ASSUMPTIONS

Review of the literature on homework reveals three facts about status of its study: (1) there is concern for production of high quality of research in the area as Mulry,[12] Stein,[17] Clymer,[3] and Strang[25] point out in their articles; (2) most of the studies have been and are being done at the elementary and secondary school level, with very little at the college level; (3) there is much effort being directed at research in instructional methods as indicated by the studies of Ruja,[15] Wispe,[21] and Jayne[10] for example.

Very few definitive conclusions have resulted from the various studies and research reviewed. All too often the conclusions reflect preconceived notions indicating mere statements of opinion rather than observed experimental results.

Suppes in his article, "The Case for Information Oriented Research in Mathematics Education,[24] emphasizes this shortcoming in the area of mathematics education. He literally issues a plea for basic research in order to understand how students learn mathematics. In other words, there is a need for research on a psychological theory of mathematics learning.

As if in response, the following article by Gagne in the same publication, discusses "The Acquisition of Knowledge."[24] Gagne considers knowledge as an inferred capability making possible the successful performance of a class or set of tasks. In the attainment of a successful performance of the task or in successful learning a major variable to be considered is that of instructions, or the content of communications from teacher to student.

The experimental study with which this dissertation was concerned most naturally falls into this category of attaining successful learning. The communication or instructional process involved in homework is divided into the two variables of close direction versus non-direction.

As is well known, there are many types of homework assignments including writing, reading, and individual projects. In the majority of these studies reviewed there was little differentiation made between types of homework. This produced results that reflected emphasis or re-emphasis on subject matter mastery, a reincarnation, so to speak, of textbook teaching. Mathematics researchers attempt to justify this approach by claiming that mathematics learning basically requires subject matter mastery. Also, in experimental research, present instruments for measurements use subject matter mastery as a basis for test construction and subsequent evaluation.

Homework practice it seems has run the gamut from requirement of nothing to over-assigning over the past half century. Presently there is still this wide range of practice in homework assignment, resulting in a somewhat disorganized "cobweb theory"[23] of homework assignment. There has been neglect of experimental studies and too many of the studies completed have been of poor design and limited scope.

One of the first significant studies concerned with attempting to determine whether compulsory homework results in improved academic achievement was conducted by DiNapoli[22] in 1935. He obtained results that led to his recommendation that compulsory homework be abandoned. Another comparatively early study in 1937 investigated effects of abolishing homework in the El Segundo (California) elementary schools.[23] This study seemed to contradict DiNapoli's finding by showing a drop in high school grades among those pupils who attended El Segundo elementary schools after homework was abolished at the elementary level.

Studies by Steiner;[18] Anderson;[1] Hines;[8] Cost, Swenson, and Taylor;[4] and Waterman[20] indicate definite gains in achievement for those who were assigned regular homework. These studies were conducted at the elementary, junior high, and high school levels.

Bond,[2] Cutler,[5] Hillman,[7] Hodges,[9] Lishan,[11] and Strang[25] in their research indicate that there are definite abuses involved in the assignment and use of homework. There is evidence that some of the problems created by these abuses far outweigh benefits that should accrue.

There is apparent in the research done and being done in homework, that there is a tacit acceptance of the necessity for homework in most academic areas, particularly the so-called disciplines. The problem, according to many of the studies, is to make homework an effective teaching tool and not merely a means of occupying the students' time. There is growing pressure for individualizing homework[25,23] and for trying the substitution of supervised study for homework.[13,23]

The objectives and purposes of homework are well stated in the NEA publication "Homework,"[23] and in Strang[25] and Anderson.[1] These objectives for the most part, are again applicable to elementary and secondary school conditions. Some of the objectives, paraphrased, from the preceding sources[1,23,25] are worthy of consideration in college level education. These are: reinforcement of classroom instruction; enrichment of classroom experiences; aid in the development of initiative, independence, mental discipline, and responsibility. Also, in the area of objectives for homework, some studies[1,2,7,16,23,25] discuss the fact that the teacher and student have roles to perform. The teacher should plan, be flexible, and above all, be consistent in his homework policy. The student should make certain the assignment is understood, should comprehend the purpose of the assignment, and should plan his work and study also, and take advantage of any aids for study.

The most coherent statements of the problems inherent in homework practices come from those[5,6,9,10,16,23,25] who argue that: homework can diminish enthusiasm for the school programs in general; the assigned homework, particularly that which comes directly from the textbook, is often copied without real learning; homework is usually geared for the average student, demonstrating the lack of individualizing homework; a great deal of time is required to properly plan, administer, and execute a productive homework policy; and students are often over-burdened with heavy homework assignments from several teachers, thus depriving the student of other activities which may be of more, or at least, equal, benefit to him.

Other interesting, if perhaps obvious, results from the studies of Goldstein,[6] Schunert,[16] and Hines[8] in particular, indicate that the brighter students are much less likely to be affected by homework assignment or non-assignment. The average or below-average student seems to receive the most benefit, in terms of measured achievement, from the regular assignment of homework. This group also appears to be more adversely affected by not having homework assigned. In this same vein Wispe[21] points out that the non-directed approach is not likely to succeed if stress is placed on passing examinations, a situation, which evidently provokes more feelings of apprehension and mental discomfort in the average and below-average student. In defense of experimental studies in mathematics it must be pointed out that without reliance on examinations or testing of some measurable type, statistical interpretation, and for that matter, any conclusions arrived at, are virtually meaningless.

The review of literature demonstrates that there are conflicting results from the previous studies concerned with the various aspects of homework. Due to the presence of this conflict and the consequent lack of definite conclusions, the researcher is justified in attempting to discover the best use for homework in an experimental situation.

In summary, for this review of the literature, the following quote from Jayne[10] should suffice: "Differences in pupil gain may be more affected by factors inherent in the pupil rather than teaching procedures.--Teaching activities must be appropriate to the objectives set up."

Delimitations for the Study

It is apparent that there are a number of variables associated with research in the area of homework. Variables such as instructor, time of day, kinds of homework, required or elective course, room location, lighting, amount of homework, points allowed for homework, what effect homework has on course grade, and others are recognized. To consider them all would be to create an unwieldy experimental situation. The results produced would not be as useful, in a pragmatic sense, as those emanating from an experiment in which only one or two variables are critically examined under more controlled conditions.

This study was limited to an attempt to determine experimentally a more effective use of homework using two homework assignment levels with six instructors each having one class at each level. In this manner there were only two independent variables considered. Originally, the study intended four levels for homework but this approach proved to be impractical. The reason was quite simple--scheduling four classes in the same course for each participating instructor created rather large scheduling problems, not to mention the bias inherent in teaching four classes in the same course. By limiting the study to two relatively extreme situations, instructors readily volunteered, and the administration was amenable to the experiment.

No attempt was made to individualize homework assignment at either of the two levels. All courses and experimental subjects had assignments taken from the exercise sets in the texts that were used. The experiment was concerned only with the effects of the two homework treatments on student achievement as measured by pre-test, unit test, and post-test scores. There was no consideration for grades that were given for student performance in the classes. This was the province of the individual instructors and was not considered as an effect on the results of the experiment.

The assignment of times for the courses was not randomly done. The Mathematics Department Chairman made the time schedule without consultation and without considering the experiment. Accidently, a good coverage of the class day did occur with class times ranging from eight in the morning until four in the afternoon.

Assumptions

An implicit assumption was that immediate feedback is much more effective than that which is delayed. This then demanded the immediate return of graded and scored assignments in the closely directed group with discussion of the assignment. The non-directed group had discussion of the assignment from the previous class meeting.

Since much of the previous research in homework produced inconclusive results and personal opinion, the researcher in this study was justified in the attempt to find the best use for homework in an experimental situation.

A basic assumption pertinent to the statistical analysis for the study was that the sample of students involved in the study was a normal university freshman and sophomore group not considering a mathematics or science major.

Definitions of Certain Terms

Homework was defined as work assigned in class to be performed outside the class.

Closely directed homework consisted of work assigned to be written up and handed in at the next class meeting. There were both prior- and post-discussions concerning the assignment. Homework assignments were graded, scored, recorded, and then returned to the student at the next class meeting after being turned in.

Non-directed homework assignments were identical to those of the closely directed. The work was not collected; therefore, not graded nor recorded. Discussion of the assignment both prior and post was carried out just as was done in the closely directed situation.

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CHAPTER III

DESIGN AND PROCEDURE

The Courses Involved in the Study

(1) College algebra, with the approach stressing structure, process, precision of language, and applications. The course was concerned with manipulation and with structural and functional development of mathematics as related to sets, number systems, operations, mathematical sentences or equations, inequalities, determinants and matrices, linear systems, linear and quadratic functions, theory of equations, binomial expansion, mathematical induction, progressions, series, probability, and additional work in modern algebra if possible. Textbook used was by Allendoerfer and Oakley.[1]

(2) College general mathematics, which covered sets, logic, truth tables, inferential statements, number systems, number bases, measurement, probability and statistics, algebra (survey), problem solving, and trigonometry. The coverage was not in depth but it did give good general mathematics that could be utilized in any non-mathematics or non-science curriculum. This course, designed as a liberal studies course, is required of all non-mathematics and non-science majors at Northern Arizona University. Textbook used was by Little and Moore.[3]

The Participating Teachers

The mathematics faculty and the administration, as well, cooperated in the study. (See Appendix A.) (Scheduling problems were minimized since participation in the study was not an additional load.) The classes were not special because they were a part of the normal mathematics curriculum offering.

For the semester in which the experiment was conducted, a group of six mathematics faculty members were involved. (See Appendix A. Mr. Graydon Bell did not participate in the experiment.) The group was composed of individuals with an average of twelve years teaching experience at college or secondary level or both. There was one professor holding the doctorate in mathematics; the remainder all have at least the master's degree in mathematics.

Those involved taught their classes, one in each of the two treatment groups, according to the pedagogy he subscribes to with the treatments of directed homework or non-directed homework in his two classes. There were regularly scheduled conferences of participating teachers once a month at least, with informal meetings held more often. These meetings had the purpose of articulation and synchronization. There was ample discussion of the experiment and its problems and progress at these meetings.

The Group Studied

There were three hundred seventy students involved at the start of the experiment. Mortality in the classes was adjusted by removal of pre-test scores for those not completing the course. The students were enrolled in twelve classes, six each in college algebra and general mathematics, with two classes for each of the six instructors. The six classes in each of the areas (algebra and general mathematics) were separated into two treatment groups of three; hence there were, in effect, twelve treatment groups or blocks.

The students were primarily liberal arts students of a state university. They were enrolled in these classes under study as part of their required set of courses for attainment of the baccalaureate degree.

The majority were college freshmen and a lesser number were sophomores. Junior and senior representation was relatively scant since both algebra and general mathematics are underclass liberal studies requirements at Northern Arizona University, generally completed at the freshman-sophomore level.

Structure of Treatments for Experimental Groups

The experimental groups in both algebra and general mathematics had a course that stressed homework in a most directed sense in that the assignments were made, checked, graded, and handed back to the students at the next class meeting. There was discussion pertaining to the homework on the class day following the assignment. The homework was graded by work-study students, graduate and undergraduate majors. There were four paper graders whose only responsibility was the experimental class homework assignments.

The control group in both algebra and general mathematics did not have the closely directed homework situation. The emphasis was on lecturing with study assignments and suggestions for work to be done, if they so desired. The assignments made were identical to those in the experimental sections. Discussion on these assignments had the extent desired by the students.,

A very emphatic attempt was made to impress upon the students in both groups that they should attempt to do all the homework, since evaluation by means of unit tests and the final examination were based on topics covered by the homework assignments.

Statistics Used

The statistical design was of the pre-test--post-test type. The design was of the following form:

$$
\begin{array}{ccc}
O_1 & X_1 & O_2 \\
O_1 & X_2 & O_2
\end{array}
\quad \text{General Mathematics}
$$

$$
\begin{array}{ccc}
O_3 & X_1 & O_4 \\
O_3 & X_2 & O_4
\end{array}
\quad \text{College Algebra}
$$

Figure 1.

Modified from Campbell, D. T., and Stanley, J. C., Pre-Test and Post-Test Control Group Design. Chapter 5, Gage.[2]

The X's indicate treatment, that is, X_1 is closely directed, X_2 is non-directed homework. O_1 and O_3 are observations in the form of pre-test for general mathematics and college algebra, respectively, (see Appendix B) administered on the first or second class meeting day. The pre-tests constitute the covariates. O_2 and O_4 were the post-tests for general mathematics and college algebra. (See Appendix B for Pre- and Post-Test Forms used.) The data received was analyzed by means of analysis of covariance.

The 2 x 3 analysis of covariance with instructors and methods as main effects in specific diagrammatic form is as follows:

General Mathematics
or College Algebra

Instructor	Closely Directed Homework	Non-Directed Homework
1		
2		
3		

Figure 2.

Each of the twelve cells had from 15 to 37 subjects. It was possible to make this a multiple analysis of covariance by incorporating, in addition to the homework variable, an instructor variable.[4,5] Also, this obtains some interaction analysis between instructor and method. Treatment was randomly assigned to the two classes of each instructor by coin toss.

As appropriate units were covered in the two areas, unit tests were administered and an analysis of covariance performed on these unit tests with pre-test as covariate.

The Hypotheses to be Tested

The null hypotheses tested are as follows: (Applicable to both general mathematics and college algebra.)

H_{01} There is no difference in achievement means of the directed and non-directed homework groups after equating on a covariate, the pre-test.

H_{02} There is no difference in student achievement means of the different instructors after equating on a covariate, the pre-test.

H_{03} There will be no interaction between student membership in both independent variable groups and their performance on criterion after equating on control measures.

Other Observed Results

There are other effects of the directed or non-directed homework conditions. One which comes to mind immediately that could be observed with relative ease would be to examine the number of visits for assistance made to the professors by students in the two groups outside of regular classroom discussion. Sheets to record these visits were provided each instructor. (See Appendix B.)

Additionally, by reference to instructors' records, it was determined how many drops, official and unofficial, occurred for the two homework levels.

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CHAPTER IV

ANALYSIS OF DATA

Preliminaries

Before classes began in September, 1968, all instructors involved in the experiment attended meetings concerned with the explanation of the experiment and their role in it. At one of these meetings a coin was flipped for each of the instructors in order to determine which of his two classes was to receive the directed homework treatment and which was to receive the non-directed homework treatment. This coin flip constituted the only explicit random selection involved in the experiment. As stated in Chapter III, this lack of random selection of subjects was the primary reason for selection of analysis of covariance as the statistical method to be used. The results of the coin flip are found in Tables 81 and 82, Appendix C.

On the first day classes met, each class was administered the pre-test. The general mathematics pre-test is found on pages 56 to 66, Appendix B. The college algebra pre-test was the ETS Algebra III Test, Form A. General mathematics had the same examination as a final, and college algebra had the ETS Algebra III Test, Form B, as their final.

The pre-test, sometimes designated as control variable or covariate, is represented by the "X" data in the tables.

The post-test, sometimes designated as the dependent variable or criterion variable, is represented by the "Y" data in the tables.

The null hypotheses that were tested are repeated here for immediate reference:

H_{01} There is no difference in achievement means of the directed and non-directed homework groups after equating on a covariate, the pre-test.

H_{02} There is no difference in achievement means of the different instructor groups after equating on a covariate, the pre-test.

H_{03} There will be no interaction between student membership in both independent variable groups and performance on the criterion after equating on a covariate, the pre-test.

Before the study of each of the units in both general mathematics and college algebra began, objectives for the unit were given to each instructor and the students were verbally advised of these objectives. The objectives for the general mathematics and college algebra units are found on pages 67 to 75, Appendix B.

Analysis for Unit Tests--General Mathematics

The tables which follow are the results of the statistical analyses of the five unit tests for general mathematics. These unit tests are the post-tests or criterion variable "Y" in the tables and the pre-test "X" is the same for all five unit or post-tests. The unit post-tests for general mathematics are found on pages 76 to 90, Appendix B. Data supporting these tables are found in Appendix C.

TABLE 1

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 1 - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	108.65	108.65	2.448
Instructor	2	627.55	313.78	7.067*
Interaction	2	60.30	30.15	0.679
Within	196	8701.22	44.39	
Total	201			

*Significant at 0.01 and 0.05 level.

TABLE 2

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 2 - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	230.6	230.6	1.902
Instructor	2	909.0	454.5	3.750*
Interaction	2	297.8	148.9	1.228
Within	196	23757.6	121.21	
Total	201			

*Significant beyond 0.05 level.

TABLE 3

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 3 - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	1.6	1.57	0.028
Instructor	2	16.9	8.45	0.153
Interaction	2	148.7	74.34	1.342
Within	196	10854.2	55.38	
Total	201			

No significant F values.

TABLE 4

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 4 - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	166.9	166.90	2.118
Instructor	2	270.7	135.85	1.724
Interaction	2	142.0	71.00	0.901
Within	196	15444.2	78.80	
Total	201			

No significant F values.

TABLE 5

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 5 - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	66.4	66.40	1.246
Instructor	2	431.1	215.55	4.044*
Interaction	2	44.3	22.15	0.416
Within	196	10447.5	53.30	
Total	201			

*Significant beyond 0.05 level.

<u>Discussion of General Mathematics Unit Test Analyses</u>

Examination of Tables 1, 2, and 5 indicates significant F values recorded for the instructor variable on Unit Tests 1, 2, and 5; therefore, on these unit tests the null hypothesis, H_{02}, is rejected.

No significant F values were determined for the homework variable or for interaction on any of the unit tests. Null hypotheses H_{01} and H_{03} are, therefore, tenable.

Table 24, Appendix C, shows the adjusted post-test means have a maximum difference of 3.351 based on the smallest mean of 22.227, a comparatively large difference.

Table 30, Appendix C, shows the adjusted post-test means have a difference of 5.193 based on a smallest mean of 29.021, again relatively large.

Table 38, Appendix C, shows the adjusted post-test means with another relatively large difference of 3.591, based on a smallest mean of 16.860.

The significant F values for the instructor variable are not to be construed as measures of instructional ability. How student membership in instructor classes affected their achievement was the variable under analysis. The significance was primarily due to the amount and intensity of coverage of the objectives. In each instance one or more of the instructors did not cover the material outlined in the objectives as thoroughly as they wished. The instructor in each case felt that the material at the end of the unit was not sufficiently covered.

Analysis of Unit Tests for College Algebra

The following tables show the results of the analyses of the four unit tests administered in college algebra. The "X" values are pre-test scores; the "Y" values are post-test scores. Unit tests for college algebra are found on pages 91 to 102, Appendix B.

TABLE 6

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 1 - College Algebra

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	800.867	800.87	2.635
Instructor	2	7139.96	3569.98	11.746*
Interaction	2	1968.38	984.19	3.238**
Within	94	28569.8	303.93	
Total	99			

*Significant beyond 0.01 level.

**Significant beyond 0.05 level.

TABLE 7

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 2 - College Algebra

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	4.230	4.23	0.0168
Instructor	2	15429.8	7714.88	30.673*
Interaction	2	1186.45	593.22	2.368
Within	94	23642.7	251.52	
Total	99			

*Significant beyond 0.01 level.

TABLE 8

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 3 - College Algebra

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	0.250	0.250	0.000971
Instructor	2	5899.87	2949.94	11.467*
Interaction	2	74.109	37.06	0.144
Within	94	24181.6	257.25	
Total	99			

*Significant beyond 0.01 level.

TABLE 9

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Unit Test 4 - College Algebra

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	844.02	844.02	2.927
Instructor	2	21280.7	10640.4	36.900*
Interaction	2	193.754	96.87	0.334
Within	94	27105.8	288.36	
Total	99			

*Significant beyond 0.01 level.

Discussion of College Algebra Unit Test Analyses

The analysis of data for the college algebra unit tests resulted in no significant F values for the homework variable;

therefore, the null hypothesis H_{01} is considered tenable for all unit tests.

Tables 6, 7, 8, and 9 indicate significant F values for the instructor variable; therefore, null hypothesis H_{02} is rejected for all these unit tests. Tables 59, 65, 71, and 77 in Appendix C all show a relatively large difference between means for instructors: 19.762 in Table 59, 29.681 in Table 65, 16.812 in Table 71, and 32.861 in Table 77.

Performance on the unit tests for Instructor Number 2 was consistently much lower, particularly when compared with Instructor Number 3. This large discrepancy between the means of the two instructors accounts for the recurring significant F value.

Caution is advised again, lest the mean difference be attributed to instructional ability of the instructors involved. The variable of instructional ability was not under analysis. The consistent low group performance, as indicated by the mean of Instructor Number 2, could be attributed to the mathematical aptitude and inclination of the entire group. Though an educational setting usually prevents it, a stratified random sample virtually eliminates such occurrences.

Table 6 shows a significant F value for interaction; therefore, null hypothesis H_{03} is rejected for Unit Test 1. The following tables indicate graphically how interaction occurs. The tables illustrate significant interaction, almost significant interaction, and definite lack of interaction. The lines indicate, as an oversimplification, regression directions for post-test means. The marked crossing of the lines indicates definite interaction that can be attributed to a reaction of instructor to method of instruction. (Solid lines in the figures represent directed homework; dashed lines represent non-directed homework.)

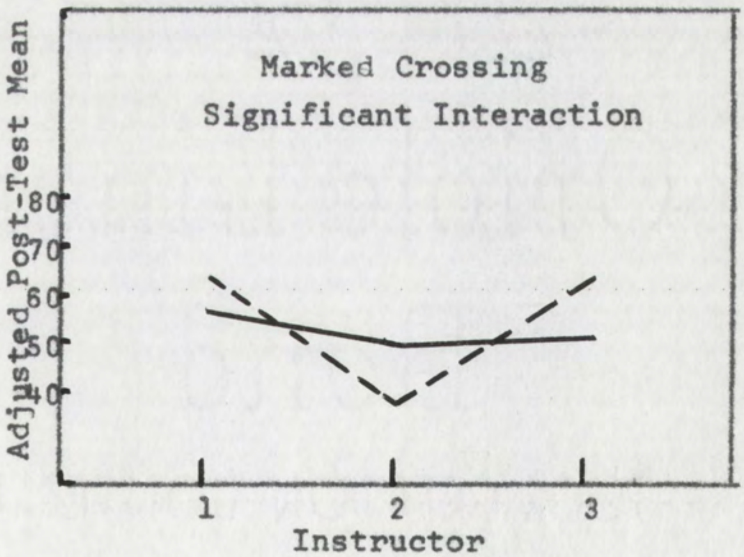


Figure 3.
Unit Test 1--Interaction

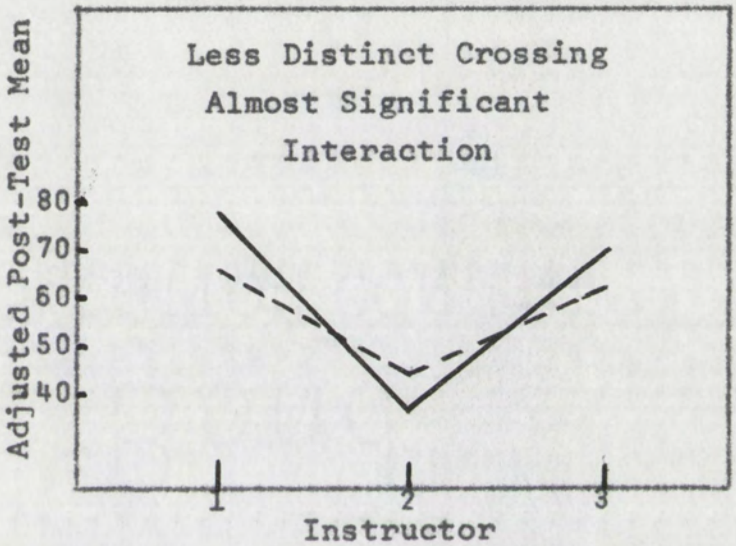


Figure 4.
Unit Test 2--Interaction

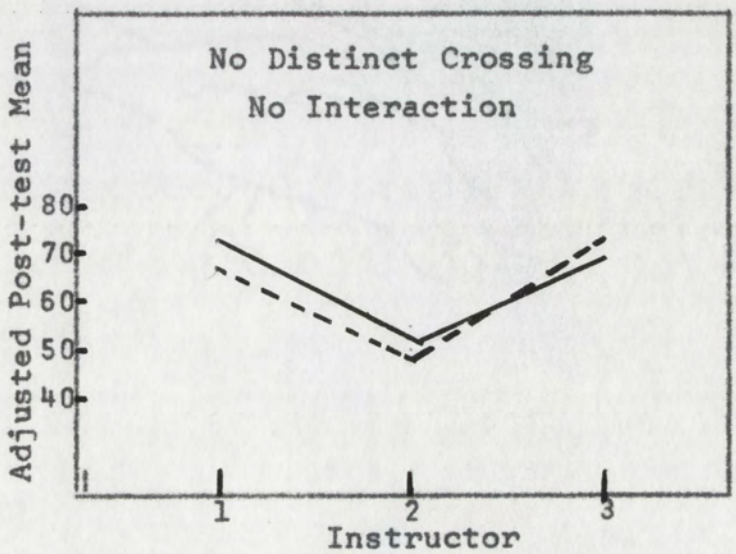


Figure 5.
Unit Test 3--Interaction

Analysis of Final Examination - General Mathematics and College Algebra

The following tables show the results of the analyses of data for the final examinations in general mathematics and college algebra:

TABLE 10

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS
Final Examination - College Algebra

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	0.381	0.38	0.0156
Instructor	2	85.828	42.91	1.760
Interaction	2	6.206	3.10	0.127
Within	94	2292.03	24.38	
Total	99			

No significant F values.

TABLE 11

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Final Examination - College Algebra

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	10.106	22.333	0.1569	22.500
Experimental	10.568	22.522	-0.1569	22.366
Instructor 1	10.333	21.167	0.2771	21.444
Instructor 2	10.031	22.219	0.1771	22.396
Instructor 3	10.513	23.538	-0.1494	23.389

POOLED REGRESSION COEFFICIENT: b = 0.67806

TABLE 12

ANALYSIS OF COVARIANCE SIGNIFICANCE TESTS

Final Examination - General Mathematics

Source of Variation	Deg of Freedom	Residuals	Mean Square	F
Homework	1	957.7	957.7	1.906
Instructor	2	711.4	355.7	0.708
Interaction	2	2710.3	1355.65	2.697
Within	196	98502.7	502.56	
Total	201			

No significant F values.

TABLE 13

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Final Examination - General Mathematics

Source	$\bar{X}$	$\bar{Y}$	Adjustment to $\bar{Y}$	Adjusted $\bar{Y}$
Homework				
Control	11.052	63.784	1.1902	64.974
Experimental	12.792	70.547	-1.1902	69.357
Instructor 1	11.710	64.710	0.3458	65.056
Instructor 2	11.075	66.104	1.2148	67.319
Instructor 3	13.104	71.209	-1.5606	69.648

POOLED REGRESSION COEFFICIENT: $b = 1.3673$

Discussion of Final Examination Analyses

The analysis of data for the final examinations in general mathematics and college algebra indicate no significant F values for any of the variables or interaction. All the null hypotheses; H_{01}, H_{02}, and H_{03}, are therefore tenable.

Analysis of Office Visits

A simple tally sheet was provided each instructor for noting office visits for assistance. A copy of this sheet is found in Appendix C.

The results of the tally are listed in the following table. In this table the general mathematics and college algebra groups were combined.

TABLE 14

OFFICE VISITS FOR ASSISTANCE

Directed Homework	Non-directed Homework
81	74

Discussion of Office Visits

The directed homework condition produced only a few more office visits for assistance. The small difference does not provide a basis for any conclusions.

Analysis of Student Withdrawals and Students Who Stopped Coming to Class

Instructor records were consulted at the end of the semester in order to determine those students who officially withdrew and those who stopped coming to class. The following tables show the results of this study. General mathematics and college algebra groups were combined for these tables.

TABLE 15

OFFICIAL WITHDRAWAL

Directed Homework	Non-directed Homework
20	16

TABLE 16

STOPPED COMING TO CLASS

Directed Homework	Non-directed Homework
17	21

Discussion of Student Withdrawals and Students Who Stopped Coming to Class

The small differences are not significant enough to provide a basis for any conclusions.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary

The experiment was conducted at Northern Arizona University, Flagstaff, Arizona. It involved six classes of general mathematics and six classes of college algebra involving a total of six instructors and three hundred four students. The study was conducted during the fall semester of 1968.

Data collected during the semester was statistically analyzed by analysis of covariance.

The primary objective of the research was to determine whether student achievement was affected by membership in directed or non-directed homework groups.

A second objective was to determine whether student achievement was affected by membership in different instructor groups.

The basic comparison was between adjusted post-test means of the two homework groups and between adjusted post-test means of instructor groups.

Interaction was also analyzed as an integral procedure involved in the statistical analysis.

Observations Concerned with the Faculty

The participating instructors were at times moved by compassion. This feeling was revealed primarily by their concern for slower students in the non-directed homework group. The instructor conferences, quite often for most of the discussion time involved, were devoted to the problem of keeping the slower student in the non-directed classes aware of his progress and thus motivating him to study. There was the ever-present temptation for the faculty to treat not only these students, but the entire non-directed class in some special manner, even to the extent of having them perform special tasks to compensate for the lack of immediate feedback that did occur in the directed homework group. Fortunately, no overt action in this direction was taken; thus, the integrity of the experiment remained. The feeling of concern for students in the non-directed groups did manifest itself in the instructor variable, the only main effect variable in which significant F values occurred.

Discussion with all mathematics department members revealed that the majority of them held to the belief that some feedback on homework was necessary, particularly for the student for whom mathematics is a constant struggle. There were strong feelings, one way or another, on the part of all about the two treatments in the experiment. Most department members indicated they would probably adhere to a policy they found most satisfactory to themselves for producing mathematical learning. This feeling indicates the strong influence of the instructor variable and partially accounts for the significant F values for the instructor variable.

An intuitive interpretation of the significant F value for instructors could be that the instructional method or methods employed in the experiment were contrary to those used by the instructor in his prior experience. In spite of the voluntary participation on the part of the instructors, personal bias could unconsciously affect instructor attitude and thus affect his presentation to his classes. The bias could very well be caused by fundamental differences in the methods of instruction. The two homework groups in the experiment did represent two different approaches to teaching; one that involved a prescriptive approach requiring close supervision by the instructor, the other a more independent approach requiring student supervision of himself.

Observations Concerned with Student Participants

Grades to be awarded generated more concern than did the method of treatment. Students in the non-directed groups had no strenuous objections to their grade being based on the tests only. Most felt that they were personally responsible for their performance. As a result of this sense of responsibility, the students felt that pressure was on them to produce satisfactory test results, but this was more acceptable than the external pressure exerted in the directed homework situation.

Many of the directed homework group members felt an immediate pressure because they were graded on their homework, but many did the homework to compensate for anticipated poor performance on tests. There was concern for how many points could be earned for homework and the effect of these points on the final grade. The directed homework groups felt relieved when told that homework point performance was being credited to their account, so to speak. There was no expressed resentment to the homework assignments, and in some cases a sense of security was present. Most participants in the directed groups felt the immediate feedback of the daily assignments being graded and returned contributed materially to some sort of self-evaluation, which helped direct their study habits.

Students were not informed directly that they were participating in an experimental study. Those who did become aware that they were involved in a study and asked about it were told that they were indeed part of a study being conducted. There are advocates of both approaches to experimentation--informing or not informing the subjects of their involvement in an experiment. This experiment made no overt moves in either direction, though students in the two classes of each instructor were soon aware of the fact that their particular instructor was experimenting with his classes. Toward the close of the semester, just before final examinations, most of the instructors did inform their classes that they had been part of a larger experiment. The students were non-plused about it, and many expressed a desire to know "how the thing turned out."

Other Observations

Discussions with faculty and graduate students about the experiment often revealed concern for what was being measured in the testing. The concern was with the inability of objective testing to measure accurately all factors involved in improvement. This leads to speculation that factors relevant to the affective area; such as, degree of interest, quality of note taking, participation in discussion or degree of involvement in the class, attitude, and most of the other aspects of motivation, are more significant than manipulation of variables that are cognitive in nature.

However, as previously indicated in this study, the multitude of variables relevant to the cognitive area make analysis difficult enough without attempting to bring in variables that are not subject to reliable statistical analysis. Effort was made to keep the study as simple as possible and examine only two relevant variables involved in student achievement. The variables are strictly from the cognitive area and were examined by objective means only.

The non-significant difference between homework variables suggests some support for the belief that college attendance is for the most part confined to average and above average students, as compared with the total high school population. In Chapter II reference was made to studies that indicated that above average students at the elementary and secondary level were not adversely affected by any homework condition. The statistical fact determined by this study is that college students involved in the courses used for the study are also not adversely affected nor are they materially aided by the method of homework treatment; hence, a relationship seems to be present.

Conclusions

Conclusions for the general mathematics groups are as follows:

(1) Students taught under the directed and non-directed homework treatments did not significantly differ in their achievement as measured by their scores on the five unit tests or the final examination.

(2) Students taught under different instructors did differ significantly in their achievement on unit tests 1, 2, and 5, and the difference occurred between instructor 1 and instructor 2 on unit test 1, between instructors 2 and 3 on unit tests 2 and 5. The achievement did not differ

significantly on unit tests 3 and 4 or the final examination.

(3) No significant interaction between homework and instructor membership and the criterion took place on the five unit tests or final examination.

Conclusions for the college algebra groups are as follows:

(4) Students taught under the directed and non-directed homework treatments did not significantly differ in their achievement as measured by their scores on four unit tests or the final examination.

(5) Students taught under different instructors differed significantly in their achievement as measured by the four unit tests. In unit tests 1, 3, and 4, the difference was between instructors 2 and 3, and on unit test 2, the difference was between instructors 1 and 2. There was no significant difference between instructor groups as measured by the final examination.

(6) There was interaction present between the homework and instructor variables and the first unit test. There was no significant interaction for unit tests 2, 3, 4, or the final examination.

Recommendations

The recommendations to be made are subject to conditions similar to those involved in this study. Recommendations are most applicable for those institutions with student bodies similar to that found at Northern Arizona University. These recommendations apply particularly to those students who are pursuing a non-technical course in college, or at most, as in the case of college algebra, studying mathematics only at the basic level in preparation for upper division courses in their area dependent upon certain mathematical fundamentals. Forestry or business majors would be an example of this latter category. Education or fine arts majors serve as examples for the first category.

The recommendations are also more appropriate for those institutions having a liberal studies program similar to that at Northern Arizona University and those institutions offering college algebra as a credit, service course.

Recommendation No. 1. Conclusions number 1 and 4 and discussion of Tables 1 through 9 and Tables 13 through 16 in Chapter IV indicate no recommendation can be made concerning directed and non-directed homework. On the basis of conclusions number 2 and 5 and discussion of Tables 1, 2, 5, 6, 7, 8, and 9 in Chapter IV, it is recommended that instructors should be permitted to utilize the homework policy that they find most effective for attainment of the objectives of significant student achievement.

Recommendation No. 2. On the basis of conclusions number 2 and 5 and discussion of Tables 1, 2, 5, 6, 7, 8, and 9 in Chapter IV, it is recommended that various ways of stating and treating objectives might seem to offer a more fruitful approach to improvement of achievement than manipulation of homework.

Recommendation No. 3. On the basis of all the statistical results and analyses, further study of the problem is recommended. A replicate of this experiment should be conducted using homogeneous and heterogeneous grouping. Also, use of at least one more control variable, such as ACT score, is advised. Other replications recommended should have: (1) variables such as instructor and student attitude scales, and (2) variables that are "new" forms of homework, such as independent study and tutoring.

APPENDIX A

NORTHERN ARIZONA UNIVERSITY
Flagstaff Arizona

College of Arts and Sciences

May 15, 1968

To Whom It May Concern:

The following faculty members have agreed to participate as instructors in an experimental study in mathematics education to be conducted at Northern Arizona University in the fall semester of the 1968-69 academic year; John R. Micklich, principal investigator.

Name	Highest degree	Teaching experience
Ashley, Howard	M.S.	4 years
Bell, Graydon	M.S.	1 year
Butchart, J. H.	Ph.D.	35 years
McMacken, Dennis	M.A.	3 years
Micklich, John R.	M.S.	16 years
Mutter, J. M.	M.A.	10 years
Rozema, W. J.	M.S.	16 years

Schedule arrangements have been made for each of these instructors to teach two sections of a course under study, and they have voluntarily agreed to participate in the study.

Respectfully,

Charles E. Little, Chairman
Department of Mathematics

APPENDIX B

Test and Forms

COLLEGE ALGEBRA

Northern Arizona University

Course Number M110

The pre-test in college algebra will be the form A, Algebra III; the post-test, Form B, Algebra III. These tests are published by Educational Testing Service.

According to ETS statistical characteristics, both of these tests have reliability coefficients of .80 or over when administered to college students. There is a fair to good (.40-.65) correlation with SCAT-Q scores, thus indicating a relatively good level of appropriateness for the classes in this experiment.

GENERAL MATHEMATICS

Northern Arizona University

Course Number M241

The pre-test included here will also be the post-test. A similar procedure was used here at NAU during the academic year (2 semesters) 1966-67 with excellent results. The results were a part of the data used in the unpublished dissertation of Charles Godat Moore (Michigan State), covering an experiment in team teaching of college general mathematics.

The test was constructed by the two authors of the textbook being used in the experimental classes in general mathematics. The topics discussed in the course M241 are, therefore, fully covered by the test questions as well as being stated in the objectives for M241.

Validity will be concerned, obviously, with content. In view of the above paragraph and the quote which follows, it is the opinion of the experimenter, that content validity is adequately insured.

From ETS HANDBOOK FOR COOPERATIVE MATHEMATICS TESTS:[13] "Content validity is best insured by entrusting test construction to persons well-qualified to judge the relationship of test contents to teaching objectives."

ACHIEVEMENT TEST
Mathematics 241 NAME ______________________________

1.a. Draw an Euler diagram for the following syllogism and test its validity.

All college students study diligently.
All freshmen are college students.

Make diagram here

Therefore, all freshmen study diligently.

Circle one: Valid Invalid

b. Using Euler diagrams to assist your reasoning, draw one valid conclusion from the following hypotheses.

Good men never cause pain.
Dentists do cause pain.

Therefore, ____.

2. Let P and Q be defined as follows: P = I am happy.
Q = I am married.

a. Write <u>in words</u> the sentences symbolized by the following:

$P \wedge Q$ ____

$P \rightarrow \tilde{Q}$ ____

b. Write the following sentence in symbolic form:

If I am not happy, then I am married. ________________

3.a. Use the listing method to name elements of the following sets:

$X = \{x: \ 0 < x < 10, \text{ and } x \text{ is odd}\}$ $X =$ ________________

b. Write in set builder notation the following set X:

$X = \{2, 4, 6, 8\}$ $X =$ ______________________________

4.a. Consider the sets: $U = \{a, b, c, d, e, f\}$

$A = \{a, b, c, d\}$ $B = \{c, d, e\}$

Find $A \cap B =$ ________________________

$\tilde{B} =$ ________________________

b. A complete sentence is represented by symbols "$B \subset A$"

Write this sentence in words: ________________________

5.a. Use Venn diagrams to determine whether the following sets are equal or unequal:

$A \cap (B \cup C) = A \cup (B \cap C)$

Circle one:

Show work here:

equal

unequal

b. Consider the sentence: "If N is divisible by 15, then N is divisible by 3." Now write in words:

The inverse: ______________________________

The contrapositive: ______________________________

c. Consider the sentence: "If I do not study hard, then I will not get a good grade." Now write this as a positive sentence which is equivalent to it.

____

____

d. Write the word "necessary" or "sufficient" in the blank in the following sentence: "For a whole number to be divisible by 9 it is ______________ that the whole number be divisible by 18.

6.a. Construct a truth table for the following statement:

$P \rightarrow \widetilde{Q}$

P	Q	

b. Use truth tables to test the validity of the following argument:

The girl is a nurse or she likes hospitals.
She does not like hospitals.
____
Therefore, she is not a nurse.

Circle one:

valid

invalid

7.a. Find the possible error and the relative error for the measurement: 2.5 feet.

Possible Error = ____________

Relative Error = ____________

b. Accuracy is determined by:

Circle one: Possible Error Relative Error

c. List the significant digits in the following measurements:

2.0 inches____________ 2.05 inches____________

0.0031 inches____________ 200 inches____________

d. Round the following to the nearest tenth:

2.349________ 3.25________ 3.255________

e. Add according to the rules for computing with approximate numbers:

6.4782	in.
23.0	in.
7.33	in.
________	

f. Find the area of a rectangle whose dimensions are recorded as follows:

width = 4.392 in., length = 2 in. Area = ______

8.a. A teacher gave a quiz and the scores were 7, 8, 5, 8, 4, 3, 5, 8.

Find the mode of these scores. Mode = ______

b. Find the median of the distribution: 4, 9, 3, 7, 6, 5, 11.

Median = ______

9. If $x_1 = 2$, $x_2 = 4$, $x_3 = 6$, and $x_4 = 8$, then

$$\sum_{i=1}^{3} x_i = \_\_\_\_\_\_$$

10.a. A teacher wishes to assign a weight of 2 to the mid-term exam and a weight of 3 to the final exam. Find the composite score of a student who makes 90 on the mid-term and 40 on the final.

Composite Score = ________

b. Use the formula for the mean of grouped data to find the mean of the distribution: 5, 5, 4, 4, 4, 3, 3, 3, 2, 1. Make a table using appropriate column headings.

Mean = ________

c. Find the standard deviation of the numbers: 15, 6, 4, and 3. Give answer correct to the nearest tenth.

Standard deviation = ________

11.a. Four hundred students took a test and the distribution of scores was approximately normal. The mean was 50 and the standard deviation was 4. Approximately how many students made scores between:

46 and 54 ________

50 and 58 ________

b. When is a sample an unbiased sample? ________

____

12.a. A box contains 5 red marbles and 2 black marbles. If one marble is drawn, find the probability that the marble is:

black________ blue________ not yellow________

b. Evaluate the following expressions:

P(5,3) = ________ C(7,3) = ________

c. How many numerals of 2 digits each can be formed from the digits 3, 4, 6, 7, and 8, if no digit is repeated in any one numeral?

Answer:________

d. How many odd numerals can be formed using the conditions of the preceding problem?

Answer: ________

e. Nine sport coats in Dan's size are on sale. He can afford to buy two. In how many ways can he choose the two coats?

Answer: ________

f. If one card is drawn from a deck of 52 playing cards, what is the probability the card is a 6 or an ace?

Answer: ________

g. If one card is drawn from a deck of 52 playing cards, what is the probability the card is a black card or a king?

Answer: ________

13.a. A bag contains 3 green marbles, 2 red marbles and 6 black marbles. If two marbles are drawn, replacing the first before the second is drawn, what is the probability the first marble is green and the second is red?

Answer: ________

b. If two marbles are drawn from the bag described in problem 13a, <u>without replacing</u> the first marble before the second is drawn, what is the probability the first is green and the second is black?

Answer: ________

c. If a coin is tossed 4 times, what is the probability that <u>exactly two</u> heads will appear?

Answer: ________

14.a. Bill paid 35 cents for a chance on a radio worth forty dollars. If 80 chances were sold, what is Bill's expectation?

Answer: ________

b. Did Bill pay too much for his chance? Circle one:

Yes No

15. What two levels of significance are most commonly used when applying the Chi-square test?

________________ and ________________

16. State the properties of addition, multiplication, or division illustrated by the following statements:

a. $2 + (3 + 4) = (2 + 3) + 4$

Addition is ______________________

b. $2(3 + 4) = 6 + 8$

Multiplication is ________________

c. $8 \div 2 \neq 2 \div 8$

Division is ______________________

17. The symbol "$<$" represents the relationship "is less than" State the properties of "$<$" illustrated by the following statements:

a. $5 \nless 5$ "$<$" is ______________________________

b. If $a < b$, then $b \nless a$. "$<$" is ____________________

c. If $2 < 7$ and $7 < 9$, then $2 < 9$. "$<$" is ____________

18.a. Identify the set of numbers (natural numbers, integers, rationals, reals, or complex numbers) to which each of the following numerals belong according to the way they are written:

$+\frac{2}{3}$ ________________ 7 ____________________

-5 ________________ $-4.272727...$ ____________

b. The natural numbers correspond to what subset of integers:

____

19.a. Write 0.277777... as a fraction.

Answer: ________

b. Assume that you wish to reduce the fraction $\frac{612}{1309}$ to lowest terms. Use the Euclidean algorithm to find the largest number that can be divided evenly into both 612 and 1309.

Answer: ________

20. Solve the following equations for x:

a. $0.2 + 0.03x = 2$ $x =$ ______

b. $\frac{x}{3} + \frac{1}{2} = \frac{3}{2}$ $x =$ ______

c. What can you say about the solutions for the following equations?

$x + 5 + 2x = 2 + 3x + 3$ $x + 3 + 4x = 5x + 4$

21. Find the square root of 7921. Answer: ________

22. Solve the following equation using the Quadratic Formula:

$x^2 + x = 12$ Answer: ________

23. Write an equation which when solved will yield an answer to the following problems. DO NOT SOLVE THE EQUATIONS.

a. How many pounds of a 70 percent acid solution and how many pounds of a 20 percent acid solution must be mixed to obtain 80 pounds of a 60 percent acid solution?

Equation: ______________________________

b. How many quarts of water must be added to 30 quarts of a 65 percent acid solution to obtain a 45 percent acid solution?

Equation: ______________________________

c. Bill can grade a set of papers in 3 hours and Joe can grade the same set in 5 hours. How many hours will it take Bill and Joe working together to grade the set?

Equation: ______________________________

d. Mary can grade a set of papers in 7 hours. Sue can grade the same set in 5 hours, Jane can grade the same set in 4 hours, and Kate can grade the same set in 3 hours. How many hours will it take all four girls working together to grade the set of papers?

Equation: ______________________________

e. A and B are 117 miles apart. They start toward each other. A travels 51 miles per hour and B travels 48 miles per hour. In how many hours will they meet?

Equation: ______________________________

f. A rectangular piece of tin is 5 inches longer than it is wide. Its area is 126 square inches. Find the width of the piece of tin.

Equation: ______________________________

24.a. Write the following expressions in a different but equivalent form:

$x^r \cdot x^t$ = _____, p^{rt} = _____, r^{a+b} = _____, $a^{x/y}$ = _____

b. Evaluate the following expressions:

4^{-2} = _____, $16^{1/2}$ = _____, $(9^0)^2$ = _____, $9^{3/2}$ = _____

25. Write the decimal numeral 432.7 in exponential form.

____

26.a. Write the five base four numerals that follow the base four numeral 31.

_____, _____, _____, _____, _____

b. Make the following conversions in the bases indicated:

212_{three} = $\_\_\_\_\_\__{ten}$ 58_{ten} = $\_\_\_\_\_\__{four}$

c. The following addition was performed in base four. Check the addition by transforming the problem to base ten and circle your conclusion.

$$\begin{array}{r} 33 \\ \underline{23} \\ 132 \end{array}$$

Circle one:

correct

incorrect

d. Perform the following computations using binary (base two) arithmetic:

Add:
```
  11
 101
 110
----
```

Multiply:
```
 111
  11
----
```

27.a. Write the following ordinary decimals in scientific notation:

378,000 = ________ 0.0023 = ________

b. Perform the following multiplication in scientific notation and place the answer in scientific notation.

$(4.4 \times 10^{13})(5.0 \times 10^{7}) =$ ____________

28.a. Write a logarithmic expression which is equivalent to the following expression:

$2^3 = 8$ ____________

b. Write an exponential expression which is equivalent to the following expression:

$\log_2 16 = 4$ ____________

29.a. Find a solution for this logarithmic equation:

$\log_9 x = 2$, $x =$ ____________

b. Use the given logarithm tables to find the following logarithms:

log 26.7 = ______ log 0.0372 = ______

N	log N
1.39	0.1430
1.63	0.2133
2.53	0.4031
2.67	0.4265
3.72	0.5705
5.56	0.7452
7.06	0.8488
7.73	0.8882

c. Evaluate the following expressions using logarithms.

$\frac{7730}{13.9} =$ ________ $(1.63)^4 =$ ________

30.a. Perform the indicated conversions from one metric to another.

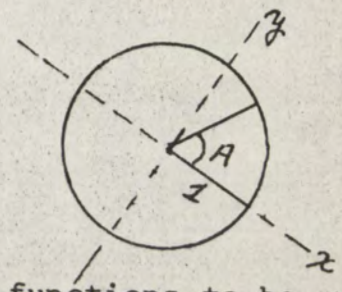
0.0625 m. = ______cm. 6250 cu.mm. = ______cu.cm.

b. What would be an appropriate metric unit to be employed in measuring the thickness of a car key?

c. 3.6 cc. of water weighs ________ g. (approximately)

d. A rifle barrel 26 inches long is approximately __________ centimeters.

31. A unit circle is given with angle A in standard position. Draw the lines whose lengths represent the sin A, cos A, and tan A, and write sin A, cos A, and tan on the proper lines.



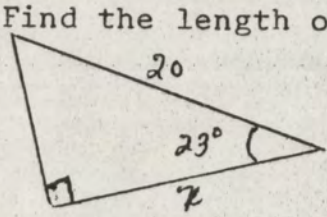
Following is a table of trigonometric functions to be used in working problems 32 and 33.

Angle	Sine	Cosine	Tangent
10°	0.1736	0.9848	0.1763
12°	0.2079	0.9781	0.2126
15°	0.2588	0.9659	0.2679
20°	0.3420	0.9397	0.3640
23°	0.3907	0.9205	0.4245

32.a. Find the values of the following trigonometric functions:

cos 168° = __________   tan (-15)° = ____________

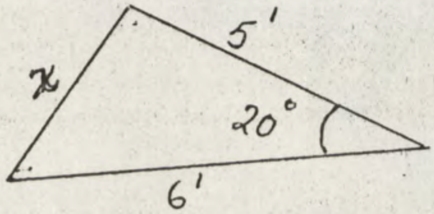
b. Find the length of six x in the given right triangle:



x = ____________

c. Apply the law of cosines to find side x in the following triangle. Just write what the law of cosines says about the triangle; do not solve.

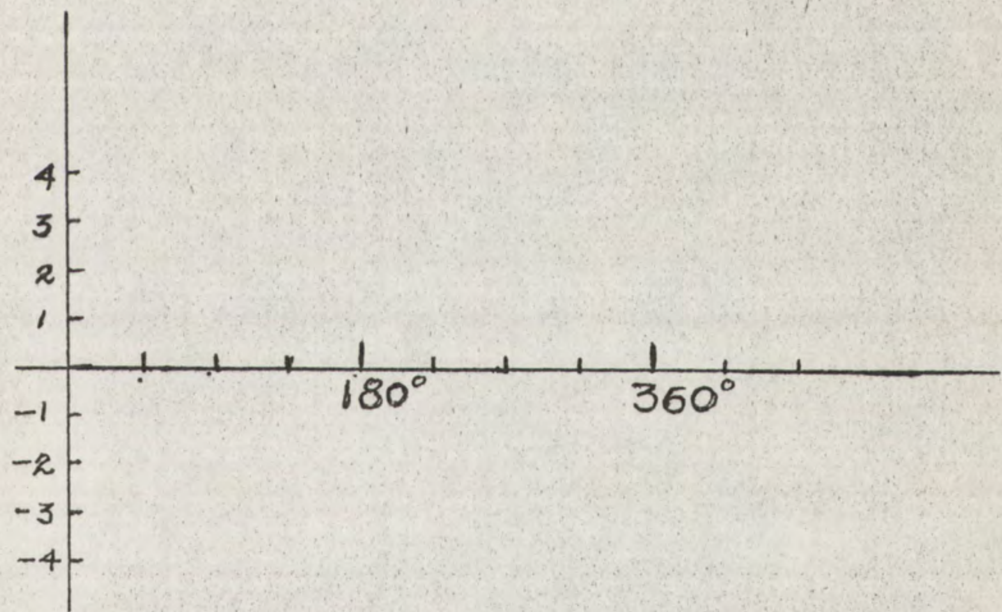
Answer: ____



33. Find the sine of 40°. Apply a trigonometric identity.

Answer: ____________________

34. Sketch the curve of sin x on the given axes with a solid line. Sketch the curve of 3 sin 2x on the same axes using a dotted line.



OBJECTIVES FOR UNIT I - MATH 241

Text: BASIC CONCEPTS OF MATHEMATICS
Moore and Little, McGraw-Hill, 1967

LOGIC AND SET THEORY

After studying Unit I, the student should be able to:

1. Test the validity of an argument using Euler diagrams.

2. Draw a valid conclusion based upon a given set of assumptions using Euler diagrams.

3. Translate verbal statements into symbolic form using symbols from logic.

4. Write the converse, inverse and contrapositive of an implication.

5. Apply the law of contraposition to simplify a given implication complicated by negatives.

6. Construct truth tables for compound statements.

7. Use truth tables to determine whether two symbolic statements are equivalent.

8. Write the inference scheme for an argument and test the validity of the argument using truth tables.

9. Identify the elements of sets using both the set builder and the listing method.

10. Identify the elements of sets resulting from operations upon given sets. The operations will be union, intersection and complement.

11. Use Venn diagrams to determine whether the results of different operations upon given sets are equal.

12. Use the concepts of "disjoint," "subset," "one-to-one correspondence," and "cardinal number" in answering questions concerning sets.

OBJECTIVES FOR UNIT II - MATH 241

Text: BASIC CONCEPTS OF MATHEMATICS
Moore and Little, McGraw-Hill, 1967

PROBLEM SOLVING, NUMBER SYSTEMS, EQUATIONS AND APPLICATIONS, MEASUREMENT

After studying Unit II, the student should be able to:

1. Identify applications of the commutative, associative and distributive properties of operations.
2. Identify applications of the reflexive, symmetric and transitive properties of relations.
3. Find fractions corresponding to given repeating decimals.
4. Find repeating decimals corresponding to given fractions.
5. Name the set of numbers to which a given numeral has reference. For example, -7 refers to an integer.
6. Apply the Euclidean algorithm to find the greatest common divisor of two given natural numbers.
7. Reduce any fraction to lowest terms using the Euclidean algorithm.
8. Solve equations involving fractions and decimals. For example: $\frac{x}{3} + \frac{2}{5} = \frac{1}{2}$ $\quad .2x + 5 = .03$
9. Write equations which will serve as models for given physical situations. For example: mixture problems, work problems, distance and rate problems.
10. Solve quadratic equations using the quadratic formula. For example: $x^2 + 2x - 4 = 0$
11. Calculate the possible error and relative error for a given measurement.
12. Indicate the relationship between possible error and relative error, and precision and accuracy.
13. Identify the significant digits in a given measurement.
14. Round off numerals and use the accountant's law.
15. Make computations using measurements and present answers according to the rules for computing with approximate numbers.

OBJECTIVES FOR UNIT III - MATH 241

Text: BASIC CONCEPTS OF MATHEMATICS
Moore and Little, McGraw-Hill, 1967

STATISTICS AND PROBABILITY

After studying Unit III, the student should be able to:

1. Identify a sum indicated by the "sigma" summation symbol.
2. Find the mean, median and mode for a given distribution.
3. Compute the mean for grouped data.
4. Compute the range and standard deviation for a small number of cases.
5. Use the properties of the normal curve to find the approximate number of cases falling between two given cases in a distribution.
6. Compute simple probabilities.
7. Select a random sample using a table of random numbers.
8. Determine whether a given situation involves mutually exclusive or non-mutually exclusive events.
9. Compute numbers of permutations and combinations.
10. Draw Venn diagrams to assist reasoning in situations concerning non-mutually exclusive events.
11. Compute mathematical expectations and interpret the mathematical expectation.

OBJECTIVES FOR UNIT IV - MATH 241

Text: BASIC CONCEPTS OF MATHEMATICS
Moore and Little, McGraw-Hill, 1967

EXPONENTS, NUMERATION AND LOGARITHMS

After studying Unit IV, the student should be able to:

1. Write an exponential expression in a different but equivalent form. For example: $x^{a+b} =$ _____.
2. Evaluate exponential expressions such as $36^{-1/2}$.
3. Write in exponential form a numeral expressed in place value notation.
4. Count in a base other than ten.
5. Convert numerals from a "new" base to base ten and from base ten to a "new" base.
6. Add in a base other than ten with tables given.
7. Write ordinary decimal numerals in scientific notation.
8. Compute using scientific notation. For example: $\frac{1}{.0004} =$ _____.
9. Write exponential expressions as logarithmic expressions.
10. Write logarithmic expressions as exponential expressions.
11. Find solutions for logarithmic equations.
12. Use a table of logarithms to find logs and antilogs.
13. Use a logarithm table as an aid in computing.

OBJECTIVES FOR UNIT V - MATH 241

Text: BASIC CONCEPTS OF MATHEMATICS
Moore and Little, McGraw-Hill, 1967

TRIGONOMETRY

After studying Unit V, the student should be able to:

1. Find the value of the sine, cosine and tangent of an angle of a right triangle in which the lengths of the sides are given.

2. Draw the lines representing the sine, cosine and tangent of angle A on a unit circle with angle A in standard position.

3. Make use of the unit circle to estimate the sine, cosine and tangent of a given angle.

4. Use a table of trigonometric functions to evaluate the functions of an angle greater than 90° and an angle less than 0°.

5. Find the resultant of two vectors of force.

6. Find the magnitude of angles and sides in right triangles using the definitions of the trigonometric functions or the Pythagorean theorem.

7. Apply the Law of Sines and the Law of Cosines in solving oblique triangles. The lengths of sides will be given as measurements with one non-zero digit. Answers will be stated in agreement with the rules for computing with approximate numbers.

OBJECTIVES FOR UNIT I   MATH 110

Text: FUNDAMENTALS OF COLLEGE ALGEBRA
Allendoerfer & Oakley, McGraw-Hill, 1967

SETS, NUMBER SYSTEMS, POLYNOMIALS

After studying Unit I, chapters 1, 3, 4, 5, the student should be able to:

1. Know what a set is and the set operations.

2. Know the structure and rules or postulates for operations in the various sets of numbers.

3. Have a working knowledge of operations with polynomials. i.e. addition, multiplication, division and subtraction.

4. Recognize and perform various factoring methods.

5. Know how to perform the various operations with algebraic fractions and know how to simplify algebraic fractions including complex fractions.

6. Know laws governing operations involving expressions with exponents.

7. Know the meaning of exponents such as integral, fractional, negative and 0.

8. Know simplification of radical expressions including rationalization of radical expressions.

OBJECTIVES FOR UNIT II MATH 110

EQUATIONS

After studying Unit II the student should be able to:

1. Know definition of an equation and know categories of equations. i.e. conditional and identity.

2. Know properties of equations and operations performed on equations.

3. Know what linear and quadratic equations are.

4. Know what a system of equations is and be able to determine whether a system is simultaneous or inconsistent.

5. Be able to solve simultaneous systems, linear or linear quadratic-graphically, or algebraically, or with Cramer's rule using determinants.

6. Know operations that can be performed with determinants.

7. Solve "word" problems.

OBJECTIVES FOR UNIT III MATH 110

INEQUALITIES

After studying Unit III the student should be able to:

1. Understand what an inequality is.
2. Know fundamental properties and theorems in inequalities.
3. Know graphical and algebraic interpretation of linear and quadratic inequalities.
4. Know applications of inequalities including use in linear programming.
5. Know what algebraic relations and functions are and their relationship to each other.
6. Know what polynomial, rational and explicit functions are.
7. Know how to graph functions.
8. Know what continuity in functions is.

OBJECTIVES FOR UNIT IV MATH 110

ROOTS OF POLYNOMIALS AND LOGARITHMS

After studying Unit IV the student should be able to:

1. Know how to use synthetic division.

2. Know how to determine rational and real roots of polynomial equations.

3. Know what exponential and logarithmic functions are.

4. Computation with logarithms using the rules for this type of oomputation.

Math 241 UNIT TEST #1 NAME ______________________________

NOTE: Read the directions for each question or problem before working on it. SCORE______SECTION__________

1. Draw an Euler diagram for each of the following syllogisms. Determine whether the syllogism is valid or invalid, and circle your answer.

   (a) All blondes are good-looking.
   No good-looking person has blue eyes.
   Therefore, no blonde has blue eyes.

   Diagram here:

   Circle one answer:

   valid

   invalid

   (b) Every bartender has a one-track mind.
   Some intelligent people have one-track minds.
   Therefore, some bartenders are intelligent.

   Diagram here:

   Circle one answer:

   valid

   invalid

2. Let P and Q be defined as: P = George is rich.
   Q = George is happy.

   (a) Translate the following symbolic statements into <u>complete</u> verbal sentences.

   $Q \vee \tilde{P}$ Answer:

   $\widetilde{Q \rightarrow P}$ Answer:

   (b) Translate the verbal statement into symbolic form.

   George is not rich and he is happy. Answer: ______________

   If George is rich or he is not happy, then he is not rich. Answer: ______________

GO ON TO NEXT PAGE

 NAME ______________________________

3. Construct the truth tables for the following statement.

$P \wedge \sim Q$

P	Q	

4. Consider the implication: If George is happy, then he is rich. Now write in complete verbal sentences its:

(a) Converse:

(b) Contrapositive:

5. Suppose you heard your friend say, "If I don't work hard, the boss will not give me a raise." Write a complete verbal sentence without negatives which is equivalent to this sentence.

6. Use truth tables to determine whether the following symbolic argument form is valid. Show the truth table and circle the column which you used to make your decision about validity. Also circle your answer,"valid or "invalid".

$$\begin{array}{l} P \vee Q \\ \sim Q \\ \hline \therefore P \end{array}$$

P	Q	

Circle one answer: valid invalid

 NAME ____________________

7. Use truth tables to determine whether or not the following pair of symbolic statements are equivalent to each other. Circle the columns in the truth tables used to make your decision, and then circle your answer.

Statements: $\sim P \vee Q$ $\qquad$ $\sim Q \rightarrow \sim P$

Truth tables here:

P	Q	

Circle one;

Equivalent

Not Equivalent

8. Use set-builder notation to name the following set:

$A = \{4, 6, 8\}$

Answer: A =

9. Use the enumeration (listing) method to name the set:

$B = \{x : 4 < x < 11, \text{ and } x \text{ is a multiple of } 3\}$

B =

10. Using the enumeration method, list all the subsets of the set $\{5, 10\}$.

Answer:

11. If the universal set is $U = \{a, b, c, d, e\}$ and $A = \{a, c, d\}$ and $B = \{a, b, c\}$, use the enumeration method to name the following sets.

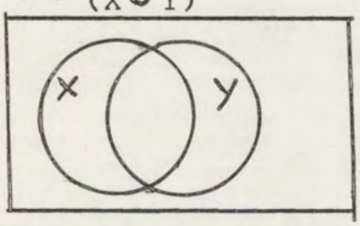
$\sim A$ = ________ $\quad A \cap B$ = ________ $\quad B \cup A$ = ________

$U \cap B$ = ________ $\quad U \cup A$ = $\quad B \cap \emptyset$ = ________

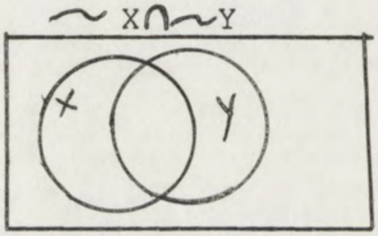
12. (a) Show in a Venn diagram the region representing each of the following sets. Shade only the region representing the particular set.

Diagrams here

$\sim(X \cup Y)$



$\sim X \cap \sim Y$



(b) Are the sets in (a) above equal? Circle one: Yes No

thematics 241
st - Unit II

Section ______

Name ______________________

. $1 \cdot A = A$, therefore 1 is called the ______________________

. $A + 0 = A$, therefore 0 is called the ______________________

. $(+3) + (-3) = 0$, therefore -3 is the ______________________ of $+3$.

. $\left(\frac{2}{5}\right) \cdot \left(\frac{5}{2}\right) = 1$, therefore $\frac{2}{5}$ is the ______________________ of $\frac{5}{2}$.

. * and V are operations and R is a relationship. State in complete sentences the properties of *, V, and R illustrated by the following statements. Assume the given statements to be true.

(x V y) V z = x V (y V z) ______________________

____

a R b $\longrightarrow$ b R a ______________________

____

x * y = y * x ______________________

____

a R a ______________________

____

x * (y V z) = (x * y) V (x * z) ______________________

____

. Name the sets of numbers we studied in Unit II in the order in which they were presented. Hint: the first set is the natural numbers.

______________, ______________, ______________,

______________, ______________

'. Find a fraction which corresponds to the following repeating decimal:
.31717171717... answer ________

show
work
here

. Use the Euclidean Algorithm to reduce the fraction $\frac{341}{527}$. Your arithmetic must be correct to receive credit.

answer ________

show
work
here

. Find solutions for the following equations:

a) $4 - 2x = 14 - 7x$

$x =$ ________

b) $\frac{x}{2} + \frac{x}{3} = 5$

$x =$ ________

c) $.02x - 3 = .6$

$x =$ ________

. What can you conclude about solutions to the following equations?

a) $5x + 3 + 2x = 7x + 2$

answer ________

b) $2x + 5 + 3x = 2 + 5x + 3$

answer ________

1. Find solutions to the following quadratic equation usinq the QUADRATIC FORMULA.

$2X^2 + 3X = 2$ Answers X_1 = _____, X_2 = __________

Show work here

2-18 Write EQUATIONS whose solutions will yield answers to the following problems. DO NOT SOLVE THE EQUATIONS.

2. A collection of coins consists of dimes and nickels. There are 3 more nickels than dimes and the value of the collection is $1.05.

____
(place equation here)

3. How much of a 30% acid solution and how much of a 70% acid solution should be mixed to yield 40 gallons of a 60% acid solution?

____

4. How much water must be mixed with 30 gallons of an 80% acid solution to obtain a 20% acid solution?

____

5. Sam can do a job in 5 hours and Bill can do the same job in 9 hours. How long will it take to complete the job if both boys work together?

____

6. Pete and Joe can mow a lawn together in 5 hours. If Joe can do the job alone in 6 hours, how long will it take Pete to do the job alone?

____

7. A and B are 300 miles apart when they start toward each other. A goes 40 miles per hour and B goes 70 miles per hour. In how long will they meet?

Equation ______________________________

3. A policeman is 7 miles behind a speeder when the chase begins. The policeman goes 80 miles per hour and catches the speeder in 30 minutes. How fast was the speeder traveling?

Equation ______________________________

. List the significant digits in the following measurements:

a. 9.00 in. ______________ b. 7.0003 in. ___________

c. .00068 in. ______________ d. 70000 in. ____________

. Find the possible error and the relative error for a measurement recorded as 4.7 feet.

possible error = _____ relative error = _______

Show
work
here

. Round off the following numbers to the nearest tenth using the rules we have studied.

3.749 ______ 3.65 ______ 3.75 _________

. Perform the following computation according to the rules we have studied.

add 4.2 in.
2.17 in.
3.2694 in

Answer ____________________

Unit Test III
General Mathematics NAME ______________________

1. If $x_1 = 4$, $x_2 = 10$, $x_3 = 15$ and $x_4 = 20$, evaluate the following. Evaluate means to show your answer as a single number.

$$\sum_{i=1}^{4} x_i =$$

2. Find the mean, median, mode, and range of the following set of numbers: 20, 6, 7, 6, 8, 6, 10.

Mean = _____, Median = _____, Mode = _____, Range = _____

3. Find the mean of the following distribution. Group the data using appropriate column headings. Use the formula for the mean of grouped data: 6, 6, 5, 5, 5, 5, 2, 2, 2

Formula = ___________ Mean = ___________

X	

4. Find the standard deviation of the following set of numbers: 11, 9, 8, 7, 5

Formula = ___________ S.D. = ___________

X	
11	
9	
8	
7	
5	

5. In order to determine a final grade a teacher decides to give a weight of 2 to homework, 3 to mid-term exam, and a weight of 10 to the final exam. Find the composite score for a student who makes 60 on homework, 30 on the mid-term exam, and 15 on the final exam.

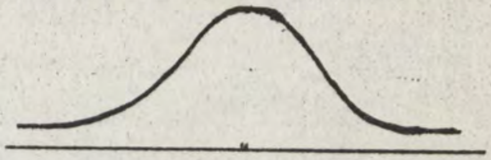
Composite Score = __________

6. A test was given to 600 students. The mean was 40 and the standard deviation was 5. Assuming the distribution to be normal, indicate this information on the normal curve and find the number of scores between:

a. 35 and 45 ________

b. 30 and 40 ________

c. above 45 ________



7. Evaluate the following expressions:

a. C(7,4) = ________   b. P(11,3) = ________

8. A box contains 5 red marbles and 6 blue marbles. One marble is drawn at random. Find the probability that the marble is:

a. red______   b. yellow______   c. not purple______

9. One card is drawn from a deck of 52 playing cards. Find the probability that the card is:

a. a king______   b. an ace or a red card_______

10. a. A marble was drawn from the box described in problem 8 and replaced in the box. Again a marble was drawn. What is the probability that both marbles were red?

____

b. Two marbles were drawn from the box described in problem 8. The first was not replaced before the second was drawn. What is the probability that both marbles were blue?

____

11. a. A certain family has a cadillac, a buick, a chevy, and a ford. They have a driveway just wide enough for one car but long enough for four. In how many arrangements can the four cars be parked in the driveway?

____

b. A rich man is going to buy three cars from a dealer who has 12 different cars. How many sets of 3 cars can the rich man select?

____

12. Bill pays 25¢ for a chance on a radio worth $60. Two hundred chances were sold.

a. Find Bill's mathematical expectation. ________

b. Did Bill pay too much for his chance? ________

13. An engineer's rule (three sides) has the sides lettered X, Y, and Z. If the rule is tossed 4 times, what is the probability that exactly two X's will occur? ________

Unit Test IV
General Mathematics NAME______________________________

Write each of the following exponential expressions in a different but equivalent form using the laws of exponents we have studied:

1. $Y^{a/b}$ = ________ 2. $(Y^a)^b$ = ________ 3. $Y^{1/a}$ = ________

4. Y^{ab} = ________ 5. Y^{a+b} = ________ 6. Y^{a-b} = ________

Evaluate the following (show the answers without using exponents):

7. 2^{-4} = ________ 8. $100^{1/2}$ = _______ 9. $100^{-1/2}$ = _____

10. $(64^0)^{1/3}$ = ________ 11. $(1^{2/3})^{3/2}$ = ________

12. $27^{2/3}$ = __________

Write the following base ten numeral in exponential form:

13. 3452 = ____

Write the following base seven numeral in exponential form:

14. 304.51 = ____

Write the four base seven numerals that follow the base seven numeral 64. (Just fill in the blanks.)

62, 63, 64, _____, _____, _____, _____

Make the following conversions in the bases indicated:

16. 301_{six} = ________$_{ten}$ 17. 1111_{two} = ________$_{ten}$

18. 75_{ten} = ________$_{five}$ 19. 31_{ten} = ________$_{two}$

Perform the following additions in the bases indicated. You may use the addition tables given.

20. Add in base five:

$$\begin{array}{r} 232 \\ \underline{321} \end{array}$$

+	0	1	2	3	4
0	0	1	2	3	4
1	1	2	3	4	10
2	2	3	4	10	11
3	3	4	10	11	12

21. Add in base two:

$$\begin{array}{r} 11101 \\ 1011 \\ 11101 \\ \underline{1101} \end{array}$$

+	0	1
0	0	1
1	1	10

Write the following ordinary decimal numerals in scientific notation:

22. 23,400,000 = __________ 23. 0.0000423 = __________

Write the following in positional notation:

24. 1.67×10^5 = __________ 25. 8.35×10^{-3} = __________

Perform the following computations using scientific notation. (Do not use logarithms and give answers according to rules for approximate numbers.)

26. $(2.2 \times 10^6)(7.0 \times 10^3)$ = __________

27. $\dfrac{6.48 \times 10^6}{3.24 \times 10^{-2}}$ = __________

Write the following in logarithmic form:

28. $64^{1/6} = 2$ __________

29. $10^{0.4771} = 3$ __________

Find a solution for the following equations:

30. $\log_2 8 = x$, x = __________

31. $\log_9 x = \frac{1}{2}$, x = __________

Find logarithms of the following numbers using the table of logarithms given:

N	log N
1.32	0.1212
1.42	0.1514
1.63	0.2122
2.31	0.3636
2.63	0.4200
2.78	0.4440
2.85	0.4544
2.93	0.4669
3.77	0.5758
3.95	0.5966
4.00	0.6021

32. log 1630 = ____________

33. log 0.00231 = ____________

Perform the following computations using the given table of logarithms:

34. 142 x 2.78 = __________

35. $\dfrac{23.1}{0.00163}$ = ____________

Perform the following computations using the given table of logarithms:

36. $(23.1)^4$

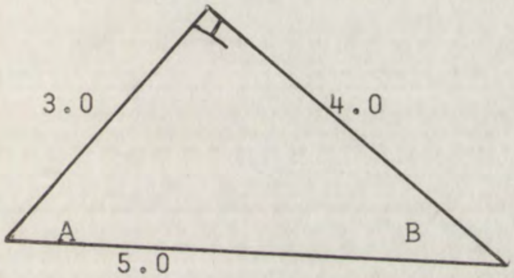
37. $\sqrt[8]{2310}$

Mathematics 241 Test Unit V TRIGONOMETRY Name ______________________
Last First

Section ______________

Note: While taking this test you are to use ONLY the values of trigonometric functions given on this test paper. <u>Do not use other tables.</u>

1. Consider the following right triangle. The lengths of the sides are indicated on the figure. Find the value of the indicated functions to the nearest tenth.



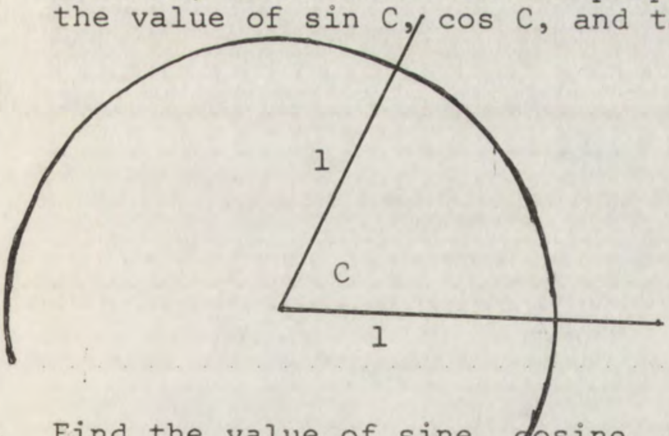
sin B = ________

cos A = ________

tan B = ________

cos B = ________

2. Angle C is given with a unit circle as indicated. <u>Draw the lines</u> whose lengths represent sin C, cos C, and tan C. <u>Write the words</u> "sin C", and "tan C" on the proper lines of the sketch. <u>ESTIMATE</u> the value of sin C, cos C, and tan C by looking at the <u>drawing.</u>



sin C = ________

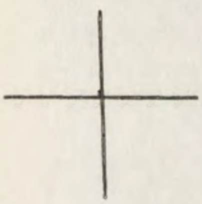
cos C = ________

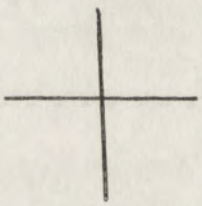
tan C = ________

3. Find the value of sine, cosine, and tangent of the angles 200° and -196°. Use the table given. Make sketches of the angles.

TABLE for No. 3

angle	sin	cos	tan
16°	.2756	.9613	.2867
20°	.3420	.9397	.3640
70°	.9397	.3420	2.9042
74°	.9613	.2811	3.4922





ANSWERS

sin 200° = ________

cos 200° = ________

tan 200° = ________

sin -196° = ________

cos -196° = ________

tan -196° = ________

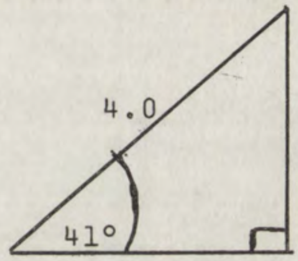
4. Find the indicated measures on the following right triangles. Give answers to nearest tenth or the nearest degree. Refer to the table of values given for problem 4. Right angles are indicated by

Ans. 4a. X = ________

TABLE for Problem No. 4, 5, 6.

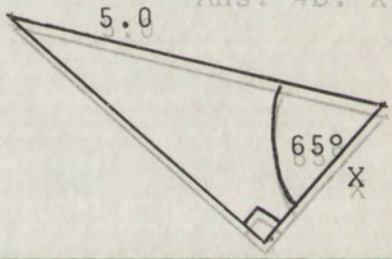
Angle	sin	cos	tan
23°	.39	.92	.42
38°	.62	.79	.78
41°	.66	.75	.87
47°	.73	.68	1.07
49°	.75	.71	1.15
61°	.87	.48	1.80
65°	.90	.42	2.14
67°	.92	.39	2.40
74°	.96	.28	3.49

4a



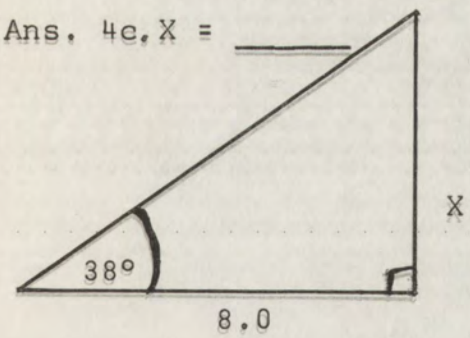
Ans. 4b. X = ________

4b

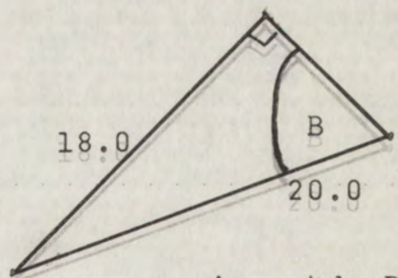


4c

Ans. 4c. X = ________

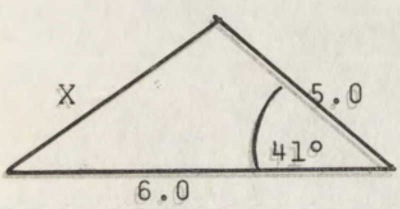


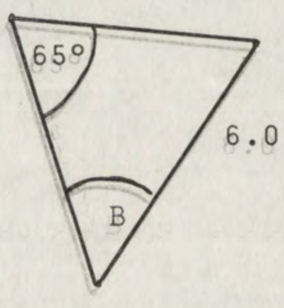
4d



Ans. 4d. B = ________

5. Find indicated measures. Use table for Prob. 4. These are not right triangles





Answer X = ________

Answer B =

6. One rope pulls South on a post with a force of 9 lbs. and a second rope pulls west on the post with a force of 5 lbs. Find the magnitude and the direction of the resultant force.

Make a sketch of the situation and show your work here. (Note: Use table for problem 4.)

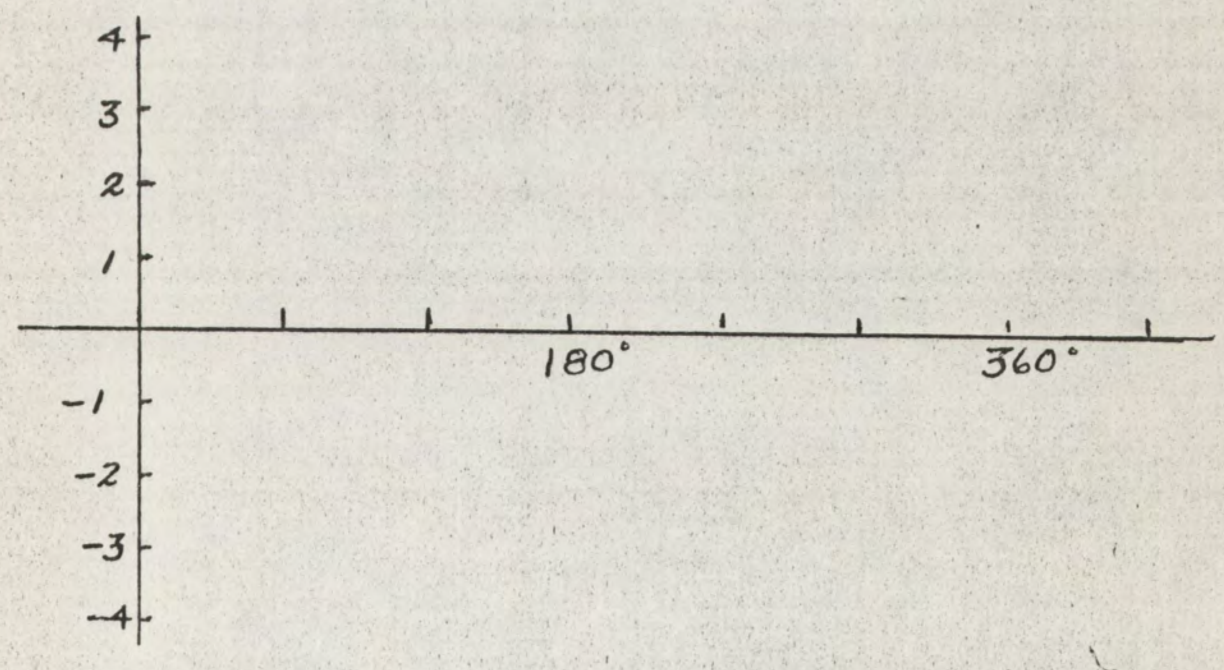
Answers:

Magnitude = ______

Direction = ______

7. On the given axes sketch the curves of sin x and 2 sin 3x.

Sketch sin x with a solid line and sketch 2 sin 3x with a dotted line. Sketch each curve from 0° to 360°.



#1

Math 110 NAME________________________________

1. Let $A = \{2,4,6,8,10\}$ $B = \{1,3,5,7,9\}$
$C = \{5,10\}$ $D = \{3,7\}$
$U = \{1,2,3,4,5,6,7,8,9,10\}$

Find:

__________________ a. $\sim A$

__________________ b. $(\sim A) \cup (\sim B)$

__________________ c. $\sim (A \cup B)$

__________________ d. $\sim B$

__________________ e. $(\sim D) \cap C$

f. State the principal steps one takes in a proof by mathematical induction.

g. Given $n \in$ Rational numbers, $n = 0.372\overline{372}\ldots$ Express n as the ratio of two integers.

h. $(a + b) + c = a + (b + c)$ displays what property of addition?

i. When one finds the product of two rational numbers and discovers that he again has another rational number, he then states that the rational numbers are__________________.

j. $\frac{5}{0}$ = __________________

2. Perform the following operations with complex numbers.

a. $(5 + 3i) + (7 + 8i)$

b. $(3 + 2i)(5 + i)$

c. $(8 - 7i) - (10 - 16i)$

d. $(9i)(2 + 5i)$

e. $\dfrac{5 + 4i}{5 + 6i}$

f. $\dfrac{4 - i}{3i}$

g. Solve for x and y: $(x + iy)6i = 12$

3. a. Expand: $(x + y)^6$

b. Expand: $(2a - b)^5$

c. Find the term with x^3y^{11} in $(x + y)^{14}$

4. a. Perform the addition: $\dfrac{x - 4}{x^2 - 5x + 6} + \dfrac{2x}{x^2 - 2x - 3}$

b. Find the product: $\dfrac{18 - 4y}{3y + 2} \cdot \dfrac{-(6y + 4)}{(6y - 27)}$

c. Simplify the fraction: $$\frac{a + 4 - \frac{7}{a - 2}}{a - 1 + \frac{2}{a - 2}}$$

5. Represent as a single fraction involving positive exponents only:

a. $$\frac{abc^{-3} - a^{-1}b^{-2}c^{2}}{a^{2}b^{-1}c^{4}}$$

b. $x^{-1} - y^{-1}$

c. $$\frac{r}{s^{-1}} + \frac{s^{-1}}{r}$$

d. Rationalize the denominator: $-\frac{\sqrt{3}}{\sqrt{7}}$

e. Rationalize the denominator: $\frac{\sqrt{x}}{\sqrt{2y}}$

f. Rationalize the denominator: $\frac{\sqrt{x} + \sqrt{y}}{\sqrt{x} - \sqrt{y}}$

* 2

College Algebra NAME ______________________

1. List all solutions of $(x + 3)^2 = 49$

2. Solve: $18x^2 + 27x - 56 = 0$

3. Find k if the solutions are real and equal, for $3x^2 - x + k = 0$

4. State the sum of the roots for $5x^2 + 3x + 6 = 0$.

5. State the x-coordinate for the lowest point of the graph of: $y = x^2 - 6x + 13$

6. Find the solution set for $\sqrt{x + 1} - \sqrt{x + 6} = 1$

7. Give the solution set for $\frac{x}{x + 2} - \frac{4}{x + 1} = \frac{-2}{x + 2}$

8. Determine the solution set for:

$$\left.\begin{array}{r} x + y + z - 1 = 0 \\ 2x - 3y - 2z + 4 = 0 \\ 3x - 2y - z + 2 = 0 \end{array}\right\}$$

9. Solve for z:

$$\begin{aligned} x - y + 2z &= 7 \\ x + 2y + 3z &= 3 \\ 2x + 3y + 2z &= 0 \end{aligned}$$

10. Solve simultaneously: $\left.\begin{aligned} y &= x + 2 \\ y &= x^2 - 6x + 8 \end{aligned}\right\}$

11. A father is now four times as old as his son. In 20 years he will be twice as old as the son. Find their present ages.

12. The height in feet of an object thrown vertically upwards is related to time in seconds by $h = 64t - 16t^2$.

    a. Find h at the highest point reached.

    b. Give the value of t at this point.

13. Name the transformation: $\left.\begin{aligned} x' &= ax \\ y' &= ay \end{aligned}\right\}$

14. Find two points that do not move under $x' = \dfrac{2x + 9}{x + 2}$

15. Simplify: $(1,2,2) + (-4, 5, 3) - (1, 8, 2) =$

16. Compute the inner product: $(2, 2, 1)\circ(-2, 1, 2)$

17. Multiply: $\begin{pmatrix} 4 & -1 & 1 \\ 2 & 3 & 0 \end{pmatrix}\begin{pmatrix} -3 & 2 \\ 5 & 2 \\ 1 & 1 \end{pmatrix}$

18. Graph the product: $\begin{pmatrix} x & y \end{pmatrix}\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}\begin{pmatrix} x \\ y \end{pmatrix} = 9$

19. Work out the inverse, if it exists: $\begin{pmatrix} 2 & 1 & -2 \\ 0 & 1 & 1 \\ 3 & 0 & -2 \end{pmatrix}$

20. Find the outer product: $(2, 1, -3) \wedge (1, 3, 4)$

Math 110
Hour Exam #3
11 December 1968 NAME ______________________

1. Solve the following inequalities for all possible values of x.

   a. $-3x - 9 > 0$

   b. $|3 - x| \leq 5$

   c. $|3x + 1| > 8$

   d. $x^2 - 5x + 6 \leq 0$

   e. $x^2 - 4 > 0$

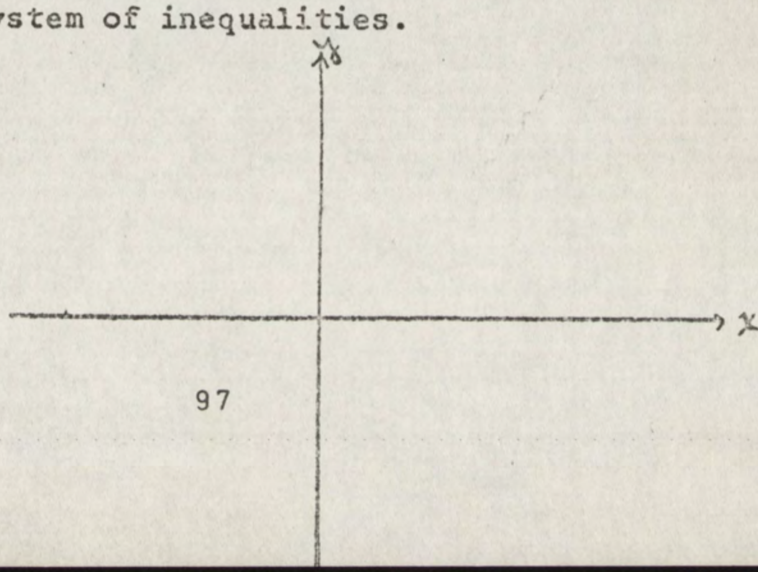
2. Graph the following system of inequalities.

   $y \geq -x^2 + 4$

   $x - y + 8 \geq 0$

   $x + y - 8 \leq 0$

   $y \geq 0$

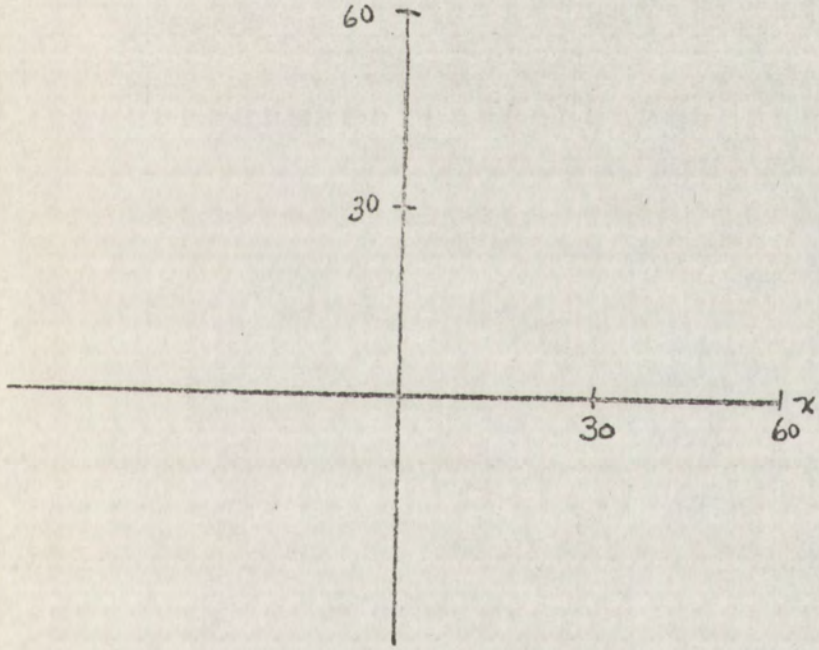


Let x = number of acres of corn
y = number of acres of peanuts

3. A farmer has at most 60 acres to divide between peanuts and corn. He has already accepted orders requiring 10 acres of peanuts and 5 acres of corn. Furthermore, hemust follow a regulation that the area of corn planted must be at least twice the acres of peanuts.

   (a) With a graph show all possibilities for different number of acres that can be allocated to each crop.

   (b) If corn gives a profit of $100 per acre and peanuts give a profit of $110 per acre, how many acres of eachcrop will give a maximum profit?



4. Given: $f(x) = x^2 + 2x + 1$ and $g(x) = x + 2$
   find:

   a. $f(0)$

   b. $f(5)$

   c. $f(6) - f(3)$

   d. $(f \circ g)(x)$

   e. $f(x) \cdot g(x)$

   f. $(g \circ f)(x)$

   g. $(f + g)(x)$

   h. $g(a + h)$

5. Given $$y^2 = 9x$$

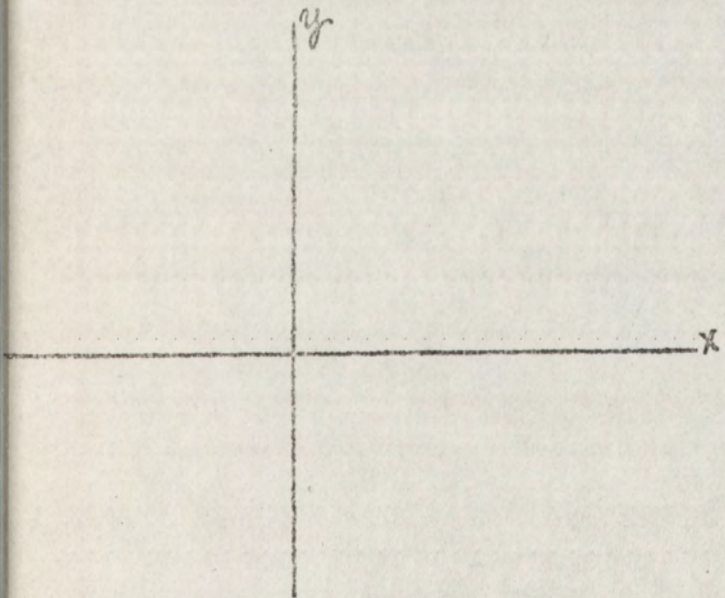
a. discuss the range and domain of this relation.

b. where will the graph cross the y-axis?

c. where will it cross the x-axis?

d. is the graph symmetric to either the x-axis, y-axis or the origin?

e. graph the relation.



Math 110-Hour Exam #4 NAME________________________

Do the following problems neatly on paper so I can see how you arrived at the answer you chose.

1. Obtain an equation whose roots are the negatives of the roots of the equation

$$3x^4 + 2x^3 - 5x + 7 = 0.$$

A. $-3x^4 - 2x^3 + 5x - 7 = 0$

B. $-3x^4 + 2x^3 + 5x + 7 = 0$

C. $3x^4 - 2x^3 + 5x - 7 = 0$

D. $3x^4 + 2x^3 + 5x + 7 = 0$

E. $3x^4 - 2x^3 + 5x + 7 = 0$

2. Obtain an equation of the form

$$x^4 + ax^3 + bx^2 + cx + d = 0$$

which has $x = 2$ as a triple root and $x = 0$ as a simple root.

A. $x^4 - 6x^3 + 12x^2 - 8x = 0$

B. $x^4 + 6x^3 + 12x^2 + 8x = 0$

C. $x^4 - 2x^3 + 4x^2 - 8x = 0$

D. $x^4 + 2x^3 + 4x^2 + 8x + 4 = 0$

E. $x^4 + 6x^3 + 12x^2 + 8x + 4 = 0$

3. Suppose that a, b, c, d, e, and f are real constants where $a \neq 0$, and that the equation

$$ax^5 + bx^4 + cx^3 + dx^2 + ex + f = 0$$

has the roots $x = 4$, $x = 2 + 3i$, and $x = 3 - 4i$. Find the product of all the other roots of the equation.

A. $18 + i$

B. $18 - i$

C. $-18 + i$

D. $-18 - i$

E. None of these answers

4. Let f(x) represent a polynomial in x of degree 3 with the values shown in the following table, and suppose that the equation $f(x) = 0$ has <u>three</u> real roots. By inspection of the table, find the successive integral values of x between which the roots lie.

When x =	-2	-1	0	1	2	3	4
then f(x) =	-11	3	5	1	-3	-1	13

A. between: -2 and -1; -1 and 0; 1 and 2

B. between: -1 and 0; 1 and 2; 2 and

C. between: -2 and -1; 0 and 1; 3 and 4

D. between: -2 and -1; 1 and 2; 3 and 4

E. None of the preceding statement is correct.

5. The equation

$$x^3 + 3x - 6 = 0$$

has just one real root between $x = 1$ and $x = 2$, and this root is near to $x = 1.3$. Find this root to the nearest hundredth. The following values of the polynomial

$$f(x) = x^3 + 3x - 6$$

are given to assist you.

When x =	2	1.3
then f(x) =	8	.10

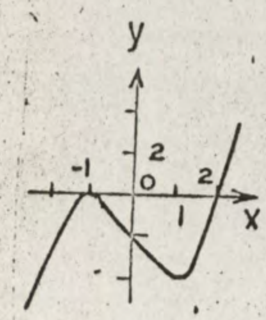
A. 1.26
B. 1.27
C. 1.29
D. 1.31
E. 1.32

6. Let $f(x) = 2x^3 - 5x^2 + kx + 3$, where k is a constant. If f(x) is exactly divisible by $(x - 2)$, find the value of k. (A solution by use of the Remainder Theorem would be convenient.) The value of k lies

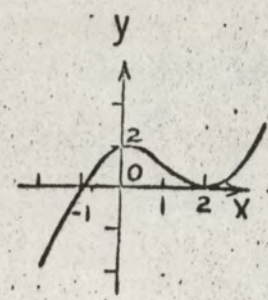
A. between 0 and 1
B. between 1 and 2
C. between 2 and 3
D. between 12 and 15
E. in none of the above intervals

7. Which one of the curves in the following figures is the best approximation to the graph of the equation

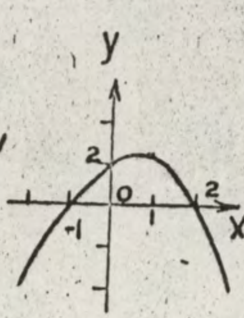
$$y = (x + 1)^2(2 - x).$$



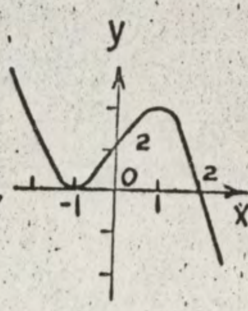
A.



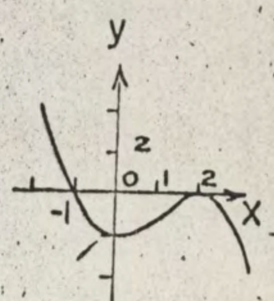
B.



C.



D.



E.

8. In the equation

$$hx^3 - 2x^2 - 2x + k = 0,$$

h and k are integers and $x = -\frac{4}{3}$ is a root. Under the usual assumption that just one of the responses is correct, which one gives the values of h and k?

A. $h = -4;\ k = 6$
B. $h = 5;\ k = 12$
C. $h = 3;\ k = 8$
D. $h = 6;\ k = -3$
E. $h = 12;\ k = -5$

9. Given that the equation

$$x^3 + 6x^2 + 4x - 15 = 0$$

has $x = -3$ as one root, then the other roots can be found by solving

A. $x^2 + 3x - 5 = 0$
B. $6x^2 + 4x - 15 = 0$
C. $x^2 - 2x - 3 = 0$
D. $x^2 + x + 3 = 0$
E. $x^2 - 4x - 7 = 0$

10. The equation

$$x^3 + 4x^2 - 5x - 14 = 0$$

has just one rational root. Find it. The rational root

A. is between 3 and 5
B. is between 5 and 8
C. is between 0 and -3
D. is between 11 and 15
E. satisfies none of these conditions

11. Do the following problems on logarithms:

Given: $\log 3 = 0.4771$

$\log 3.2 = 0.5051$

Find:

a. $\log 300 =$ ______________

b. $\log 32 =$ ______________

c. $\log 96 =$ ______________

d. $\log \frac{32}{3} =$ ______________

e. $\log (32)^2 =$ ______________

OFFICE VISITS FOR ASSISTANCE IN CLASSES INVOLVED IN EXPERIMENT

Experimental	Control

APPENDIX C

Formulas and Tables

Formulas Used in Computation with Data

The following formulas were used for all the post-tests; therefore, they are stated in general form.

For computation of deviations for dependent variable--used to compile part of Tables

For total:

$$\sum y^2 = \sum Y^2 - \frac{(\sum Y)^2}{N}$$

For homework:

$$\sum y^2 = \frac{(\sum Y_D)^2}{n_D} + \frac{(\sum Y_{ND})^2}{n_{ND}} - \frac{(\sum Y)^2}{N}$$

For instructor:

$$\sum y^2 = \frac{(\sum Y_{I_1})^2}{n_{I_1}} + \frac{(\sum Y_{I_2})^2}{n_{I_2}} + \frac{(\sum Y_{I_3})^2}{n_{I_3}} - \frac{(\sum Y)^2}{N}$$

For interaction:

$$\sum y^2 = \left[\frac{(\sum Y_{DI_1})^2}{n_{DI_1}} + \frac{(\sum Y_{DI_2})^2}{n_{DI_2}} + \frac{(\sum Y_{DI_3})^2}{n_{DI_3}} + \frac{(\sum Y_{NDI_1})^2}{n_{NDI_1}} + \frac{(\sum Y_{NDI_2})^2}{n_{NDI_2}} + \frac{(\sum Y_{NDI_3})^2}{n_{NDI_3}} \right] - \frac{(\sum Y)^2}{N}$$

$$- \left[\sum y^2_{HW} + \sum y^2_{Inst} \right]$$

For within:

$$\sum y^2 = \sum Y^2 - \left[\frac{(\sum Y_{DI_1})^2}{n_{DI_1}} + \frac{(\sum Y_{DI_2})^2}{n_{DI_2}} + \frac{(\sum Y_{DI_3})^2}{n_{DI_3}} + \frac{(\sum Y_{NDI_1})^2}{n_{NDI_1}} + \frac{(\sum Y_{NDI_2})^2}{n_{NDI_2}} + \frac{(\sum Y_{NDI_3})^2}{n_{NDI_3}} \right]$$

Computation of deviation for control variable involved formulas identical in form to those for dependent variable. Wherever y appears in preceding formulas, insert x, similar for Y and X. These were used also in Tables

Computation of deviation for cross products used the following formulas:

For total:

$$\sum xy_T = \sum XY - \frac{(\sum X)(\sum Y)}{N}$$

For homework:

$$\sum xy_{HW} = \frac{(\sum X_D)(\sum Y_D)}{n_D} + \frac{(\sum X_{ND})(\sum Y_{ND})}{n_{ND}} - \frac{(\sum X)(\sum Y)}{N}$$

For instructor:

$$\sum xy_{Inst} = \frac{(\sum X_{I_1})(\sum Y_{I_1})}{n_{I_1}} + \frac{(\sum X_{I_2})(\sum Y_{I_2})}{n_{I_2}} + \frac{(\sum X_{I_3})(\sum Y_{I_3})}{n_{I_3}} - \frac{(\sum X)(\sum Y)}{N}$$

For interaction:

$$\sum xy_{IA} = \frac{(\sum X_{DI_1})(\sum Y_{DI_1})}{n_{DI_1}} + \frac{(\sum X_{DI_2})(\sum Y_{DI_2})}{n_{DI_2}} + \frac{(\sum X_{DI_3})(\sum Y_{DI_3})}{n_{DI_3}}$$

$$+ \frac{(\sum X_{NDI_1})(\sum Y_{NDI_1})}{n_{NDI_1}} + \frac{(\sum X_{NDI_2})(\sum Y_{NDI_2})}{n_{NDI_2}} + \frac{(\sum X_{NDI_3})(\sum Y_{NDI_3})}{n_{NDI_3}}$$

$$- \frac{(\sum X)(\sum Y)}{N} - [\sum xy_{HW} + \sum xy_{Inst}]$$

For within:

$$\sum xy_{Within} = \sum XY - \left[\frac{(\sum X_{DI_1})(\sum Y_{DI_1})}{n_{DI_1}} + \frac{(\sum X_{DI_2})(\sum Y_{DI_2})}{n_{DI_2}}\right.$$

$$+ \frac{(\sum X_{DI_3})(\sum Y_{DI_3})}{n_{DI_3}} + \frac{(\sum X_{NDI_1})(\sum Y_{NDI_1})}{n_{NDI_1}} + \frac{(\sum X_{NDI_2})(\sum Y_{NDI_2})}{n_{NDI_2}}$$

$$\left. + \frac{(\sum X_{NDI_3})(\sum Y_{NDI_3})}{n_{NDI_3}}\right]$$

Deviation values for sum of square combined with within

Adjusted $\sum y^2$ (H.W.) = $\sum y^2$ (H.W.) + $\sum y^2$ (Within)

Adjusted $\sum x^2$ (H.W.) = $\sum x^2$ (H.W.) + $\sum x^2$ (Within)

Adjusted $\sum xy$ (H.W.) = $\sum xy$ (H.W.) + $\sum xy$ (Within)

The same procedure is followed for instructor and interaction.

Computation of b, Regression Coefficient for Homework, Instructor, and Interaction using adjusted SS from previous computation:

$$b_{H.W.} = \frac{\text{Adj}\sum xy(\text{H.W.})}{\text{Adj}\sum x^2(\text{H.W.})}$$

The same procedure is followed for b_{Inst}, $b_{\text{Interaction}}$.

Computation of residual $\sum y^2$ for H.W., Instructor, and Interaction using Adjusted $\sum y^2$ for H.W., Instructor and Within.

$$\text{Residual} \sum y^2(\text{H.W.}) = \text{Adj}\sum y^2(\text{H:W.}) - b_{H.W.}[\text{Adj}\sum xy(\text{H.W.})] - \sum y^2(\text{within})$$

Same procedure for residual SS for instructor and interaction.

Degrees of Freedom

Df_{Inst} = Number of Instructors - 1

$Df_{\text{H.W.}}$ = Number of Homework Levels - 1

$Df_{\text{Interaction}} = (Df_{\text{H.W.}})(Df_{\text{Inst}})$

Df_{Within} = Total Number of subjects - 1 - Number of Control Variables - $(Df_{HW} + Df_{\text{Inst}} + Df_{\text{Inter}})$

Computation of Mean Square

$$\text{Mean Square}_{H.W.} = \frac{\text{Residual}\sum y^2(\text{H:W.})}{Df_{HW}}$$

Same procedure for Mean square for Instructor, Interaction, and Within.

Computation of F values:

$$F_{H.W.} = \frac{\text{Mean Square (H.W.)}}{\text{Mean Square (Within)}}$$

Same procedure used to determine F for instructor and interaction.

Data Supporting Table 1

TABLE 17

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 1 - General Mathematics

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	35	823	23.514		477	13.628	
Instructor 2	37	953	25.757		397	10.730	
Instructor 3	34	844	24.824		482	14.176	
Total		2620		68950	1356		23406
Non-directed Homework							
Instructor 1	34	706	20.765		331	9.735	
Instructor 2	30	791	26.367		345	11.500	
Instructor 3	33	712	21.576		396	12.000	
Total		2209		56173	1072		15756
GRAND TOTAL	203	4829		125123	2428		39162

TABLE 18

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 1 - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	125,123
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	60,506

TABLE 19

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 1 - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	153.5039	191.357	171.3945
Instructor	541.1016	144.5859	-148.168
Interaction	121.7109	197.0625	139.3789
Within	9395.750	9626.535	2585.703

TABLE 20

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 1 - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	9780.04	9587.12	2757.10
Instructor	9771.12	9936.85	2437.54
Interaction	9823.60	9517.46	2725.08

TABLE 21

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 1 - General Mathematics

Source	b
Homework	0.28191
Instructor	0.24946
Interaction	0.27740
Within	0.26860

TABLE 22

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 1 - General Mathematics

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	11.052	22.773	0.2338	23.007
Experimental	12.792	24.717	-0.2338	24.483
Instructor 1	11.710	22.159	-0.06794	22.091
Instructor 2	11.075	26.029	0.23864	26.268
Instructor 3	13.104	23.224	-0.30658	22.917
POOLED REGRESSION COEFFICIENT: b = 0.268602				

Data Supporting Table 2

TABLE 23

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 2 - General Mathematics

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	35	1159	33.114		477	13.629	
Instructor 2	37	1328	35.892		397	10.730	
Instructor 3	34	1055	31.029		482	14.176	
Total				131460			23406
Non-directed Homework							
Instructor 1	34	1056	31.059		331	9.735	
Instructor 2	30	925	30.833		345	11.500	
Instructor 3	33	940	28.485		396	12.000	
Total				103381			15756
GRAND TOTAL	203	6463		234841			39162

TABLE 24

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 2 - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	234,841
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	83,564

TABLE 25

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 2 - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	552.125	153.504	291.125
Instructor	504.043	144.586	-268.719
Interaction	53.020	197.062	-124.969
Within	27966.5	9626.535	6365.313

TABLE 26

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 2 - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	9780.039	28518.63	6656.438
Instructor	9771.121	28470.54	6096.594
Interaction	9823.598	28019.52	6240.344

TABLE 27

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 2 - General Mathematics

Source	b
Homework	0.68062
Instructor	0.62394
Interaction	0.63524
Within	0.66123

TABLE 28

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 2 - General Mathematics

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	11.052	30.113	0.5756	30.691
Experimental	12.792	33.415	-0.5755	32.839
Instructor 1	11.710	32.101	-0.16724	31.934
Instructor 2	11.075	33.627	0.58746	34.214
Instructor 3	13.104	29.776	-0.75472	29.021
POOLED REGRESSION COEFFICIENT: b = 0.66122				

Data Supporting Table 3

TABLE 29

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 3 - General Mathematics

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	35	935	26.714		477	13.629	
Instructor 2	37	1015	27.432		397	10.730	
Instructor 3	34	852	25.059		482	14.176	
Total				80480			23406
Non-directed Homework							
Instructor 1	34	895	26.324		331	9.735	
Instructor 2	30	771	25.700		345	11.500	
Instructor 3	33	900	27.273		396	12.000	
Total				72546			15756
GRAND TOTAL	203	5368		153026	2428		39162

TABLE 30

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 3 - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	153,026
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	64,971

TABLE 31

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 3 - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	0.0	153.504	- 1.738
Instructor	9.324	144.586	-36.566
Interaction	134.238	197.062	-74.828
Within	10934.56	9626.535	879.680

TABLE 32

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 3 - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Group	9780.039	10934.56	877.941
Instructor	9771.121	10943.89	843.113
Interaction	9823.598	11068.80	804.852

TABLE 33

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 3 - General Mathematics

Source	b
Homework	0.08977
Instructor	0.08629
Interaction	0.08193
Within	0.09138

TABLE 34

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 3 - General Mathematics

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	11.052	26.453	0.07954	26.532
Experimental	12.792	26.434	-0.07954	26.374
Instructor 1	11.710	26.522	-0.02311	26.499
Instructor 2	11.075	26.657	0.08119	26.738
Instructor 3	13.104	26.149	-0.10430	26.045

POOLED REGRESSION COEFFICIENT: b = 0.091381

Data Supporting Table 4

TABLE 35

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 4 - General Mathematics

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	35	945	27.000		477	13.628	
Instructor 2	37	918	24.811		397	10.730	
Instructor 3	34	901	26.500		482	14.176	
Total				79708			23406
Non-directed Homework							
Instructor 1	34	870	25.588		331	9.735	
Instructor 2	30	644	21.467		345	11.500	
Instructor 3	33	768	23.273		396	12.000	
Total				63512			15756
GRAND TOTAL	203	5046		143220	2428		39162

TABLE 36

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 4 - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	143,220
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	64,577

TABLE 37

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 4 - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	329.312	153.503	224.82
Instructor	304.492	144.586	70.71
Interaction	64.633	197.062	-55.07
Within	17092.5	9626.535	3983.41

TABLE 38

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 4 - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	9780.04	17421.81	4208.23
Instructor	9771.12	17396.99	4054.11
Interaction	9823.60	17157.13	3928.33

TABLE 39

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 4 - General Mathematics

Source	b
Homework	0.43029
Instructor	0.41491
Interaction	0.39989
Within	0.41379

TABLE 40

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 4 - General Mathematics

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	11.052	23.526	0.36019	23.886
Experimental	12.792	26.076	-0.36019	25.715
Instructor 1	11.710	26.304	-0.10466	26.199
Instructor 2	11.075	23.313	0.36763	23.681
Instructor 3	13.104	24.910	-0.47230	24.438

POOLED REGRESSION COEFFICIENT: b = 0.41379

Data Supporting Table 5

TABLE 41

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 5 - General Mathematics

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\overline{Y}$	ΣY^2	ΣX	$\overline{X}$	ΣX^2
Directed Homework							
Instructor 1	35	661	18.886		477	13.628	
Instructor 2	37	632	17.081		397	10.730	
Instructor 3	34	752	22.118		482	14.176	
Total				44423			23406
Non-directed Homework							
Instructor 1	34	598	17.588		331	9.735	
Instructor 2	30	483	16.100		345	11.500	
Instructor 3	33	637	19.303		396	12.000	
Total				37106			15756
GRAND TOTAL	203	3763		81529	2428		39162

TABLE 42

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 5 - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	81,529
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	47,834

TABLE 43

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 5 - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	126.625	153.504	139.414
Instructor	569.113	144.586	285.691
Interaction	51.012	197.062	37.770
Within	11027.75	9626.535	2363.422

TABLE 44

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 5 - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	9780.04	11154.38	2502.84
Instructor	9771.12	11596.86	2649.11
Interaction	9823.60	11078.76	2401.19

TABLE 45

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 5 - General Mathematics

Source	b
Homework	0.25591
Instructor	0.27112
Interaction	0.24443
Within	0.24551

TABLE 46

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 5 - General Mathematics

Source	$\bar{X}$	$\bar{Y}$	Adjustment to $\bar{Y}$	Adjusted $\bar{Y}$
Homework				
Control	11.052	17.711	0.2137	17.925
Experimental	12.792	19.292	-0.2137	19.079
Instructor 1	11.710	18.246	-0.0621	18.184
Instructor 2	11.075	16.642	0.2181	16.859
Instructor 3	13.104	20.731	-0.2802	20.451
POOLED REGRESSION COEFFICIENT: b = 0.24511				

Data Supporting Table 13

TABLE 47

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Final Examination - General Mathematics

Main Effect Groups	Criterion Variable Post-Test				Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	35	2257	64.486		477	13.628	
Instructor 2	37	2606	70.432		397	10.730	
Instructor 3	34	2615	76.912		482	14.176	
Total				587126			23406
Non-directed Homework							
Instructor 1	34	2208	64.941		331	9.735	
Instructor 2	30	1823	60.767		345	11.500	
Instructor 3	33	2156	65.333		396	12.000	
Total				454615			15756
GRAND TOTAL	203	13665		1041741	2428		39162

TABLE 48

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Final Examination - General Mathematics

Measure	Symbol	Total
Post-Test	ΣY^2	1,041,741
Pre-Test	ΣX^2	39,162
Cross-Products	ΣXY	177,287

TABLE 49

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Final Examination - General Mathematics

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	2317.00	153.504	596.438
Instructor	1581.94	144.586	415.418
Interaction	1479.62	197.062	- 328.480
Within	116499.3	9626.535	13162.25

TABLE 50

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Final Examination - General Mathematics

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	9780.04	118812.3	13758.69
Instructor	9771.12	118081.2	13577.67
Interaction	9823.60	117978.9	12833.77

TABLE 51

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Final Examination - General Mathematics

Source	b
Homework	1.4068
Instructor	1.3896
Interaction	1.3064
Within	1.3673

Data Supporting Table 6

TABLE 52

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 1 - College Algebra

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	13	762	58.62		151	11.61	
Instructor 2	15	748	49.87		164	10.93	
Instructor 3	16	864	54.00		150	9.37	
Total				145822			5669
Non-directed Homework							
Instructor 1	17	1020	60.00		159	9.35	
Instructor 2	17	670	39.41		157	9.23	
Instructor 3	23	1666	54.00		260	11.30	
Total				223890			6708
GRAND TOTAL	101	5730		369712	1041		12377

TABLE 53

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 1 - College Algebra

Measure	Symbol	Total
Post-Test	ΣY^2	369,712
Pre-Test	ΣX^2	12,377
Cross-Products	ΣXY	62,251

TABLE 54

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 1 - College Algebra

Source of Variation	Σy^2	Σx^2	Σxy
Homework	601.750	5.320	-56.586
Instructor	7733.375	4.109	177.035
Interaction	3490.063	90.484	510.582
Within	32808.69	1547.574	2561.258

TABLE 55

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 1 - College Algebra

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	1552.895	33410.44	2504.672
Instructor	1551.684	40542.06	2738.293
Interaction	1638.059	36298.75	3071.840

TABLE 56

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 1 - College Algebra

Source	b
Homework	1.6129
Instructor	1.7647
Interaction	1.8752
Within	1.6550

TABLE 57

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 1 - College Algebra

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	10.105	58.877	0.38305	59.150
Experimental	10.568	53.954	-0.38308	53.572
Instructor 1	10.333	59.400	-0.06764	59.332
Instructor 2	10.003	44.312	0.43232	44.745
Instructor 3	10.513	64.872	-0.36469	64.507
POOLED REGRESSION COEFFICIENT: b = 1.65501				

Data Supporting Table 7

TABLE 58

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 2 - College Algebra

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\overline{Y}$	ΣY^2	ΣX	$\overline{X}$	ΣX^2
Directed Homework							
Instructor 1	13	1022	78.615		151	11.61	
Instructor 2	15	590	39.333		164	10.93	
Instructor 3	16	1075	67.188		150	9.37	
Total				187677			5669
Non-directed Homework							
Instructor 1	17	1148	67.529		159	9.35	
Instructor 2	17	756	44.471		157	9.23	
Instructor 3	23	1502	65.304		260	11.30	
Total				226876			6708
GRAND TOTAL	101	6093		414553	1041		12377

TABLE 59

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 2 - College Algebra

Measure	Symbol	Total
Post-Test	ΣY^2	414,553
Pre-Test	ΣX^2	12,377
Cross-Products	ΣXY	66,120

TABLE 60

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 2 - College Algebra

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	42.938	5.320	15.102
Instructor	16288.94	4.109	216.805
Interaction	1106.12	90.484	65.863
Within	29544.31	1547.574	3022.10

TABLE 61

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 2 - College Algebra

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	1552.895	29587.25	3037.207
Instructor	1551.684	45833.23	3238.910
Interaction	1638.059	30650.44	3087.969

TABLE 62

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 2 - College Algebra

Source	b
Homework	1.9558
Instructor	2.0873
Interaction	1.8851
Within	1.9528

TABLE 63

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 2 - College Algebra

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	10.105	59.754	0.45198	60.506
Experimental	10.568	61.068	-0.45200	60.616
Instructor 1	10.333	72.333	-0.07981	72.254
Instructor 2	10.003	42.062	0.51010	42.573
Instructor 3	10.513	66.077	-0.43031	65.647

POOLED REGRESSION COEFFICIENT: b = 1.9528

Data Supporting Table 8

TABLE 64

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 3 - College Algebra

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\overline{Y}$	ΣY^2	ΣX	$\overline{X}$	ΣX^2
Directed Homework							
Instructor 1	13	940	72.307		151	11.61	
Instructor 2	15	809	53.933		164	10.93	
Instructor 3	16	1115	69.688		150	9.37	
Total				202094			5669
Non-directed Homework							
Instructor 1	17	1138	66.941		159	9.35	
Instructor 2	17	878	51.647		157	9.23	
Instructor 3	23	1635	71.087		260	11.30	
Total				255581			6708
GRAND TOTAL	101	6515		457675	1041		12377

TABLE 65

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 3 - College Algebra

Measure	Symbol	Total
Post-Test	ΣY^2	457,675
Pre-Test	ΣX^2	12,377
Cross-Products	ΣXY	70,608

TABLE 66

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 3 - College Algebra

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	26.812	5.320	11.938
Instructor	6533.25	4.109	156.012
Interaction	245.31	90.484	133.863
Within	30620.00	1547.574	3156.563

TABLE 67

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 3 - College Algebra

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	1552.895	30646.81	3168.500
Instructor	1551.684	37153.25	3312.574
Interaction	1638.059	30865.31	3290.426

TABLE 68

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 3 - College Algebra

Source	b
Homework	2.0404
Instructor	2.1348
Interaction	2.0087
Within	2.0397

TABLE 69

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 3 - College Algebra

Source	$\bar{X}$	$\bar{Y}$	Adjustment to $\bar{Y}$	Adjusted $\bar{Y}$
Homework				
Control	10.105	64.053	0.47209	64.525
Experimental	10.568	65.091	-0.47212	64.619
Instructor 1	10.333	69.267	-0.08336	69.183
Instructor 2	10.003	52.719	0.53280	53.252
Instructor 3	10.513	70.513	-0.44945	70.063
POOLED REGRESSION COEFFICIENT: b = 2.0397				

Data Supporting Table 9

TABLE 70

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Unit Test 4 - College Algebra

Main Effect Groups	Criterion Variable Post-Test				Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	13	844	64.923		151	11.61	
Instructor 2	15	452	30.133		164	10.93	
Instructor 3	16	940	58.750		150	9.37	
Total				141240			5669
Non-directed Homework							
Instructor 1	17	990	58.235		159	9.35	
Instructor 2	17	572	33.647		157	9.23	
Instructor 3	23	1622	70.522		260	11.30	
Total				205400			6708
GRAND TOTAL	101	5420		346640	1041		12377

TABLE 71

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Unit Test 4 - College Algebra

Measure	Symbol	Total
Post-Test	ΣY^2	346,640
Pre-Test	ΣX^2	12,377
Cross-Products	ΣXY	59,106

TABLE 72

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Unit Test 4 - College Algebra

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	631.062	5.320	-57.953
Instructor	22334.75	4.109	293.613
Interaction	1104.313	90.484	336.168
Within	31714.44	1547.574	2670.609

TABLE 73

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Unit Test 4 - College Algebra

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	1552.895	32345.50	2612.656
Instructor	1551.684	54049.19	3964.223
Interaction	1638.059	32818.75	3006.777

TABLE 74

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Unit Test 4 - College Algebra

Source	b
Homework	1.6824
Instructor	1.9103
Interaction	1.8355
Within	1.7256

TABLE 75

ADJUSTMENTS OF CRITERION VARIABLES USING POOLED REGRESSION COEFFICIENT

Unit Test 4 - College Algebra

Source	$\overline{X}$	$\overline{Y}$	Adjustment to $\overline{Y}$	Adjusted $\overline{Y}$
Homework				
Control	10.105	55.860	0.39941	56.259
Experimental	10.567	50.818	-0.39943	50.419
Instructor 1	10.333	61.133	-0.07524	61.063
Instructor 2	10.003	32.000	0.45077	32.451
Instructor 3	10.513	65.692	-0.38026	65.312
POOLED REGRESSION COEFFICIENT: b = 1.7257				

Data Supporting Table 15

TABLE 76

SUMS AND MEANS OF EXPERIMENTAL AND CONTROL GROUPS (RAW SCORE SUMS), CLASSIFIED ACCORDING TO MEMBERSHIP IN INSTRUCTOR CLASSES

Final Examination - College Algebra

Main Effect Groups		Criterion Variable Post-Test			Control Variable Pre-Test		
	n	ΣY	$\bar{Y}$	ΣY^2	ΣX	$\bar{X}$	ΣX^2
Directed Homework							
Instructor 1	13	287	22.077		151	11.61	
Instructor 2	15	336	22.400		164	10.93	
Instructor 3	16	368	23.000		150	9.37	
Total				23607			5669
Non-directed Homework							
Instructor 1	17	348	20.471		159	9.35	
Instructor 2	17	375	22.059		157	9.23	
Instructor 3	23	550	23.913		260	11.30	
Total				30271			6708
GRAND TOTAL	101	2264		53878	1041		12377

TABLE 77

SUMMARY OF RAW SCORE SQUARES AND CROSS-PRODUCTS FOR CRITERION AND CONTROL VARIABLES

Final Examination - College Algebra

Measure	Symbol	Total
Post-Test	ΣY^2	53,878
Pre-Test	ΣX^2	12,377
Cross-Products	ΣXY	24,442

TABLE 78

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS

Final Examination - College Algebra

Source of Variation	Σy^2	Σx^2	Σxy
Homework Group	0.8867	5.320	2.176
Instructor	97.203	4.109	9.758
Interaction	26.910	90.484	45.836
Within	3003.535	1547.574	1049.340

TABLE 79

DEVIATION VALUES FOR SUMS OF SQUARES AND CROSS-PRODUCTS COMBINED WITH WITHIN

Final Examination - College Algebra

Within Plus	Σx^2	Σy^2	Σxy
Homework Groups	1552.895	3004.422	1051.516
Instructor	1551.684	3100.738	1059.098
Interaction	1638.059	3030.445	1095.176

TABLE 80

REGRESSION COEFFICIENTS FOR ADJUSTMENT OF DEVIATION VALUES FOR SUM OF SQUARES FOR CRITERION

Final Examination - College Algebra

Source	b
Homework	0.67713
Instructor	0.68255
Interaction	0.68858
Within	0.67806

TABLE 81

ASSIGNMENT OF DIRECTED AND NON-DIRECTED TREATMENTS FOR GENERAL MATHEMATICS

Instructor	Directed	Non-directed
Micklich	8:00 A.M.	11:00 A.M.
McMacken	1:00 P.M.	2:00 P.M.
Rozema	4:00 P.M.	10:00 A.M.

TABLE 82

ASSIGNMENT OF DIRECTED AND NON-DIRECTED TREATMENTS FOR COLLEGE ALGEBRA

Instructor	Directed	Non-directed
Ashley	9:00 A.M.	2:00 P.M.
Butchart	1:00 P.M.	8:00 A.M.
Mutter	11:00 A.M.	8:00 A.M.

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CURRICULUM VITAE

John Robert Micklich was born on August 14, 1925, in Pueblo, Colorado, where he attended Central High School, and was graduated in 1943.

He served in the United States Navy from 1943 to 1946 as a seaman and then Ensign.

He received his Bachelor of Arts Degree from Baker University, Kansas, in 1948. His teaching career began in 1952 at New Mexico Military Institute, Roswell, New Mexico. He completed his Master of Science Degree at Eastern New Mexico University in 1957. In 1963 he was employed as an Assistant Professor of Mathematics at what was then Arizona State College; now Northern Arizona University where he is currently employed.