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EFFECT OF UNANNOUNCED EXAMINATIONS ON ACHIEVEMENT,

TEST ANXIETY, AND ATTITUDE IN CERTAIN

JUNIOR COLLEGE MATHEMATICS COURSES

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TABLE OF CONTENTS

		Page
ACKNOWLEDGMENTS		iii
LIST OF TABLES		vi
Chapter		
I.	INTRODUCTION	1
	Statement of the Problem	2
	Hypotheses	2
	Definition of Terms	3
	Significance of the Study	4
II.	REVIEW OF LITERATURE	6
	Unannounced Examinations	6
	Anxiety	15
	Attitude	20
	Summary of Literature	22
III.	EXPERIMENTAL PROCEDURE	24
	Methods of Examining the Students	25
	Beginning Differences in the Students	25
	Procedure for Testing Hypothesis 1	26
	Construction of the Pretests	27
	Procedure for Testing Hypothesis 2	27
	Procedure for Testing Hypothesis 3a	28
	Construction of the Semantic Differential for Attitude	29
	Procedure for Testing Hypothesis 3b	30
IV.	TREATMENT OF THE DATA COLLECTED	31
	Test of Hypothesis 1	31
	Test of Hypothesis 2	38
	Test of Hypotheses 3a and 3b	40

Chapter		Page
V.	SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS . . .	51
	Summary of Findings	51
	Conclusions	55
	Recommendations	57
REFERENCES		58
APPENDIX A:	CATALOG DESCRIPTION OF COURSES	63
APPENDIX B:	ACHIEVEMENT TESTS	64
APPENDIX C:	ANXIETY DIFFERENTIAL	73
APPENDIX D:	ATTITUDE DIFFERENTIAL	77
APPENDIX E:	RAW SCORES ON ACHIEVEMENT TESTS	79
APPENDIX F:	ANALYSIS OF COVARIANCE FORMULAS	83
APPENDIX G:	RAW SCORES ON THE ANXIETY DIFFERENTIAL .	85
APPENDIX H:	DIFFERENCE SCORES ON THE ATTITUDE DIFFERENTIAL	88
APPENDIX I:	WILCOXON TEST	94

LIST OF TABLES

Table		Page
1.	Test for Homogeneity of Regression Coefficents	32
2.	Analysis of Covariance for General College Mathematics	33
3.	Means and Mean Gains for General College Mathematics	34
4.	Analysis of Covariance for Elementary College Algebra	35
5.	Means and Mean Gains for Elementary College Algebra	35
6.	Analysis of Covariance for Intermediate College Algebra	36
7.	Means and Mean Gains for Intermediate College Algebra	36
8.	Analysis of Covariance for College Algebra . .	37
9.	Means and Mean Gains for College Algebra . . .	37
10.	X^2 Test for Test Anxiety	39
11.	Wilcoxon Test for Attitude Change in the Unannounced Examination Section of General College Mathematics	42
12.	Wilcoxon Test for Attitude Change in the Unannounced Examination Section of Elementary College Algebra	43
13.	X^2 Test for the Concept "Elementary College Algebra".	44
14.	X^2 Test for the Concept "Myself as a Mathematics Student".	44

Table		Page

15. χ^2 Test for the Concept "Mathematics Textbook" 44

16. Wilcoxon Test for Attitude Change in the Unannounced Examination Section of Intermediate College Algebra 46

17. χ^2 Test for the Concept "Mathematics Assignments". 46

18. χ^2 Test for the Concept "My Understanding of Mathematics" 47

19. Wilcoxon Test for Attitude Change in the Unannounced Examination Section of College Algebra 48

20. χ^2 Test for the Concept "Mathematics Textbook" 48

EFFECT OF UNANNOUNCED EXAMINATIONS ON ACHIEVEMENT, TEST ANXIETY, AND ATTITUDE IN CERTAIN JUNIOR COLLEGE MATHEMATICS COURSES

CHAPTER I

Introduction

Butler and Wren (1951, pp. 126-135) have suggested several methods to initially motivate a student to learn mathematics. Nevertheless, for many students initial motivation will not sustain their interest when they are asked to study the detailed intricacies of mathematics. For example, a student's interest may be aroused when he is told that the path of a projectile can be described by a mathematical equation, but when he is asked to study the formal properties of this equation he may soon lose interest.

The successful mathematics student continually strengthens and enlarges his initial learning. This is partially accomplished by frequently reviewing and giving additional thought to material previously studied. There are various ways for a teacher to encourage the student to review mathematics. One method employed by some mathematics teachers is to give unannounced examinations. They hold the opinion that unannounced examinations cause a student to be conscientious about his assignments and thorough in his preparation for class. There is no general agreement concerning this motivating device, for some teachers think that unannounced examinations may cause the student to develop a negative attitude toward mathematics and that they may create unnecessary test anxiety. Therefore, a study that will help to determine whether unannounced examinations should or should not be employed as an external motivating device would be of value to the teacher and to the student.

Statement of the Problem

This study was designed to answer the primary question: Do students achieve more in a mathematics class if their examinations are unannounced than they do if their examinations are announced?

Unannounced examinations may cause students to achieve more, but they may create unnecessary test anxiety and cause the students' attitude toward mathematics to become less favorable. Thus, two corollary questions to be considered were:

(1) Do unannounced examinations create more test anxiety in mathematics students than announced examinations?

(2) Do mathematics students' attitudes toward mathematics become less favorable if they are given unannounced examinations rather than examinations that are announced in advance?

Hypotheses

The following hypotheses were formulated:

Hypothesis 1: There is no significant difference in mathematics students' mean gain in achievement regardless of whether their examinations are announced or unannounced.

Hypothesis 2: There is no significant difference in mathematics students' test anxiety regardless of whether their examinations are announced or unannounced.

Hypothesis 3a: Mathematics students who are working under a system of unannounced examinations will exhibit no significant negative attitude change toward mathematics.

If those students who are working under a system of unannounced examinations demonstrate a negative change in attitude toward mathematics, it should be of interest to know how their attitude change compares to that expressed by those students whose examinations are announced. Thus, if hypothesis 3a is rejected, a subsequent hypothesis will be tested to determine any significant difference in attitude change between groups.

Hypothesis 3b: There is no significant difference in mathematics students' attitude change toward mathematics whether their examinations are announced or unannounced.

Definition of Terms

Certain terms frequently used in this study are defined as follows:

Mathematics Student--is a student who enrolls in General College Mathematics or in one of the sequential courses beginning with Elementary College Algebra, followed by Intermediate College Algebra, and terminating with College Algebra.

Achievement--is the difference in students' mean scores on a mathematics pretest and posttest.

Semester--is a college session that lasts sixteen weeks.

Attitude--is the students' scores on a semantic differential.

Anxiety--is the students' scores on the *Anxiety Differential*.

Unannounced Examination--is a one-hour examination planned in advance by the instructor with the date known only by him.

Significance of the Study

Rosenberg (1970) said "some mathematics teachers like to inject an element of suspense by occasionally giving their classes unannounced (surprise) quizzes (p. 153)." Thus, whether a mathematics teacher favors giving unannounced examinations or not, he should be aware of their use. Yet, if a mathematics teacher is trying to decide whether or not to give unannounced examinations he finds little help. The teacher finds different points of view that are, for the most part, only expressed opinions.

Mendenhall (1970) said that "...unannounced quizzes are very effective in helping the student learn the new language of statistics (p. xii)." On the other hand, Wilson (1969) holds the opinion that the teacher who gives unannounced examinations "...runs the risk of developing negative attitudes toward learning. Such arbitrary and often punitive activities on the part of teachers build ill will and frequently create resentment among capable students who are desirious of learning (p. 502)." Consequently, there exists a need for more information to aid the mathematics teacher who is trying to decide whether or not to use unannounced examinations. The purpose of this study was to provide the mathematics teacher with additional information concerning the effect unannounced examinations might have on mathematics students' achievement, test anxiety, and attitude toward mathematics.

CHAPTER II

REVIEW OF LITERATURE

Unannounced Examinations

Gable (1935) conducted a study to determine what effect daily examinations as compared with announced unit examinations and unannounced unit examinations might have on student achievement. The study consisted of two experiments involving two teachers and 274 ninth grade female biology students. Each teacher taught three groups of students. The groups were: (1) a daily examination group, (2) an announced examination group, and (3) an unannounced examination group. Each experiment lasted seven weeks with the daily examination group exchanging roles with the unannounced examination group for the second experiment.

The students were equated on intelligence, results of a pretest in biology, and socio-economic status. The pretest was given to the students again at the end of each experimentation period. The announced examination group was given one day to prepare for the examination, whereas the daily examination group and the unannounced examination group were not given warning of the examination.

The mean gains from pretest to posttest were compared, and the following results were reported: (1) in both experiments, the announced examination group gained significantly more than the daily examination group, (2) the announced examination group gained more than the unannounced examination group in both experiments, but only for the second experiment was the gain significant, and (3) the unannounced examination group gained more than the daily examination group in both experiments, but only for the first experiment was the gain significant. The order of standing for the three groups was: (1) announced examination group, (2) unannounced examination group, and (3) daily examination group. The three groups were given the pretest again, without warning, after a lapse of three months. The order of standing for the three groups remained the same, but none of the differences in mean gains were significant.

Eisenstat (1969) conducted an experiment to determine if students in certain college classes would achieve more when they were subjected to a system of unannounced examinations than if their examinations were all announced. His study involved 25 classes, 11 teachers, 729 students, and 4 subject areas. Four teachers each taught General College Mathematics and Life Science, two teachers taught Physical Science, and one teacher taught World Geography. With the exception of the geography teacher, each teacher taught both an announced and unannounced examination class, one each semester during the academic year. The geography teacher taught five classes in one semester, three announced examination classes and two unannounced examination classes.

The students were given a pretest at the beginning of the semester and an announced final examination. The pretest served as the final examination in General College Mathematics and Physical Science.

An F ratio was computed for each of the four subject areas to determine if the analysis of covariance could be applied to the examination scores. Only the F ratio for General College Mathematics was found to be significant at the five per cent level. Eisenstat, however, made the decision to include the group in his study.

The analysis of covariance was performed on the examination data and Eisenstat found that the unannounced examination group gained significantly more in achievement than the announced examination group in General College Mathematics, Life Science, and World Geography. Although the unannounced examination group in Physical Science gained numerically more than the announced examination section, the gain was not significant.

The students in the unannounced examination groups were given a questionnaire on final examination day to determine their opinion of unannounced examinations. The results were: (1) the students did not like unannounced examinations, (2) the amount of time spent and the quality of preparation for class was no different than if they had been given announced examinations, and (3) the students felt less confident, but experienced no greater test anxiety than they did in classes where the examinations were announced.

Gable's and Eisenstat's studies were the only ones found that used a system of unannounced examinations to compare the achievement made by students in announced versus unannounced examination classes. The following studies reported the use of an unannounced examination.

Tyler and Chalmers (1943) sought to determine what effect the warning of a forthcoming examination would have on a student's score in that examination. They matched two groups of students in each of seventeen junior high school, general science classes. The students were accustomed to having an examination at the completion of each six week unit of study. After completion of one unit of study, one group was given an examination, without "specific" warning, and the other group was told they would have the unit examination two days later.

After comparing the students' scores, the authors concluded: "It does not appear that knowledge of a forthcoming test had much influence on the test results of these students (Tyler and Chalmers, 1943, p. 293)." Both groups were given the same examination six weeks later without warning. The differences between groups were even smaller on the retest than on the first administration of the examination.

Tyler and Chalmers (1943) felt they were justified in drawing the following conclusion:

...the average scores of junior high school pupils on unit

> tests in general science may be increased slightly, but only slightly, (approximately one to two per cent) by giving specific warning of the date of the examination two days before it is to be administered. This result seems especially significant, since we might expect emotional disturbance to lower the scores of students confronted with an unexpected test (p. 295).

Pease (1930) conducted three experiments to determine the value of "cramming" for an examination. The procedure for each experiment was as follows: Two groups of students were equated on intelligence and on the day an examination was to be given, one of the groups was dismissed with instructions to "cram" at least one hour. The group that remained was given the examination, and the dismissed group took the same examination at the next class meeting. A few weeks later, both groups were given the same examination without warning.

The first study used 408 highschool and college students, and the retest was given six weeks after the first administration of the examination. In both examinations, the group given extra time to review scored significantly higher than the other group.

The second study used eighty-two college psychology students, and the retest was given twelve weeks after the first administration of the examination. Again, the group given extra study time scored highest on both examinations, but only the difference in scores on the first examination was significant.

The third study used ninty-four college psychology students, and the retest was given six weeks later than the first administration of the examination. The group given extra time for study scored higher on both administrations of the examination, but only the difference in scores for the first examination was significant.

Pease (1930) concluded that "so far as the field of psychology is concerned, the author considers that the proof for the value of cramming is clear, therefore the consequent value of giving warning respecting tests and examinations (p. 277)."

Keys (1934) used two sections of an educational psychology course, each containing 143 students matched for sex and initial knowledge of the subject, to determine if frequency of examinations can affect student achievement. His study was based on three experiments, each lasting four weeks. In the first experiment, the experimental group was given daily assignments and weekly examinations, whereas the control group received only a "lump" assignment and one examination. In the second experiment, both groups received daily assignments, but again the experimental group was given weekly tests and the control group only one examination. In the third experiment, both groups had a single examination, but the experimental group received weekly assignments while the control group did not.

The students were given an examination at the beginning of the semester and the results were used to match the students. Two weeks before the final examination this examination was given again. Keys (1934) stated: "This test was given entirely without warning, and so constituted an uncommonly fair measure of comparative retention by the two groups after a lapse of five weeks without special review (p. 431)." The experimental group scored seven per cent above the control on this examination. However, Keys (1934) found that on the regular final examination "...taken after the usual intensive preparation of 'cramming,' no such differences appear (p. 436)."

Nachman and Opochinsky (1958) predicted that the reason so many research studies do not show a significant difference between different teaching techniques is that "waiting until a final examination (or any other announced examination) confounds the problem by permitting many other variables to operate, one of the most obvious of which is extra study (p. 245)." Since as they stated: "Typically, in measuring the effectiveness of different teaching methods, one of the major dependent variables has been the performance of the students on the final examination (p. 245)," they conclude then "...that in order to test the effect of a particular classroom technique, evaluation should be done immediately after the technique is employed (p. 245)."

They matched twenty-one students on previous performance in a general psychology course. One group met as a single class, whereas the other group met with 140 other students. Both classes were given two "pop-quizzes." The result showed that the students in the small class did better on the "pop-quizzes," whereas the two groups did the same on a regularly scheduled final examination.

Vallance (1947) conducted three experiments to compare essay-type examinations with objective-type examinations. In the first experiment, 179 high school seniors were divided into three groups. They were administered an objective pretest and then given a pamphlet to study. They were given instructions to be ready for an examination three days later. On the day of the examination one group received an objective examination, the second group was given an essay examination, and the third group was excused. Twenty days later all three groups received, without warning, the pretest and an essay examination containing two questions. The author found no significant difference in the groups' scores and thus concluded that as a learning experience there is no difference between essay-type and objective-type examinations.

In the second experiment, two groups of students, twenty-six in one group and twenty in the other group, were given an objective-type pretest and then were given the pamphlet to study. One group was told to be prepared for an essay examination, the other group for an objective examination two days later. On the designated examination day, both examinations were called off. Six days later, both groups were given, without warning, the pretest and a two-question essay examination. The author found no significant difference in the groups' scores and thus rejected the hypothesis that preparation for an essay examination is superior as a learning procedure to preparation for an objective examination.

To answer the question, "Is there value in the final examinations?," Schutte (1925) used an unannounced final examination in his study. Two groups of women, 100 in each group, were enrolled in an introductory education course. On a pretest, the two groups appeared to be quite equal in mental ability. One group was told at the beginning of the semester to expect a final examination and were repeatedly warned during the semester. The other group was told at the beginning of the semester that they wouldn't have a final examination. The two groups received similar instruction and examinations throughout the semester.

Cramming for the final examination was halted by giving the final examination group special work during the week before the final examination. On final examination day the group that had been told not to expect an examination was given the same examination as the other group. The results showed that the group anticipating an examination did better on examinations throughout the semester, scored higher on the final examination, and gave more intelligent answers than the group that was not expecting a final examination.

Corey (1935) used a "surprise quiz" in his study to show a low correlation between intelligence and achievement when motivation to prepare for an examination is absent. Corey defined intelligence as scores on the Army Alpha. There were 104 educational psychology students involved in the study. He gave the students a "surprise" examination over a recent assignment and found a correlation of only .06 with the Army Alpha. However, when the students' announced final examination scores were compared with their Army Alpha scores a correlation of .62 was found. Corey concluded that achievement depends not only on capacity to learn, but also on motivation to learn.

Selakovich (1962) attempted to determine the effectiveness of frequent testing as an aid to learning in beginning college courses in American Government. He had two classes with a total of thirty-eight students. The experimental group received twelve "pop-quizzes" along with three hour-long examinations throughout one semester. The control group received only announced examinations. Selakovich found no significant difference in the achievement of the two groups. However, when the experimental group was questioned, the students were near unanimous in their opinion of the course. They favored the giving of "pop-quizzes."

Two other studies which employed an unannounced examination are reviewed in the section on anxiety.

Anxiety

Mandler and Sorason (1952) believe that anxiety affects performance on an examination. They hypothesized the following:

> Anxiety reactions are generalized from previous experiences to testing situations. The anxiety drive (S_A) primarily elicits responses that tend to reduce the drive. These responses are considered to be of two general types: (a) Anxiety responses which are not specifically connected with the nature of the tasks or materials. These responses (designated as R_A) may be manifested as feelings of inadequacy, helplessness, heightened somatic reaction, anticipations of punishment or loss of status and esteem, and implicit attempts at leaving the test situation. It might be said that these responses are self rather than task centered.

> (b) Anxiety responses which are directly related to the completion of the task and which reduce anxiety by leading to completion of the task (Mandler and Sorason, 1952, p. 166).

Later, Sorason, Mandler, and Craighill (1952) concluded:

> When a stimulus situation contains elements which specifically arouse test or achievement anxiety, this increase in anxiety drive will lead to poorer performance in individuals who have task-irrelevant anxiety responses, in their response repertory. For individuals without such response tendencies these stimulus elements will raise their general drive level and result in improved performance (p. 561).

If unannounced examinations create high test anxiety in mathematics students, then some students' examination performance might decrease. However, the findings of research do not always show an inverse relation between test anxiety and test performance.

Smith (1965) gave seventy-one subjects the <u>Test Anxiety Questionnaire</u> (TAQ), developed by Mandler and Sorason (1952), under neutral conditions, that is, before the subjects were given a group intelligence test without warning. Seventy-five subjects were given the TAQ after the intelligence test, that is, at a time when the students' anxiety was considered to be in an aroused state. The results showed that the TAQ scores in both the neutral and aroused states were related in the same way to intelligence. There was, however, no significant difference between the means and variances of TAQ scores measured prior (neutral) and following (aroused) the group intelligence test.

French (1962) reported a study in which 2047 subjects from 16 highschools were given 2 different forms of the

College Board Scholastic Aptitude Test. One form was to be used by the colleges and was thus thought to induce high test anxiety. The subjects were told that the other form would only be used by the highschools for research purposes and would not be reported to the colleges. These tests were followed by a questionnaire to determine the students' feeling of anxiousness and their reasons for feeling anxious. After analyzing the data, French found that the effect of anxiety on the students' performance on the two different test forms was small.

Hastings (1944) used eighty ninth grade mathematics students to determine the relationship between tension and achievement. Among other results, Hastings (1944) concluded:

> Concomitant variation between tension scores and examination scores tends to be inverse, but the magnitude of this relationship, as shown by correlation, is so small that little importance can be attached to the degree of relationship. High tensions do not necessarily accompany low examination scores nor contrariwise (p. 162).

After reviewing several studies which sought to determine the relationship between anxiety and achievement, Sorason (1957) came to a "disappointing" conclusion. He found that anxiety had been shown to influence performance in "numerous" laboratory situations, whereas in "real life" situations such as academic achievement the literature indicated no demonstrable effect. Sorason (1957) felt drawn to re-examine what general anxiety scales were measuring, that is, rather than using general anxiety scales maybe situational anxiety scales should be designed to "...assess the specific conditions under which anxiety is aroused...(p. 485)."

For 305 Yale University liberal arts undergraduate students, Sorason had the following measures: (a) Test Anxiety score, (b) General Anxiety score, (c) Scholastic Aptitude Test scores, (d) Mathematical Aptitude scores, and (e) yearly course grade point averages. After running several correlations, Sorason (1957) concluded:

> Test Anxiety scores tended to correlate negatively with measures of academic achievement, although with increase in number of years in college the negative correlation disappeared. General Anxiety scores failed to correlate significantly with entrance examination scores, but tended to correlate positively with grade point averages (p. 489).

Sorason believed that the results supported his assumption that any relationship found between anxiety and achievement is dependent on the type of instrument employed to measure anxiety.

In agreement with Sorason (1957), Alexander and Husek (1962), after reviewing the research literature on anxiety, came to the conclusion that:

> ...currently available measures of anxiety often provide confusing or contradictory results when used by different experimenters. In addition, attempts to determine whether or not the various measures are related to one another have led to rather disappointing results (p. 325).

They felt that a need existed for an instrument to measure situational anxiety that would meet certain criteria. That is, in addition to reliability and validity, the instrument should:

> (a) be of such a nature that subjects are unlikely to falsify their responses, (b) not be susceptible to response sets, (c) be scorable by an objective, non-judgemental key, (d) be easily administered to groups of

any size, (e) be short, and (f) inexpensive (Alexander and Husek, 1962, p. 326).

After a considerable amount of testing and refining, they ultimately developed an instrument which they felt met the stated criteria. They called their instrument the Anxiety Differential (AD).

To determine the versatility of the AD, Husek and Alexander (1963) conducted two studies to investigate the sensitivity of the AD to pre-examination anxiety experienced in a college setting. In both studies the AD was administered to an experimental and control group as follows: (1) The experimental group received the AD a few minutes prior to their final examination, and (2) the control group took the AD during a regular class meeting, at which time an examination had not been scheduled. From these two studies the authors concluded that the AD could distinguish between the anxiety in an examination and non-examination situation.

Wittrock and Husek (1962) used the AD to determine the effect of anxiety on retention of verbal learning. Two sections of an educational psychology class were involved in their study. The experimental group contained sixty-six students. On the day of the regularly scheduled mid-term examination the experimental group was given the AD followed by a complex Buddhism passage. The students were told that they couldn't take the mid-term examination until they completed the experimental materials. The control group was given the same experimental materials on a day for which no examination had been announced. Two weeks later, each group took an unannounced examination over the Buddhism passage.

After analyzing the data, the authors found a significant difference in the test anxiety expressed by the two groups. The experimental group showed a higher test anxiety. Further, there was a significant difference between the two groups on the retention test. Again, the experimental group showed the larger mean. Wittrock and Husek (1962) concluded that "...anxiety may enhance learning and retention of complex material when that learning does not present a serious ego threat to S [student] (p. 78)." Husek and Alexander (1963) claimed that a further conclusion of Wittrock and Husek's (1962) study was the ability of the AD to discriminate between examination stress and non-examination stress.

Attitude

Hartung (1953) believes there is a positive relationship between attitudes and achievement. He stated:

> Attitudes influence behavior and hence act as motive. They are learned and, in turn, they often make new learning easier or harder to acquire. One of the chief obstacles to the effective learning of mathematics is the unfavorable attitude toward the subject which has been acquired by many students (Hartung, 1953, pp. 45-46).

He also believes that teachers should be aware of this relationship, for he later stated:

> To change an unfavorable attitude once formed into a favorable one is a difficult assignment. Efforts on the part of teachers to arrange conditions so that unfavorable attitudes are not learned will, in the long run, probably pay generous dividends (Hartung, 1953, p. 66).

Thus, if unannounced examinations should cause the students' attitude to change in the negative direction, then a decrease in achievement might be expected. The assumption is that a significant positive relation exists between attitude and achievement. Cristantiello (1962), Jackson (1968), Neale (1969), and Aiken (1970), in their reviews of the literature on the relationship between attitude and achievement, all came to essentially the same conclusion. Neale (1969) summarized the literature succintly by saying, "In short, positive or negative attitudes toward mathematics appear to have only a slight causal influence on how much mathematics is learned, remembered, and used (p. 635)." However, in agreement with Hartung (1953), Aiken (1970) said, "Obviously, the assessment of attitudes toward mathematics would be of less concern if attitudes were not thought to affect performance in some way (p. 558)."

There are several attitude scales in existence. Some of the more popular ones are: (1) Thurstone, (2) Guttman, (3) Likert, and (4) semantic differential technique. To measure specific attitude toward mathematics, Aiken and Dreger (1961) constructed a Likert-type instrument which they called the Mathematics Attitude Scale (MAS). They reported a high test-re-test reliability for this instrument.

Anttonen (1967) used both the Aiken MAS and a semantic differential in his longitudinal study of the relationship of attitude change toward mathematics and achievement in mathematics.

McCallon and Brown (1971) constructed a semantic differential to determine a student's attitude toward mathematics. They reported a significant, .001 level, correlation between their semantic differential and the Aiken MAS. Their conclusion was:

> It was therefore concluded that the semantic differential constructed for this study proved to be as effective a measure of attitude toward mathematics as the MAS. Considering the ease with which the semantic differential was constructed and the fact that no extensive refinement of the instrument was necessary, application of the semantic differential technique would appear to be a more practical approach to the measurement of attitudes in mathematics (McCallon and Brown, 1971, p. 72).

Summary of Literature

An unannounced examination has been used in several studies, but only two were found that employed a system of unannounced examinations. Gable (1936) found that when ninth grade biology students were given a system of unannounced examinations they achieved less than those students whose examinations were announced. Eisenstat (1969), on the other hand, found that in certain college classes those students who were given unannounced examinations achieved more than those students who were given advance notice of an examination.

Numerous researchers have sought to determine any relationship between test anxiety and test performance. Their findings are not always in accord, but overall they show that the effect test anxiety has on a student's performance on an examination depends on the student's individual personality.

Attitude studies are certainly in abundance. Aiken (1970) said that studies dealing with attitudes toward mathematics alone have increased geometrically since 1960. But, the relationship between attitude toward mathematics and achievement in mathematics is not always clear. One aspect that possibly hinders clear results in this area is that, according to Neale (1969), the relationship between attitudes and achievement is reciprocal, that is, attitudes affect achievement and in turn achievement affects attitudes.

CHAPTER III

EXPERIMENTAL PROCEDURE

This study was conducted at Oscar Rose Junior College, Midwest City, Oklahoma, during the fall semester, 1971. Oscar Rose Junior College opened in September, 1970, and at the time of this study had an enrollment of over 3000 students. There were 3 instructors, 8 mathematics classes, and 164 students involved in this experiment.

This study sought to determine what effect unannounced examinations might have on mathematics students' achievement, test anxiety, and attitude toward mathematics. Two sections in each of four mathematics subject areas were selected for use in the study. The four subject areas were: (1) General College Mathematics, (2) Elementary College Algebra, (3) Intermediate College Algebra, and (4) College Algebra. (Catalog descriptions of these courses appear in Appendix A.) The two sections in each of the four subject areas were chosen for the reason that they could be treated the same in the following respects: instructor, textbook, material covered, pace of the course, hour for class, classroom, and homework assignments. The two sections did, however, meet on different days. Thus, there were essentially only two variables left for the experimenter to work with. These variables were: (1) methods of examining the students, and (2) beginning differences in the students' mathematical achievement.

Methods of Examining the Students

A coin was tossed to determine which section in each of the four subject areas would receive unannounced examinations throughout the semester. This section was designated the experimental group, and the section to receive announced examinations served as the control group. The schedules of examination dates for both sections were determined before the semester began. The announced examination sections were informed of these dates, and reminders were issued throughout the semester. During the first week of classes, the experimental sections were told to expect an examination at any time, without warning.

The examinations given to the students in the two sections were not the same. An attempt was made, however, to construct the examinations as similarly as possible with regard to length, degree of difficulty, and topics emphasized. The examinations used throughout the semester were constructed by the instructors involved in the study. The examinations contained both essay-type and objective-type questions.

Beginning Differences in the Students

Students at Oscar Rose Junior College may enroll in any section of a course so long as room is available. Thus, existing conditions would not permit a random selection of students for the two sections in each of the four courses.

Procedure for Testing Hypothesis 1

Hypothesis 1: There is no significant difference in mathematics students' mean gain in achievement regardless of whether their examinations are announced or unannounced.

Since a random selection of students was not possible, the analysis of covariance was chosen to test hypothesis 1. The analysis of covariance allows the experimenter to work with intact classes by taking into account beginning differences in the students. Kerlinger (1964) stated:

> The analysis of covariance statistically matches the pupils for him [experimenter], which is remarkable—he gets the advantage of random assignment as in a simple one-way analysis and the benefits of matching, without the difficulties of arranging the matching (p. 34).

According to Edwards (1968, p. 326), the analysis of covariance takes into account beginning differences by making use of a concomitant variable. The concomitant variable chosen for this study was the students' scores made on a pretest for mathematical achievement. The pretest was given to the students in both the experimental and control sections during the first week of the semester.

The pretest was also given as a posttest during the final examination period. Both sections were given advance notice of a final examination, but they were not told to expect the same examination they had been given at the beginning of the semester. The pretest scores and posttest scores, in conjunction with the analysis of covariance, were used to compute an *F* ratio which was used to test hypothesis 1.

Construction of the Pretests

The pretests for each of the four courses were constructed by the instructors participating in the study with the help of the director of this dissertation. To allow for beginning differences in the students' mathematical achievement gained during the semester, the pretests were made up of two parts. The first part of the pretest contained questions that dealt with the material covered in the preceding course, and the second part of the pretest contained questions from the course the students were presently enrolled in. To minimize subjectivity in the scoring of the pretests, all questions were of the objective-type. (The pretests for each of the four subject areas appear in Appendix B.)

There were certain advantages to be gained by giving the students the same examination as a pretest and as a posttest. These advantages were: (1) only one measuring instrument was required, (2) with only one measuring instrument, an analysis of gain scores could be readily made, and (3) if two instruments had been used, the analysis of covariance would have required the means on the posttest to be adjusted before a comparison of student achievement could be made.

Procedure for Testing Hypothesis 2

Hypothesis 2: There is no significant difference in mathematics students' test anxiety regardless of whether their examinations are announced or unannounced.

Husek and Alexander (1963) have developed a semantic differential, which they call the Anxiety Differential (AD), that can be used to distinguish between anxiety in an examination and non-examination situation. (The Anxiety Differential may be seen in Appendix C.) The AD was administered to both the experimental and control sections in each of the four subject areas three weeks before the close of the semester. This was a time when an examination had not been scheduled for any of the sections. Thus, the announced examination section was in a non-examination situation, whereas the unannounced examination section was in an examination situation. The scores on the AD were used to determine the frequency of students exhibiting high test anxiety and also low test anxiety. The frequencies were then used to compute a value of χ^2 which was used to test hypothesis 2.

Procedure for Testing Hypothesis 3a

Hypothesis 3a: Mathematics students who are working under a system of unannounced examinations will exhibit no significant negative attitude change toward mathematics.

The students were given a semantic differential during the first week of the semester to determine their beginning attitude toward certain concepts related to mathematics. The semantic differential was administered to the experimental sections before they were told to expect unannounced examinations. During the final examination period they were administered the same semantic differential. This procedure allowed a difference score to be obtained for each individual in the experimental sections. This difference score not only told the magnitude of the student's change in attitude, but also the direction, that is, positive or negative. These difference scores were then used in conjunction with the Wilcoxon matched pairs signed-ranks test to compute a value of T, the test statistic for the Wilcoxon test, which was used to test hypothesis 3a.

Construction of the Semantic Differential for Attitude

Anttonen (1967) and McCallon and Brown (1971) have shown that a semantic differential can be effective in measuring attitude toward mathematics. The semantic differential used in this study was constructed by the experimenter with guidance provided by one of the dissertation committee members. The procedure for construction, administering, and scoring the semantic differential was taken from Osgood (1967). There were eleven concepts related to a student's attitude toward mathematics on the semantic differential. Each concept appeared on a separate page of a booklet. Beneath the concept were ten bi-polar adjectives, for example, good-bad. Between the adjectives a scale was drawn with seven slots. The students were asked to check one of the seven possible positions, ranging from strongly agree to strongly disagree, for each of the ten bi-polar adjectives. Seven of the bi-polar adjectives were used by Anttonen (1967). The other three bi-polar adjectives were: mild-intense, optimistic-pessimistic, and positive-negative. (The eleven concepts and the ten bi-polar adjectives appear in Appendix D.)

Procedure for Testing Hypothesis 3b

Hypothesis 3b: There is no significant difference in mathematics students' attitude change toward mathematics whether their examinations are announced or unannounced.

An attempt was made to treat the experimental and control sections as similarly as possible, except for the with-holding of examination dates from the experimental section. However, since the semantic differential could be administered to the control as well as the experimental sections, hypothesis 3b served as a check on hypothesis 3a. That is, if hypothesis 3a was rejected a comparison of attitude change could be readily made between the experimental and control groups.

If hypothesis 3a was rejected for a particular concept, then the frequency of those students showing a negative attitude change and those showing a positive attitude change was computed for both the experimental and control groups in each of the four subject areas. These frequencies were then used to compute a value of χ^2 which was used to test hypothesis 3b.

CHAPTER IV

TREATMENT OF THE DATA COLLECTED

Test of Hypothesis 1

Hypothesis 1: There is no significant difference in mathematics students' mean gain in achievement regardless of whether their examinations are announced or unannounced.

The students were given a pretest for mathematical achievement at the beginning of the semester. There were four pretests, one for each of the four subject areas treated in this study. Each pretest was composed of two parts. The two parts were: (1) multiple choice questions taken from the course the students were enrolled in, and (2) multiple choice questions taken from the preceding course. The pretest was given at the end of the semester as a final examination for the purpose of having a common measure to use in comparing the students' achievement. (Student raw scores together with means, medians, modes, ranges, and standard deviations appear in Appendix E.) The difference in the final examination scores was of major interest. Since random selection of students was not possible, the analysis of covariance was used to obtain a reduced estimate of experimental error by taking into account the regression of the final examination scores on the examination scores made at the beginning of the semester.

Homogeneity of Regression Coefficents

Before the analysis of covariance could be applied to determine if there was a significant difference in the achievement made by the two groups, a test was applied to determine if the regression coefficents were homogenous. The procedure for applying this test was taken from Edwards (1968, p. 338). Table 1 shows the results of the application of this test for the four subject areas. (The formulas used for computation purposes are shown in Appendix F.)

TABLE 1

TEST FOR HOMOGENEITY OF REGRESSION COEFFICENTS

Source	Sum of Squares	df	Mean Square	F
1. General College Mathematics				
Groups	.933	1	.933	.036
Residual	897.214	35	25.635	
2. Elementary College Algebra				
Groups	34.271	1	34.271	1.015
Residual	1654.333	49	33.762	
3. Intermediate College Algebra				
Groups	6.744	1	6.744	.313
Residual	646.884	30	21.563	
4. College Algebra				
Groups	.976	1	.976	.031
Residual	1055.519	34	31.045	

None of the *F* ratios shown in Table 1 were significant at the five per cent level. According to Edwards (1968) an assumption can be made that the regression coefficents for these groups are similar enough to allow an application of the analysis of covariance. The data used to test hypothesis 1 are shown in Table 2 for General College Mathematics, in Table 4 for Elementary College Algebra, in Table 6 for Intermediate College Algebra, and in Table 8 for College Algebra.

General College Mathematics

The test data, obtained from the two sections of General College Mathematics, used in applying the analysis of covariance are shown in Table 2.

TABLE 2

ANALYSIS OF COVARIANCE FOR GENERAL COLLEGE MATHEMATICS

Source	Sum of Squares	df	Mean Square	F
Between	1.990	1	1.990	.080
Within	898.147	36	24.949	

The *F* ratio of .080 with 1 and 36 degrees of freedom shown in Table 2 did not prove to be a statistically significant value. A value this small may be expected to occur when chance alone is operating more than ten times out of one hundred. Therefore, hypothesis 1 was not rejected.

Data are shown in Table 3 to determine if there was a numerical difference in the gain scores. The entries in the column labeled "Difference Between Means" were obtained by subtracting the mean of the pretest from the mean of the posttest. Since the pretest and the posttest were identical, this subtraction was a valid operation. The data in Table 3 disclose a difference between the gains made by the two groups. The announced examination section had the larger gain. The column labeled "Superiority of Announced Group" emphasizes the gain.

TABLE 3

MEANS AND MEAN GAINS FOR GENERAL COLLEGE MATHEMATICS

Examination Group	Mean of Pretest	Mean of Posttest	Difference Between Means	Superiority of Announced Group
Announced	22.091	33.364	11.273	.155
Unannounced	20.647	31.765	11.118	

The data presented in both Table 2 and Table 3 shows that the announced examination section of General College Mathematics did better than the unannounced examination section but the difference was not significant.

Elementary College Algebra

Data in Table 4 were obtained from both sections of Elementary College Algebra. To test hypothesis 1, the analysis of covariance was used to compute an *F* ratio. The *F* ratio of 3.165 with 1 and 50 degrees of freedom was significant beyond the ten per cent level, and was close to significance at the five per cent level. Therefore, hypothesis 1 was rejected. Data used to show which of the two groups achieved more numerically are shown in Table 5.

TABLE 4

ANALYSIS OF COVARIANCE FOR ELEMENTARY COLLEGE ALGEBRA

Source	Sum of Squares	df	Mean Square	F
Between	77.975	1	77.975	3.165*
Within	1231.719	50	24.634	

*Significant beyond the 10% level.

TABLE 5

MEANS AND MEAN GAINS FOR ELEMENTARY COLLEGE ALGEBRA

Examination Group	Mean of Pretest	Mean of Posttest	Difference Between Means	Superiority of Unannounced Group
Announced	25.129	30.484	5.355	
Unannounced	25.000	32.864	7.864	2.509

The data shown in Tables 4 and 5 indicates that those students in Elementary College Algebra who received unannounced examinations gained significantly more in mathematical achievement than those students whose examinations were announced in advance.

Intermediate College Algebra

Data obtained from the two Intermediate College Algebra sections are shown in Table 6. The data were used to compute an *F* ratio. This *F* ratio of .934 with 1 and 31 degrees of freedom was not a statistically significant value. A value this small may be expected to occur more than ten times out of one hundred. Therefore, hypothesis 1 was not rejected. Data are shown in Table 7 to determine which group gained numerically more in achievement.

TABLE 6

ANALYSIS OF COVARIANCE FOR INTERMEDIATE COLLEGE ALGEBRA

Source	Sum of Squares	df	Mean Square	F
Between	19.700	1	19.700	.934
Within	653.628	31	21.085	

TABLE 7

MEANS AND MEAN GAINS FOR INTERMEDIATE COLLEGE ALGEBRA

Examination Group	Mean of Pretest	Mean of Posttest	Difference Between Means	Superiority of Unannounced Group
Announced	16.555	23.444	6.889	
Unannounced	11.812	19.500	7.688	.779

Tables 6 and 7 show that the unannounced examination section in Intermediate College Algebra gained numerically more in achievement than the announced examination section, but the gain was not significant.

College Algebra

Data used for an application of the analysis of covariance to examination scores obtained from the two sections of College Algebra are shown in Table 8. To determine which section gained numerically more in achievement, data are shown in Table 9.

TABLE 8

ANALYSIS OF COVARIANCE FOR COLLEGE ALGEBRA

Source	Sum of Squares	df	Mean Square	F
Between	303.161	1	303.161	10.005*
Within	1056.495	35	30.186	

*Significant beyond the 5% level.

TABLE 9

MEANS AND MEAN GAINS FOR COLLEGE ALGEBRA

Examination Group	Mean of Pretest	Mean of Posttest	Difference Between Means	Superiority of Unannounc-ced Group
Announced	14.600	22.133	7.533	
Unannounced	16.478	28.522	12.044	4.511

The *F* ratio of 10.005 with 1 and 35 degrees of freedom shown in Table 8 was significant beyond the five per cent level. The probability of obtaining a value this large by chance alone is less than five times out of a thousand. Hypothesis 1 was rejected. Tables 8 and 9 show that College Algebra students whose examinations were unannounced gained significantly more in mathematical achievement than those students whose examinations were announced.

Summary of Statistical Conclusions for Hypothesis 1

Hypothesis 1 was rejected for Elementary College Algebra and College Algebra. In both courses the unannounced examination section demonstrated a significant gain in mathematical achievement over the announced examination section.

Hypothesis 1 was not rejected for General College Mathematics and Intermediate College Algebra. For General College Mathematics, the announced examination section gained numerically more in achievement than the unannounced examination section, whereas in Intermediate College Algebra the unannounced examination section gained numerically more in achievement than the announced examination section.

Test of Hypothesis 2

Hypothesis 2: There is no significant difference in mathematics students' test anxiety regardless of whether their examinations are announced or unannounced.

Three weeks before the end of the semester the Anxiety Differential was administered to the students. (Student raw scores are shown in Appendix G.) The announced examination sections in each of the four courses were not anticipating an examination. The announced and unannounced examination sections in each of the four courses were each partitioned into two groups, (1) those students who scored above four, and (2) those students who scored four or below. The interpretation was that a student who scored above four was demonstrating high test anxiety and that a score of four or below was the student's expression of low test anxiety. The original plan was to test hypothesis 2 for each subject area. However, when student frequencies were computed, the cell frequencies for those students scoring above four, for both the experimental and control sections, were so small that a χ^2 could not be computed. Thus, since the Anxiety Differential was the same for all students, no distinction was made between courses within each group.

To test hypothesis 2, the data in Table 10 was used to compute a value of χ^2. The procedure for applying the test was taken from Guilford (1965, p. 240).

TABLE 10

χ^2 TEST FOR TEST ANXIETY

Source	Low Test Anxiety	High Test Anxiety
Announced	76	6
Unannounced	60	7

$\chi^2 = .147$, df = 1

After combining student frequencies, two cell frequencies were still small, 6 and 7. Yates correction for continuity was employed which produced a $\chi^2 = .147$. The probability of obtaining a $\chi^2 = .147$ with one degree of freedom is greater than .70. Therefore, hypothesis 2 was not rejected.

Test of Hypotheses 3a and 3b

Hypothesis 3a: Mathematics students who are working under a system of unannounced examinations will exhibit no significant negative attitude change toward mathematics.

A semantic differential was administered to the two groups, announced and unannounced, in all four courses during the first week of the semester and on the day of their final examination. (Student difference scores are shown in Appendix H.) The reason for administering the same semantic differential twice during the semester was to determine if students whose examinations were all unannounced would express a significant negative change in attitude toward concepts specifically related to mathematics. Further, would a negative change in attitude be significantly different from that experienced by those students whose examinations were all announced? Thus, if hypothesis 3a was rejected for a particular concept, then a subsequent hypothesis was tested.

Hypothesis 3b: There is no significant difference in mathematics students' attitude change toward mathematics whether their examinations are announced or unannounced.

There were eleven concepts on each semantic differential for the four subject areas. The Wilcoxon matched pairs signed-ranks test was used to test hypothesis 3a for each of the eleven concepts in each of the four courses. (The procedure for applying this test was taken from Mendenhall, 1971, pp. 379-381, and is described in Appendix I.) If hypothesis 3a was rejected for a particular concept, then hypothesis 3b was tested by computing a value of X^2.

General College Mathematics

Data obtained from the unannounced examination section of General College Mathematics are shown in Table 11. In Table 11, the column headed by "Concept" contains the eleven concepts that appeared on the semantic differential. The column headed by "Attitude Change" shows whether the students' attitude change was in the positive or negative direction for each concept. The column headed by "N" shows the number of students used in the test, for some of the students' attitude did not change. The column headed by "T" shows the smaller sum of like signed ranks. None of the values of T found in Table 11 were significant at the five per cent level for a one-sided test. Therefore, hypothesis 3a was not rejected.

Elementary College Algebra

Data obtained from the unannounced examination section of Elementary College Algebra are shown in Table 12. The procedure for analyzing the data was the same as that described for General College Mathematics. In Table 12, a significant value of T was found for the three concepts, "Elementary College Algebra," "Myself as a Mathematics Student," and "Mathematics Textbook." Hypothesis 3a was rejected for these

TABLE 11

WILCOXON TEST FOR ATTITUDE CHANGE IN THE UNANNOUNCED EXAMINATION SECTION OF GENERAL COLLEGE MATHEMATICS

Concept	Attitude Change	N	T
Oscar Rose Junior College	Negative	14	34.0
General College Mathematics	Negative	14	40.0
Mathematics	Negative	14	39.0
My Success in Mathematics	Negative	15	41.0
Myself as a Mathematics Student	Positive	15	46.5
My Understanding of Mathematics	Positive	13	25.0
Mathematics Teacher	Negative	13	38.0
Mathematics Textbook	Negative	13	43.5
Mathematics Assignments	Negative	13	24.0
Preparation for Mathematics Examinations	Positive	15	38.5
Mathematics Examinations	Positive	14	43.5

concepts, consequently hypothesis 3b was tested. In both the announced and unannounced examination group, the frequency of students whose attitude change was negative and the frequency of students whose attitude was positive was computed. These frequencies are shown in Tables 13, 14, and 15 for "Elementary College Algebra," "Myself as a Mathematics Student," and

"Mathematics Textbook," respectively.

TABLE 12

WILCOXON TEST FOR ATTITUDE CHANGE IN THE UNANNOUNCED EXAMINATION SECTION OF ELEMENTARY COLLEGE ALGEBRA

Concept	Attitude Change	N	T
Oscar Rose Junior College	Negative	21	86.5
Elementary College Algebra	Negative	21	50.5*
Mathematics	Positive	21	94.0
My Success in Mathematics	Negative	18	69.5
Myself as a Mathematics Student	Negative	20	43.0*
My Understanding of Mathematics	Negative	21	95.0
Mathematics Teacher	Positive	22	112.5
Mathematics Textbook	Negative	19	44.0*
Mathematics Assignments	Negative	19	58.0
Preparation for Mathematics Examinations	Negative	21	100.0
Mathematics Examinations	Negative	20	76.5

*Significant at the 5% level for a one-sided test.

The data shown in Table 13 produced a $\chi^2 = .015$ which was not significant with only one degree of freedom. Hypothesis 3b was not rejected for the concept "Elementary College Algebra." The data shown in Table 14 produced a $\chi^2 = 2.42$ which was not significant with only one degree of freedom.

Hypothesis 3b was not rejected for the concept "Myself as a

TABLE 13

χ^2 TEST FOR THE CONCEPT "ELEMENTARY COLLEGE ALGEBRA"

Source	Positive Attitude Change	Negative Attitude Change
Announced	9	20
Unannounced	6	15

$\chi^2 = .015$, df = 1

TABLE 14

χ^2 TEST FOR THE CONCEPT "MYSELF AS A MATHEMATICS STUDENT"

Source	Positive Attitude Change	Negative Attitude Change
Announced	14	13
Unannounced	5	15

$\chi^2 = 2.42$, df = 1

TABLE 15

χ^2 TEST FOR THE CONCEPT "MATHEMATICS TEXTBOOK"

Source	Positive Attitude Change	Negative Attitude Change
Announced	10	18
Unannounced	5	14

$\chi^2 = .130$, df = 1

Mathematics Student." The data shown in Table 15 produced a $\chi^2 = .130$ which was not significant with only one degree of freedom. Hypothesis 3b was not rejected for the concept "Mathematics Textbook."

Data shown in Tables 12, 13, 14, and 15 may be interpreted as follows: Although the unannounced examination section of Elementary College Algebra experienced a significant negative attitude change toward three out of the eleven concepts on the semantic differential, the change was not significantly different from the attitude change experienced by the announced examination section.

Intermediate College Algebra

Data obtained from the unannounced examination section of Intermediate College Algebra are shown in Table 16. Table 16 shows that a significant value of $\underline{T}$ was obtained for the two concepts, "My Understanding of Mathematics" and "Mathematics Assignments." Hypothesis 3a was rejected for these concepts. Data are shown in Tables 17 and 18 that were used to test hypothesis 3b for the concepts, "Mathematics Assignments" and "My Understanding of Mathematics," respectively. A nonsignificant value of $X^2 = .640$ with one degree of freedom was obtained from the data in Table 17. Hypothesis 3b was not rejected for the concept "Mathematics Assignments." However, a significant value of $X^2 = 4.630$ with one degree of freedom was obtained from the data in Table 18. This value of X^2 was significant at the five per cent level. Hypothesis 3b was rejected for the concept "My Understanding of Mathematics."

TABLE 16

WILCOXON TEST FOR ATTITUDE CHANGE IN THE UNANNOUNCED EXAMINATION SECTION OF INTERMEDIATE COLLEGE ALGEBRA

Source	Attitude Change	N	T
Oscar Rose Junior College	Negative	12	26.0
Intermediate College Algebra	Negative	15	53.0
Mathematics	Negative	15	38.5
My Success in Mathematics	Negative	12	29.5
Myself as a Mathematics Student	Negative	13	23.0
My Understanding of Mathematics	Negative	15	26.0*
Mathematics Teacher	Negative	15	48.0
Mathematics Textbook	Negative	14	31.5
Mathematics Assignments	Negative	15	24.5*
Preparation for Mathematics Examinations	Positive	14	51.5
Mathematics Examinations	Positive	14	39.0

*Significant at the 5% level for a one-sided test.

TABLE 17

χ^2 TEST FOR THE CONCEPT "MATHEMATICS ASSIGNMENTS"

Source	Positive Attitude Change	Negative Attitude Change
Announced	12	8
Unannounced	5	10

$\chi^2 = .640$, df = 1

TABLE 18

χ^2 TEST FOR THE CONCEPT "MY UNDERSTANDING OF MATHEMATICS"

Source	Positive Attitude Change	Negative Attitude Change
Announced	11	6
Unannounced	4	11

$\chi^2 = 4.63$, df = 1, significant beyond the 5% level.

College Algebra

Data obtained from the unannounced examination section of College Algebra are shown in Table 19. Table 19 shows that the two concepts, "Mathematics Textbook" and "Mathematics Examinations," produced a significant value of T. The values of T, 64.0 and 54.5, were significant at the five per cent level for a one-sided test. However, the students' attitude toward "Mathematics Examinations" was in the positive direction. Therefore, hypothesis 3a was rejected only for the concept, "Mathematics Textbook." Data used to test hypothesis 3b for this concept are shown in Table 20. The data in Table 20 produced a $\chi^2 = .930$ with one degree of freedom, which was not a significant value. Hypothesis 3b was not rejected for the concept "Mathematics Textbook."

Summary of Statistical Conclusions for Hypotheses 3a and 3b

General College Mathematics

The students in the unannounced examination section of

TABLE 19

WILCOXON TEST FOR ATTITUDE CHANGE IN THE UNANNOUNCED EXAMINATION SECTION OF COLLEGE ALGEBRA

Concept	Attitude Change	N	T
Oscar Rose Junior College	Negative	22	112.0
College Algebra	Negative	23	131.5
Mathematics	Positive	23	99.5
My Success in Mathematics	Negative	22	96.0
Myself as a Mathematics Student	Negative	20	94.5
My Understanding of Mathematics	Positive	22	79.5
Mathematics Teacher	Positive	23	129.0
Mathematics Textbook	Negative	22	64.0*
Mathematics Assignments	Positive	23	100.5
Preparation for Mathematics Examinations	Positive	20	82.0
Mathematics Examinations	Positive	21	54.5*

*Significant at the 5% level for a one-sided test.

TABLE 20

χ^2 TEST FOR THE CONCEPT "MATHEMATICS TEXTBOOK"

Source	Positive Attitude Change	Negative Attitude Change
Announced	8	7
Unannounced	7	15

$\chi^2 = .930$, df = 1

General College Mathematics did not experience a significant negative change in attitude toward mathematics throughout the semester.

Elementary College Algebra

The students in the unannounced examination section of Elementary College Algebra experienced a significant negative change in attitude toward the concepts, "Elementary College Algebra," "My Understanding of Mathematics," and "Mathematics Textbook." However, when the unannounced examination section was compared with the announced examination section no significant difference in attitude change was found between groups.

Intermediate College Algebra

The students in the unannounced examination section of Intermediate College Algebra experienced a significant change in attitude toward the concepts, "Mathematics Assignments" and "My Understanding of Mathematics." When the unannounced examination section was compared with the announced examination section a significant difference in attitude change was found for the concept "My Understanding of Mathematics." The unannounced examination section experienced a negative change in attitude, whereas the announced examination section experienced a positive change in attitude.

College Algebra

The students in the unannounced examination section of College Algebra experienced a significant change in attitude toward the concepts, "Mathematics Textbook" and "Mathematics Examinations." However, the students' attitude change toward

"Mathematics Examinations" was in the positive direction. When the unannounced examination section was compared with the announced examination section no significant difference in attitude change was found between groups for the concept "Mathematics Textbook."

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

This study attempted to determine what effect unannounced examinations might have on mathematics students' achievement, test anxiety, and attitude toward mathematics. If a mathematics teacher is trying to decide whether or not to use unannounced examinations in his classes, then this study could be useful.

Summary of Findings

Effect of Unannounced Examinations on Achievement

Hypothesis 1: There is no significant difference in mathematics students' mean gain in achievement regardless of whether their examinations are announced or unannounced.

To test hypothesis 1, two sections from each of four mathematics courses were selected at the beginning of the fall semester, 1971. A coin was tossed to determine which section was to receive the unannounced examinations throughout the semester.

The students were given a pretest during the first week of the semester and the same test was given at the end of the semester. An *F* ratio was computed for each course to determine if the analysis of covariance could be applied to the test data. No significant *F* ratio was found. The analysis of covariance was then applied to the data to determine an *F* ratio. The mean gains of the two sections were compared to determine which group, announced or unannounced, showed the most gain. The results are summarized as follows:

1. Hypothesis 1 was rejected for Elementary College Algebra and College Algebra. In both courses the unannounced examination section demonstrated a significant gain in mathematical achievement over the announced examination section.

2. Hypothesis 1 was not rejected for General College Mathematics and Intermediate College Algebra. For General College Mathematics, the announced examination section gained numerically more in achievement than the unannounced examination section, whereas in Intermediate College Algebra the unannounced examination section gained numerically more in mathematical achievement than the announced examination section.

Effect of Unannounced Examinations on Test Anxiety

Hypothesis 2: There is no significant difference in mathematics students' test anxiety regardless of whether their examinations are announced or unannounced.

Three weeks before the end of the semester, on a day when an examination had not been scheduled for the announced examination section, the *Anxiety Differential* was given to both groups. Since the *Anxiety Differential* was the same for all four subject areas, the papers were pooled into two groups, announced and unannounced. In each of the two groups, the frequency of students scoring above four and four or below were tallied. A score above four was considered to be a student's expression of high test anxiety and a score of four or below was considered to be a student's expression of low test anxiety. Using the student frequencies, a value of χ^2 was computed. This value was not significant; therefore, hypothesis 2 was not rejected. That is, there was no significant difference in the test anxiety expressed by the two groups.

Effect of Unannounced Examinations on Attitude Toward Mathematics

Hypothesis 3a: Mathematics students who are working under a system of unannounced examinations will exhibit no significant negative attitude change toward mathematics.

To test hypothesis 3a, a semantic differential containing eleven concepts was given to all the students during the first week of the semester and again at the end of the semester. A difference score was obtained for each student in the unannounced examination sections. A value of T, the test statistic for the Wilcoxon matched pairs signed-ranks test, was then computed for each concept. If a significant value of T was found and if the students' attitude change was negative, then both the announced and unannounced groups were used to test hypothesis 3b by computing a value of χ^2.

Hypothesis 3b: There is no significant difference in mathematics students' attitude change toward mathematics whether their examinations are announced or unannounced.

The results are summarized as follows:

1. The students in the unannounced examination section of General College Mathematics did not experience a significant change in attitude toward mathematics throughout the semester.

2. The students in the unannounced examination section of Elementary College Algebra experienced a significant negative change in attitude toward three concepts. However, when the unannounced examination group was compared with the announced examination group no significant difference in attitude change was found between the groups.

3. The students in the unannounced examination section of Intermediate College Algebra experienced a significant negative change in attitude toward two concepts. When the unannounced examination section was compared with the announced examination section a significant difference in attitude change between the groups was found for the concept, "My Understanding of Mathematics."

4. The students in the unannounced examination section of College Algebra experienced a significant negative change in attitude toward one concept. When the unannounced examination section was compared with the announced examination section no significant difference in attitude change was found between the groups.

Conclusions

In view of the foregoing summary, the following conclusions regarding the limitations of the study, the suitability of the method used, and the resulting statistical implications were derived.

Limitations of the Study

One limitation of the study was the type of school where the study was conducted. Only one junior college was used in the study.

A second limitation lies in the testing instruments used. The four achievement tests used in this study were prepared by four experienced college mathematics teachers. However, their validity and reliability were assumed. The semantic differential used in this study to determine any attitude change was constructed by the experimenter following the procedure described by Osgood (1967). However, the validity and reliability of this instrument were assumed.

Suitability of the Method

Hypothesis 1 was tested by the analysis of covariance, which is an acceptable statistical procedure to use when an experimenter must work with intact classes.

Since the scores on a semantic differential are only in ordinal scale, the Wilcoxon matched pairs signed-ranks test and the χ^2 test, both nonparametric tests, were acceptable statistical tests to use in testing hypotheses 2, 3a, and 3b. Further, Osgood (1967) recommended the use of these tests when treating data obtained from a semantic differential.

Statistical Implications

Overall, students achieve more in mathematics classes when they are given unannounced examinations rather than announced examinations. In three of the four courses involved in this study the unannounced examination section gained numerically more in mathematical achievement than the announced examination section, and in two courses the gain was significant.

Unannounced examinations do not seem to create high test anxiety. Only seven of the sixty-seven students in the unannounced examination classes who took the Anxiety Differential demonstrated high test anxiety, whereas six of the eighty-two students in the announced examination classes who took the Anxiety Differential demonstrated high test anxiety. The difference was not significant.

Unannounced examinations do not appear to have a significant effect on a student's attitude toward mathematics. In only one out of forty-four possible comparisons did the students in an unannounced examination section experience a significant negative change in attitude when compared with the announced examination section. Further, three of the four unannounced examination sections experienced a positive change in attitude toward mathematics examinations and preparation for mathematics examinations, and one of these was significant.

Recommendations

Since there have been few studies that compared achievement in announced versus unannounced examination classes and since they are not always in accord, the following recommendations are made.

1. A replication of this study should be conducted, since it is the first study to employ only mathematics classes.

2. A study should be conducted comparing achievement, test anxiety, and attitude toward mathematics in announced versus unannounced examination classes where the students could be selected randomly.

3. A study should be designed to determine why students achieve more in unannounced examination classes.

4. A study should be conducted to determine the effectiveness of unannounced examinations on achievement in other mathematics classes.

5. A study should be made to determine if there is a difference in achievement when students are subjected to a system of unannounced examinations as opposed to the use of "pop-quizzes" along with announced examinations.

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APPENDIX A

CATALOG DESCRIPTION OF COURSES

Math 0123 ELEMENTARY COLLEGE ALGEBRA (3-0-3)
Includes a study of elementary algebra with topics on special products and factoring, fractions, quadratic equations, graphs and functions. (Does not count toward degree requirements.)

Math 1123 INTERMEDIATE COLLEGE ALGEBRA (3-0-3)
For students who have not completed Algebra II in high school. Special products, factoring, fractional exponents, radicals, linear and quadratic equations in one unknown, graphical representation of equations.
PREREQUISITE: One unit of high school algebra or permission of the instructor, and satisfactory score on Mathematics Placement test.

Math 1153 COLLEGE ALGEBRA (3-0-3)
Course content includes quadratic equations, theory of equations, probability, logarithms, elementary matrix algebra, and binomial theorem.
PREREQUISITE: Two years of high school algebra or Math 1123 and satisfactory score on Mathematics Placement test.

Math 1114 GENERAL COLLEGE MATHEMATICS (4-0-4)
This course is designed for the non-mathematical major. It is a broad survey course taught from an intuitive and meaningful standpoint. Topics to be discussed are: logic, probability, non-metric geometry, systems of numeration, mathematical systems, sets and statements, the computer, and algebra.
PREREQUISITE: One year of high school algebra and geometry or permission of the instructor.

APPENDIX B

ACHIEVEMENT TESTS

1. General College Mathematics

In the following problems, perform the indicated operations.

1. Add: (a) $\begin{array}{r} 34 \\ \underline{23} \end{array}$ (b) $\begin{array}{r} 2,301 \\ \underline{209} \end{array}$

2. Subtract: (a) $\begin{array}{r} 23 \\ \underline{11} \end{array}$ (b) $\begin{array}{r} 1,205 \\ \underline{42} \end{array}$

3. Multiply: (a) $\begin{array}{r} 16 \\ \underline{8} \end{array}$ (b) $\begin{array}{r} 369 \\ \underline{42} \end{array}$

4. Divide: (a) $3\overline{)621}$ (b) $14\overline{)168}$

5. Add: (a) $4/5 + 3/5 =$ (b) $1/2 + 1/3 =$

6. Subtract: (a) $2/3 - 1/3 =$ (b) $3/4 - 1/2 =$

7. Multiply: (a) $4 \times 1/2 =$ (b) $2/3 \times 4/5 =$

8. Divide: (a) $15 \div 1/3 =$ (b) $2/3 \div 3/4 =$

For the following questions several alternative answers are given. Determine which one is correct and place the letter associated with it beside the question number in the space provided. Your chances of having more correct answers is greater if you solve the problem before indicating your answer.

___ 9. What is the value of the expression $3n + 5$ when n is replaced by 2? (a) 11 (b) 8 (c) 15 (d) none of the above

___ 10. $(-4 + 3) - (-7)$ is equal to: (a) 5 (b) 6 (c) -8 (d) none of the above

___11. Which of the following numbers is a solution of the equation $2x + 2 = x + 2$? (a) -1 (b) 0 (c) $4/3$ (d) none of the above

___12. If the length of a hallway is represented by the letter "L" and its width by "W", which of the following open sentences states that the length of the hallway is 2 feet more than 4 times its width? (a) $L + 2 = 4W$ (b) $L = 4(W + 2)$ (c) $L = 4W + 2$ (d) none of the above

___13. Which of the following numbers is a solution of the equation $a - 2(a + 5) = 7$? (a) 3 (b) 17 (c) -3 (d) 2 (e) none of the above

___14. The expansion of $(3x + 2)^2$ is: (a) $9x^2 + 12x + 4$ (b) $9x^2 + 4$ (c) $6x^2$ (d) none of the above

___15. Together a house and lot cost $40,000. The house costs seven times as much as the lot, thus, the lot costs: (a) $33,000 (b) $5,714.29 (c) $5,000 (d) $35,000 (d) none of the above

___16. What is the sum of 432 and 214 in base 5? (a) 646 (b) 1201 (c) 1200 (d) none of the above

___17. If $A = \{2,3,5,6\}$ and $B = \{1,2,3,4,5\}$, what is $A \cup B$? (a) $\{1,2,3,4,5,6\}$ (b) $\emptyset$ (c) $\{2,4,5\}$ (d) none of the above

___18. If the statement "p" is false and the statement "q" is true, what is the truth value of the statement, "If p then q"? (a) true (b) false (c) none of the above

___19. How many even primes are there? (a) 1 (b) 2 (c) infinite number (d) none of the above

___20. A fair coin is tossed 5 times. What is the probability that all 5 tosses result in a head? (a) 1/5 (b) 1/32 (c) 5/10 (d) none of the above

2. Elementary College Algebra

In the following problems, perform the indicated operation.

1. Add: (a) $\begin{array}{r} 34 \\ \underline{23} \end{array}$ (b) $\begin{array}{r} 16 \\ \underline{99} \end{array}$ (c) $\begin{array}{r} 2{,}301 \\ \underline{209} \end{array}$

2. Subtract:	(a)	23 11	(b)	24 15	(c)	1,205 42
3. Multiply	(a)	16 8	(b)	24 15	(c)	369 43
4. Divide:	(a)	3 ⟌621	(b)	14 ⟌168		
5. Add:	(a)	4/5 + 3/5 =	(b)	1/2 + 1/3 =		
6. Subtract:	(a)	2/3 - 1/3 =	(b)	3/4 - 1/2 =		
7. Multiply:	(a)	4 x 1/2 =	(b)	2/3 x 4/5 =		
8. Divide:	(a)	15 ÷ 1/3 =	(b)	2/3 ÷ 3/4 =		

For the following questions several alternative answers are given. Determine which one is correct and place the letter associated with it in the space provided beside the question number. Your chances of having more correct answers is greater if you solve the problem before indicating your answer.

___ 9. Mr Smith bought a used car priced at $900. The sales tax was $27, the tag cost $22, and the registration fee was $2. The dealer allowed Mr. Smith $250 for his car. How much money did Mr. Smith need to make the trade? (a) $1201 (b) $599 (c) $701 (d) none of the above

___10. What is 5% of 20? (a) 10 (b) 5 (c) 1 (d) none of the above

___11. The value of the expression 3n + 5 when n is replaced by 2 is: (a) 11 (b) 8 (c) 15 (d) none of the above

___12. (-4 + 3) - (-7) is equal to: (a) 5 (b) 6 (c) -8 (d) none of the above

___13. Which of the following numbers is a solution of the equation 2x + 2 = x + 2? (a) -1 (b) 0 (c) 4/3 (d) none of the above

___14. If the length of a hallway is represented by the letter "L" and its width by "W", which of the following open sentences states that the length of the hallway is 2 feet more than 4 times its width? (a) L + 2 = 4W (b) L = 4(W + 2) (c) L = 4W + 2 (d) none of the above

___15. Which of the following numbers is a solution of the equation, $a - 2(a + 5) = 7$? (a) 3 (b) 17 (c) -3 (d) 2 (e) none of the above

___16. The expansion of $(3x + 2)^2$ is: (a) $9x^2 + 12x + 4$ (b) $9x^2 + 4$ (c) $6x^2$ (d) none of the above

___17. Together a house and lot cost \$40,000. If the house costs seven times as much as the lot, how much does the lot cost? (a) \$33,000 (b) \$5,714.29 (c) \$5,000 (d) \$35,000 (e) none of the above

___18. Add and simplify: $\dfrac{-4a^3}{-2a^{-2}b^{-3}} + \dfrac{7ab}{a^{-4}b^{-2}}$, $a,b \neq 0$.

(a) $5a^5b^3$ (b) $-4a^3b^2$ (c) $9a^5b^3$ (d) none of the above

___19. What is the solution set of $|x + 2| = 4$? (a) $\{2\}$ (b) $\{2,4\}$ (c) $\{2,-6\}$ (d) $\{-6\}$ (e) none of the above

___20. What is the remainder when $2x^2 - 3$ is divided by $x - 3$? (a) 0 (b) x (c) -1 (d) -2x (e) none of the above

Intermediate College Algebra

For the following questions several alternative answers are given. Determine which one is correct and place the letter associated with it beside the question number in the space provided. Your chances of having more correct answers is greater if you solve the problems before indicating your answers.

___1. $3 - 5$ is equal to: (a) -2 (b) 3 (c) -5 (d) none of the above

___2. The value of the expression $3n + 5$ when n is replaced by 2 is: (a) 11 (b) 8 (c) 15 (d) none of the above

___3. 2^3 is equal to: (a) 5 (b) 6 (c) 8 (d) none of the above

___4. In the expression $2x^2 - x - 1$, if x is replaced by -3 the resulting value of the expression is: (a) 14 (b) 20 (c) -10 (d) none of the above

___ 5. If the length of a hallway is represented by the letter "L" and its width by "W", which of the following open sentences states that the length of the hallway is 2 feet more than 4 times its width? (a) $L + 2 = 4W$ (b) $L = 4(W + 2)$ (c) $L = 4W + 2$ (d) none of the above

___ 6. $(-4 + 3) - (-7)$ is equal to: (a) 5 (b) 6 (c) -8 (d) none of the above

___ 7. Which of the following numbers is a solution of the equation $2x + 2 = x + 2$? (a) -1 (b) 0 (c) 4/3 (d) 2 (e) none of the above

___ 8. Add and simplify: $\dfrac{-4a^3}{-2a^{-2}b^{-3}} + \dfrac{7ab}{a^{-4}b^{-2}}$, $a,b \neq 0$.
(a) $5a^5b^3$ (b) $-4a^3b^2$ (c) $9a^5b^3$ (d) none of the above

___ 9. Which of the following numbers is a solution of the equation $a - 2(a + 5) = 7$? (a) 3 (b) 17 (c) -3 (d) none of the above

___10. Together a house and lot cost $40,000. The house cost seven times as much as the lot, thus, the lot cost: (a) $33,000 (b) $5,714.29 (c) $5,000 (d) $35,000 (e) none of the above

___11. What is the solution set of $|x + 2| = 4$? (a) $\{2\}$ (b) $\{2,4\}$ (c) $\{2,-6\}$ (d) $\{-6\}$ (e) none of the above

___12. What is the product of $4a^5$ and $3a^3$? (a) $12a^8$ (b) $7a^8$ (c) $7a^{15}$ (d) $12a^{15}$ (e) none of the above

___13. The expansion of $(3x + 2)^2$ is: (a) $9x^2 + 12x + 4$ (b) $9x^2 + 4$ (c) $6x^2$ (d) none of the above

___14. The remainder when $2x^2 - 3$ is divided by $x - 1$ is: (a) 0 (b) x (c) -1 (d) -2x (e) none of the above

___15. What is the value of $4b^3$ if b is replaced by 2? (a) 512 (b) 32 (c) 24 (d) 16 (e) none of the above

___16. Simplify: $\frac{15x^3y^2}{3xy^2}$, $x, y \neq 0$. (a) $5x^2$ (b) $12xy^2$ (c) $5xy^2$ (d) none of the above

___17. One factor of $x^2 + 2x - 8$ is: (a) $x - 2$ (b) $x - 4$ (c) $x - 8$ (d) none of the above

___18. What is the slope of the line whose equation is $y = 2x + 4$? (a) 2 (b) 4 (c) 6 (d) none of the above

___19. Simplify: $\frac{(x^2 - 1)/2}{(x - 1)/2}$ (a) 2 (b) $x + 1$ (c) $x - 1$ (d) none of the above

___20. Subtract: $\frac{x}{2x^2 - 4} - \frac{1}{x^2 - 2}$, $x \neq \pm\sqrt{2}$. (a) 0 (b) $(x - 1)/(3x^2 - 6)$ (c) $(x - 1)/(x^2 - 2)$ (d) $(x - 2)/(2x^2 - 4)$ (e) none of the above

___21. The roots of the quadratic equation $2x^2 - 4x + 1 = o$ are: (a) 1 ± 2 (b) $(2 \pm\sqrt{2})/2$ (c) $(4 \pm\sqrt{24})/4$ (d) none of the above

___22. One root of the equation $(x - 2)(x + 3) = 0$ is: (a) 6 (b) 3 (c) 2 (d) none of the above

___23. The system of equations $\left\{\begin{array}{l} 2x - 4y = 3 \\ -x + 2y = 1 \end{array}\right\}$ has, (a) one solution (b) no solution (c) more than one solution (d) none of the above

___24. A group of hikers walk 6 miles due west from their base camp, then north for 3 miles, then due east. They spend the night at a point 5 miles northwest of base camp. How far east did they walk? (a) 4 (b) 2 (c) 1 (d) none of the above

4. College Algebra

For the following questions several alternative answers are given. Determine which one is correct and place the letter associated with it in the space provided beside the question number. Your chances of having more correct answers is greater if you solve the problems before indicating your answers.

___1. One factor of $x^2 + 2x - 8$ is: (a) $x - 2$ (b) $x - 4$ (c) $x - 8$ (d) none of the above

___2. The expression $\dfrac{(x^2 - 1)/2}{(x - 1)/2}$ $(x \neq 1)$ can be simplified to:

(a) 2 (b) $x + 1$ (c) $x - 1$ (d) none of the above

___3. One root of the equation $(x - 2)(x + 3) = 0$ is: (a) 6 (b) 3 (c) 2 (d) none of the above

___4. Divide: $(x/y)/(x^2/y^2)$, $x,y \neq 0$. (a) x/y (b) x^2/y^2

(c) y/x (d) y^2/x^2 (e) none of the above

___5. What is the solution set of the inequality $2x - 4 < 0$? (a) $\{x \mid x > 2\}$ (b) $\{x \mid x = 2\}$ (c) $\{x \mid x < 2\}$ (d) none of the above

___6. One factor of $(3x^2 - 2)^2 - x^2$ is: (a) $(3x^2 + 2) - x$ (b) $3x^2 - 2 - x$ (c) $3x^2 - 2$ (d) none of the above

___7. Subtract: $x/(2x^2 - 4) - 1/(x^2 - 2)$, $x \neq \pm\sqrt{2}$

(a) 0 (b) $(x - 1)/(2x^2 - 4)$ (c) $(x - 2)/(x^2 - 2)$ (d) $(x - 2)/(2x^2 - 4)$ (e) none of the above

___8. Solve for x: $4/(x - 4) = 2/(x - 1)$

(a) 4 (b) -6 (c) -2 (d) none of the above

___9. What is the slope of the line whose equation is $y = 2x + 4$? (a) 2 (b) 4 (c) 6 (d) none of the above

___10. The system of equations $\begin{Bmatrix} 2x - 4y = 3 \\ -x + 2y = 1 \end{Bmatrix}$ has:

(a) one solution (b) no solution (c) more than one solution (d) none of the above

___11. What is the equation of the line that passes through the points (2,4) and (3,7)? (a) $y = 2x$

(b) $y = x + 4$ (c) $y = 3x + 1$ (d) none of the above

___12. $\sqrt{6^2 + 8^2}$ is equal to: (a) 14 (b) 10 (c) 7 (d) none of the above

___13. A group of hikers walks 6 miles due west from their base camp, then north for 3 miles, then due east. They spend the night at a point 5 miles northwest of base camp. How far east did they walk? (a) 4 (b) 2 (c) 1 (d) none of the above

___14. What are the roots of the quadratic equation $2x^2 - 4x + 1 = 0$? (a) 1 ± 2 (b) $2 \pm \sqrt{2}$ (c) $(4 \pm \sqrt{24})/4$ (d) none of the above

___15. The roots of the quadratic equation $x^2 - 5x + 3 = 0$ are: (a) real and equal (b) not real (c) real and unequal (d) none of the above

___16. What is the vertex of the parabola $y = x^2 - 2x$? (a) (1,-1) (b) (-2,0) (c) (1,-2) (d) none of the above

___17. What are the roots of the quadratic equation $x^2 + 1 = 0$? (a) ± 1 (b) $\pm i$ (c) $1 \pm i$ (d) none of the above

___18. If $\log_{10} 2 = .3010$ and $\log_{10} 3 = .4771$, then $\log_{10} 6$ is:

(a) (.3010)(.4771) (b) .4771 - .3010 (c) .3010 + .4771 (d) none of the above

___19. The rational root theorem predicts that a possible root of $x^{52} - 49x^{32} + x^{20} - 6 = 0$ is: (a) -49 (b) 2 (c) -55 (d) none of the above

___20. One card is drawn from a standard bridge deck. What is the probability that it is an ace or a spade?

(a) 16/52 (b) 17/52 (c) 1/52 (d) none of the above

___21. What is the sum of the first 1000 counting numbers, 1 + 2 + 3 + ... + 1000? (a) 500,000 (b) 500,250

(c) 500,500 (d) none of the above

___22. Which of the following is a solution of the matrix equation, $\begin{pmatrix} 2 & 5 \\ 3 & 7 \end{pmatrix} X = \begin{pmatrix} 1 \\ 0 \end{pmatrix}$? (a) $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$ (b) $\begin{pmatrix} -2 \\ 5 \end{pmatrix}$ (c) $\begin{pmatrix} -7 \\ 3 \end{pmatrix}$ (d) none of the above

___23. Which of the following ordered triples of numbers is a solution of the system of equations $\begin{Bmatrix} x + 2y + z = -2 \\ -x - y + z = 2 \\ 2x + y - z = -1 \end{Bmatrix}$

(a) (-2,0,0) (b) (-5,2,-1) (c) (1,-2,1)
(d) none of the above

___24. $8^{\frac{2}{3}}$ can be rewritten as: (a) 16/3 (b) 4 (c) 12
(d) none of the above

___25. $(3 + 4i)(3 - 4i)$ is equal to: (a) 5 (b) $9 - 16i$
(c) -7 (d) none of the above

APPENDIX C

ANXIETY DIFFERENTIAL

The instructions for taking the Anxiety Differential appeared on the first page of a booklet and were stated as follows:

The purpose of this study is to measure the meanings of certain things to various people by having them judge them against a series of descriptive scales. In taking this test, please make your judgements on the basis of what these things mean to you. On each page of this booklet you will find a different concept to be judged and beneath it a set of scales. You are to rate the concept on each of these scales in order.
Here is how you are to use these scales:
If you feel that the concept at the top of the page is very closely related to one end of the scale, you should place your check-mark as follows:

fair _X_ : ___ : ___ : ___ : ___ : ___ : ___ unfair
fair ___ : ___ : ___ : ___ : ___ : ___ : _X_ unfair

If you feel that the concept is quite closely related to one or the other end of the scale (but not extremely), you should place your check-mark as follows:

strong ___ : _X_ : ___ : ___ : ___ : ___ : ___ weak
strong ___ : ___ : ___ : ___ : ___ : _X_ : ___ weak

If the concept seems only slightly related to one side as opposed to the other side (but not really neutral), then you should check as follows:

active ___ : ___ : _X_ : ___ : ___ : ___ : ___ passive
active ___ : ___ : ___ : ___ : _X_ : ___ : ___ passive

The direction toward which you check, of course, depends upon which of the two ends of the scale seem most characteristic of the thing you're judging.

If you consider the concept to be neutral on the scale, both sides of the scale equally associated with the concept, or if the scale is completely irrelevant, unrelated to the concept, then you should place your check-mark in the middle space:

safe____:____:____:_X__:____:____:____dangerous

IMPORTANT: (1) Place your check-marks in the middle of spaces, not on the boundaries:

____:____:____:_X__:____:____X____
THIS NOT THIS

(2) Be sure you check every scale for every concept-do not omit any.

(3) Never put more than one check-mark on a single space.

Sometimes you may feel as though you've had the same item before on the test. This will not be the case, so do not look back and forth through the items. Do not try to remember how you checked similar items earlier in the test. Make each item a separate and independent judgement. Work at fairly high speed through this test. Do not worry or puzzle over individual items. It is your first impressions, the immediate "feelings" about the items, that we want. On the other hand, please do not be careless, because we want your true impressions.

The Anxiety Differential appeared as follows:

FINGERS

straight____:____:____:____:____:____:____twisted*

ME

helpless____:____:____:____:____:____:____secure

*The adjective representing high test anxiety is underlined for the readers benefit only.

SCREW

strong____:____:____:____:____:____:____weak

HANDS

wet____:____:____:____:____:____:____dry

TODAY

loose____:____:____:____:____:____:____tight

ME

frightened____:____:____:____:____:____:____fearless

GERMS

deep____:____:____:____:____:____:____shallow

HANDS

good____:____:____:____:____:____:____bad

BREATHING

careful____:____:____:____:____:____:____carefree

FINGERS

stiff____:____:____:____:____:____:____relaxed

ME

calm____:____:____:____:____:____:____jittery

HANDS

tight____:____:____:____:____:____:____loose

BREATHING

hot____:____:____:____:____:____:____cold

SCREW

loose____:____:____:____:____:____:____tight

ME

carefree____:____:____:____:____:____:____worried

ANXIETY

clear____:____:____:____:____:____:____hazy

FINGERS

loose____:____:____:____:____:____:____tight

APPENDIX D

ATTITUDE DIFFERENTIAL

The instructions for taking the attitude differential were the same as the instructions for taking the *Anxiety Differential* and are given in Appendix C. There were eleven pages in the test booklet. At the top of each page appeared a concept and below it were ten bi-polar adjectives with a seven space scale between them. The concepts were: (1) Oscar Rose Junior College, (2) Mathematics, (3) My Success in Mathematics, (4) Myself as a Mathematics Student, (5) My Understanding of Mathematics, (6) Mathematics Teacher, (7) Mathematics Textbook, (8) Mathematics Assignments, (9) Preparation for Mathematics Examinations, (10) Mathematics Examinations, and (11) either General College Mathematics, Elementary College Algebra, Intermediate College Algebra, or College Algebra depending on which group of students was taking the test.

The bi-polar adjectives were (the underlined adjective represents negative attitude): (1) good-*bad*, (2) *tense*-relaxed, (3) pleasing-*annoying*, (4) valuable-*worthless*, (5) *unfair*-fair, (6) mild-*intense*, (7) optimistic-*pessimistic*, (8) *negative*-positive, (9) *excitable*-calm, and (10) *low*- high.

The following is a sample page from the attitude differential.

MATHEMATICS

good:____:____:____:____:____:____:____:bad

tense:____:____:____:____:____:____:____:relaxed

pleasing:____:____:____:____:____:____:____:annoying

valuable:____:____:____:____:____:____:____:worthless

unfair:____:____:____:____:____:____:____:fair

mild:____:____:____:____:____:____:____:intense

optimistic:____:____:____:____:____:____:____:pessimistic

negative:____:____:____:____:____:____:____:positive

excitable:____:____:____:____:____:____:____:calm

low:____:____:____:____:____:____:____:high

APPENDIX E

RAW SCORES ON ACHIEVEMENT TESTS

1. General College Mathematics

	Announced Examinations			Unannounced Examinations	
Student	Pre-test	Post-test	Student	Pre-test	Post-test
1	26	35	1	24	23
2	15	30	2	12	19
3	31	37	3	20	36
4	23	36	4	20	35
5	16	35	5	15	24
6	18	32	6	15	30
7	21	37	7	22	41
8	24	32	8	21	35
9	19	31	9	18	38
10	12	13	10	23	33
11	29	41	11	16	22
12	28	38	12	26	37
13	21	38	13	24	33
14	25	30	14	24	29
15	19	27	15	19	33
16	25	41	16	29	35
17	20	34	17	23	37
18	21	38			
19	29	35			
20	23	36			
21	21	30			
22	20	28			
Mean	22.091	33.364		20.647	31.765
Standard Deviation	4.704	5.864		4.294	6.412
Median	20.750	34.800		20.500	32.800
Range	12-31	13-41		12-29	19-41
Mode	21	30, 35, 38		24	33, 35

2. Elementary College Algebra

Announced Examinations			Unannounced Examinations		
Student	Pre-test	Post-test	Student	Pre-test	Post-test
1	22	31	1	37	36
2	26	36	2	15	38
3	25	31	3	28	28
4	32	33	4	25	29
5	28	37	5	26	35
6	20	22	6	24	37
7	25	36	7	30	36
8	23	27	8	30	35
9	25	26	9	26	27
10	26	20	10	28	35
11	25	37	11	12	17
12	27	34	12	31	38
13	24	26	13	25	34
14	22	25	14	28	36
15	16	23	15	26	36
16	27	30	16	26	41
17	21	33	17	21	26
18	26	32	18	25	32
19	31	35	19	21	36
20	35	39	20	28	33
21	24	37	21	18	33
22	21	17	22	21	25
23	18	24			
24	20	24			
25	29	26			
26	33	37			
27	26	34			
28	30	36			
29	19	30			
30	28	33			
31	25	34			
Mean	25.129	30.484		25.000	32.864
Standard Deviation	4.368	5.735		5.418	5.373
Median	25.200	31.670		25.750	34.800
Range	16-35	17-39		12-37	17-41
Mode	25	37		26, 28	36

3. Intermediate College Algebra

Announced Examinations			Unannounced Examinations		
Student	Pre-test	Post-test	Student	Pre-test	Post-test
1	9	27	1	12	22
2	23	25	2	14	23
3	24	23	3	3	24
4	13	31	4	16	21
5	15	29	5	12	16
6	16	26	6	8	19
7	11	16	7	12	14
8	26	28	8	12	7
9	22	24	9	11	19
10	7	15	10	8	14
11	22	25	11	15	26
12	16	22	12	9	20
13	12	21	13	11	26
14	16	24	14	20	25
15	18	21	15	22	26
16	12	22	16	4	10
17	21	21			
18	15	22			
Mean	16.555	23.444		11.812	19.500
Standard Deviation	4.105	3.978		4.875	5.687
Median	15.800	23.500		11.750	20.500
Range	7-28	5-32		8-24	13-35
Mode	16	21, 22		12	26

4. College Algebra

	Announced Examinations			Unannounced Examinations	
Student	Pre-test	Post-test	Student	Pre-test	Post-test
1	16	24	1	15	27
2	16	26	2	19	29
3	10	26	3	18	31
4	10	26	4	11	35
5	23	32	5	13	34
6	19	25	6	17	26
7	8	17	7	13	33
8	13	5	8	12	13
9	7	16	9	17	21
10	18	21	10	21	31
11	11	22	11	19	33
12	28	24	12	22	30
13	19	20	13	23	29
14	13	20	14	15	30
15	8	28	15	8	26
			16	13	24
			17	14	27
			18	11	24
			19	22	32
			20	17	35
			21	19	29
			22	24	25
			23	16	32
Mean	14.600	22.133		16.478	28.522
Standard Deviation	5.827	6.107		4.178	4.952
Median	12.500	26.000		16.670	28.500
Range	7-28	5-32		8-24	13-35
Mode	8,10,13 16,19	26		13,17 19	29

APPENDIX F

ANALYSIS OF COVARIANCE FORMULAS

To apply the analysis of covariance to raw test scores, the following expressions are required: S_1, S_2, S_3, S_4, and S_5. If one group has n students and another group has m students and x_i represents raw scores on a posttest and y_i represents raw scores on a pretest then,

$$\underline{S}_1 = x_w - \left[\frac{(\sum^n x_i y_i - \sum^n x_i \sum^n y_i/n)^2}{\sum^n y_i^2 - (\sum^n y_i)^2/n} + \frac{(\sum^m x_i y_i - \sum^m x_i \sum^m y_i/m)^2}{\sum^m y_i^2 - (\sum^m y_i)^2/m} \right]$$

where,

$$x_w = \sum^n x_i^2 + \sum^m x_i^2 - \left[\frac{(\sum^n x_i)^2}{n} + \frac{(\sum^m x_i)^2}{m} \right].$$

$\underline{S}_2 = x_w - (xy_w)^2/y_w$ where,

$xy_w = \sum^n x_i y_i + \sum^m x_i y_i - [(\sum^n x_i \sum^n y_i)/n + (\sum^m x_i \sum^m y_i)/m]$ and,

y_w is computed in the same way as x_w simply by replacing the x_i's by the y_i's.

$\underline{S}_3 = \underline{S}_2 - \underline{S}_1$ and $\underline{S}_4 = x_t - (xy_t)^2/y_t$ where,

$x_t = \sum^n x_i^2 + \sum^m x_i^2 - (\sum^n x_i + \sum^m x_i)^2/(n + m)$ and, y_t is computed in the same way as x_t simply by replacing the x_i's by y_i's.

$$xy_t = \sum^{n} x_i y_i + \sum^{m} x_i y_i - (\sum^{n} x_i + \sum^{m} x_i)(\sum^{n} y_i + \sum^{m} y_i)/(n + m)$$

and $S_5 = S_4 - S_2$.

A condition that must be satisfied before the analysis of covariance can be applied is that the regression coefficents are homogeneous. To determine if this condition is satisfied an F ratio must be computed. The formula for this F ratio is as follows:

$$F = \frac{S_3/1}{S_2/(n + m - 4)}.$$

If this F ratio is not significant then the analysis of covariance may be applied to the test data by computing another F ratio. This F ratio is found as follows:

$$F = \frac{S_5/1}{S_2/(n + m - 3)}.$$

APPENDIX G

RAW SCORES ON THE ANXIETY DIFFERENTIAL

1. General College Mathematics

Announced Examinations		Unannounced Examinations	
Student	Score	Student	Score
1	2.33	1	2.83
2		2	2.44
3	3.11	3	2.44
4	2.38	4	
5	2.61	5	
6	2.16	6	3.50
7	3.66	7	3.44
8	3.88	8	3.38
9	2.88	9	3.38
10	3.66	10	2.50
11	3.11	11	3.33
12	2.77	12	4.05
13	3.05	13	3.00
14	2.88	14	3.11
15		15	3.00
16	2.50	16	3.88
17	2.50	17	3.50
18			
19	4.00		
20	2.77		
21	3.27		
22	3.44		

2. Elementary College Algebra

1	2.83	1	3.94
2	3.05	2	2.33
3	3.61	3	
4	3.50	4	4.16
5	2.38	5	4.22
6	2.88	6	2.94
7	3.05	7	2.38

2. Elementary College Algebra (cont.)

Announced Examinations		Unannounced Examinations	
Student	Score	Student	Score
8	3.83	8	3.16
9	3.94	9	2.88
10	3.33	10	3.11
11	3.00	11	
12	3.27	12	4.38
13	3.66	13	3.77
14	4.44	14	2.72
15	2.33	15	2.05
16	3.72	16	
17	3.77	17	
18	2.94	18	3.66
19	4.50	19	
20	3.55	20	3.00
21	3.16	21	2.50
22	2.77	22	4.33
23	2.72		
24	3.94		
25	4.38		
26	3.05		
27	2.83		
28	3.72		
29	3.44		
30	4.44		
31	3.61		

3. Intermediate College Algebra

1	3.22	1	2.38
2	2.38	2	4.00
3	2.61	3	2.33
4	2.50	4	3.05
5	2.22	5	
6	2.38	6	
7	3.44	7	3.88
8	3.16	8	
9	3.00	9	
10	4.27	10	2.44
11	2.94	11	3.22
12	2.22	12	4.00
13	2.88	13	3.33
14	3.00	14	2.66
15	3.00	15	3.50
16	2.77		
17			
18			

4. College Algebra

Announced Examinations: Student	Score	Unannounced Examinations: Student	Score
1	3.38	1	2.22
2	3.05	2	3.72
3	3.38	3	3.16
4	3.72	4	2.77
5		5	3.38
6	3.38	6	4.11
7	2.33	7	2.88
8	3.66	8	3.38
9	2.72	9	3.11
10	3.72	10	2.88
11	3.55	11	3.11
12	3.00	12	4.00
13	2.00	13	3.38
14	4.05	14	2.33
		15	2.77
		16	2.77
		17	3.00
		18	2.77
		19	2.83
		20	3.38
		21	2.38
		22	3.05
		23	4.61

APPENDIX H

DIFFERENCE SCORES ON THE ATTITUDE DIFFERENTIAL*

1. General College Mathematics: Announced Examination Section

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	2	8	-3	6	4	-2	-2	5	5	2	9
2	3	-1	-1	3	3	7	9	6	2	2	1
3											
4	-5	-1	-3	0	0	-4	-3	-6	2	2	1
5	14	9	-2	-6	-2	0	7	-9	-1	-7	2
6	4	-2	-3	2	12	3	0	5	1	-3	-2
7	-5	-3	0	0	-3	-4	1	3	6	-2	1
8											
9	2	1	12	1	-4	15	-3	3	-6	8	8
10	0	-2	3	8	-3	2	2	-6	1	11	2
11	-13	-11	-9	-12	0	-6	-7	-7	-8	8	2
12											
13	-1	-3	-3	26	12	3	0	-7	-18	-17	15
14	0	1	16	4	-1	4	18	12	0	0	34
15											
16	-18	-14	-14	-8	-7	-6	-6	-16	3	-5	13
17	0	-6	6	-11	-14	0	0	0	7	0	12
18	-6	-14	-3	-1	4	17	0	3	6	32	-1
19	12	-5	1	19	-3	6	3	7	5	23	33
20	-6	-2	7	7	-11	-9	-6	-6	1	-18	-16
21											
22	-1	-3	-9	-9	-5	3	-2	-7	-8	8	11

*All scores in these tables should be divided by ten.

1. General College Mathematics: Unannounced Examination Section

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	-15	2	4	-9	-1	1	-1	-2	-6	-8	-9
2	1	1	1	6	7	8	0	2	1	12	9
3	2	1	8	2	4	0	-4	7	3	13	6
4	-7	2	-2	-2	2	3	-4	-1	-12	13	26
5	2	11	4	-2	8	5	2	0	2	14	-1
6											
7	-5	-5	4	1	3	5	0	-1	-2	-2	3
8	-3	-2	-2	-3	-1	2	1	-8	-3	-5	2
9	-16	-4	-8	-14	-14	-5	-5	0	-6	-22	5
10											
11	3	-4	-22	-1	-9	-12	1	-7	-5	-12	-9
12	-11	0	1	-1	-3	0	1	-1	0	-2	2
13	7	20	0	11	18	7	10	12	1	17	19
14	5	7	-2	-6	4	4	6	5	2	1	1
15	0	-5	-3	-7	1	-4	3	-11	2	-17	-4
16	5	-8	-5	19	-1	7	-3	14	0	2	-7
17	-17	-4	-8	-1	-1	5	-9	4	-4	8	0

2. Elementary College Algebra: Announced Examination Section

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	3	0	3	2	3	1	-6	-9	-10	-5	-3
2	-3	-12	-3	-6	-1	-2	-3	-8	-7	4	-10
3	0	-4	-3	-3	4	4	-1	3	-3	7	-5
4	-4	-1	-3	7	-2	5	-4	0	-2	-1	1
5	7	5	7	13	-1	4	21	18	2	-1	-3
6	8	-10	3	-17	-33	3	-7	15	-36	-13	1
7	5	-9	2	-2	4	-2	-1	-1	1	2	-5
8	3	-9	-6	-6	-12	-6	2	-5	-9	-5	-7
9	5	-5	3	-8	-2	-9	-2	-12	3	-6	-6
10	-2	-13	2	6	3	-5	-11	-8	-2	4	1
11	-2	5	9	4	5	2	-6	-15	3	1	0
12	-8	13	11	-8	1	2	3	5	15	16	3
13											
14	-1	18	8	22	15	20	20	10	11	18	4
15	4	-3	5	11	6	-4	6	3	21	6	13
16	-25	-1	12	20	13	17	-6	6	-8	14	14

2. Elementary College Algebra (cont.)

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
17	-13	-8	-7	8	-2	-1	0	-8	-6	-8	-1
18	-2	3	9	8	8	8	-2	-10	-3	12	21
19	10	13	11	-11	-32	14	0	-7	-7	-12	19
20	8	3	-8	-4	-7	-5	-5	-8	-7	-10	-14
21	4	-3	8	4	2	-2	-1	1	0	3	0
22	6	2	5	1	0	7	-3	9	3	0	8
23	-5	-11	0	-1	-5	-5	-5	-5	4	-7	3
24	-8	-13	1	-3	0	-3	-3	-21	1	-14	-9
25	-5	-10	4	10	11	3	-5	-2	16	-18	11
26	3	-14	1	-1	2	1	-8	-1	-2	-11	-5
27	-9	2	5	1	0	-11	0	3	2	10	5
28	7	3	3	4	-3	-1	5	-2	0	-6	0
29	-1	-8	-1	3	9	-3	-3	-1	-4	-7	0
30	-20	-15	-10	-8	-6	-2	-18	-7	-10	-6	5
31	1	-13	3	1	-5	-3	1	0	-4	1	-25

2. Elementary College Algebra: Unannounced Examination Section

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	-6	-4	3	0	0	0	-6	-12	-4	-18	-6
2	-1	-3	-1	4	-2	-7	12	2	-4	1	-5
3	6	0	12	8	13	1	-1	-3	11	12	6
4	7	6	7	0	-24	-1	5	-10	3	-4	-7
5	-1	-6	-2	-1	-1	10	5	-5	0	0	4
6	0	-12	-10	-10	-13	-6	3	5	-12	-6	-1
7	-11	-6	1	0	1	4	-1	-4	-1	4	13
8	-2	5	-1	4	-1	4	-1	7	-3	-3	-3
9	13	-2	0	-8	-2	-7	5	-3	-9	-10	-4
10	-1	6	3	5	4	3	2	-1	-1	1	-4
11	2	-13	7	15	0	12	-2	11	2	-2	12
12	-3	-10	-10	-14	-9	-6	-9	-10	0	2	0
13	-9	5	3	-7	-3	-14	-2	0	-5	-1	-12
14	-4	-13	-8	0	1	-3	-20	-24	-11	8	-18
15	7	-7	2	11	-10	-3	3	0	-3	-9	-8
16	1	4	1	2	-2	1	7	0	5	5	6

2. Elementary College Algebra (cont.)

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
17	-17	-11	2	-7	-7	-15	-4	1-	0	-12	1
18	-4	-2	10	-7	-2	1	-5	-7	-1	-9	-8
19	6	-1	-5	-11	-8	-4	-1	-2	-15	-1	12
20	-2	2	9	10	3	7	8	3	7	6	7
21	-7	-10	2	-8	-10	-4	-11	-13	-1	-1	0
22	-3	-5	-10	-11	-17	-5	2	-16	-12	6	-10

3. Intermediate College Algebra: Announced Examination Section

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	-2	2	-2	-4	6	1	6	4	2	3	2
2	6	4	-7	9	6	11	-2	0	13	-9	10
3	-7	-12	-6	-4	-6	7	10	15	19	-5	-1
4	-13	28	23	19	29	28	15	7	11	39	20
5	4	11	9	8	10	1	6	-1	9	15	-8
6	1	6	2	5	5	11	6	8	9	13	12
7	-11	8	-15	6	-2	-5	21	15	-2	-4	-18
8	-2	7	6	10	7	-4	18	11	-7	13	6
9	7	-1	-3	3	3	-8	-1	-17	-13	-6	-2
10	-9	-7	1	3	0	2	1	2	-3	2	2
11	-3	-5	4	4	3	2	4	11	-11	7	-3
12	-3	15	1	-7	3	1	5	0	0	-11	-5
13	-2	-2	-1	2	8	4	-9	14	8	16	22
14	-5	-3	-2	3	-1	0	-4	-10	-4	7	8
15	4	5	2	9	7	7	10	3	4	9	17
16	6	-1	-19	-1	-3	-10	9	-6	19	-26	3
17	-15	-12	2	-4	0	-8	-2	1	2	-9	-10
18											
19	12	8	20	13	14	-4	25	8	2	-5	5
20	-7	-3	-5	1	-3	0	-2	0	-7	1	0
21	5	8	-1	0	-11	0	21	0	9	6	10

3. Intermediate College Algebra: Unannounced Examination Section

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	6	-20	-17	-18	-26	-16	-6	-7	-15	35	11
2	-13	-2	-4	-7	-16	-5	-16	-5	-11	-14	-6
3	-2	-2	4	8	4	2	5	-12	-9	6	3
4	0	4	2	4	3	-2	-3	5	3	6	4
5	-6	-4	-9	-8	-18	-17	-12	7	-8	-24	-4
6	-5	11	-6	-10	-18	-1	5	-8	-4	2	-1
7	12	5	6	3	-1	-4	14	2	4	3	3
8											
9	-4	-4	-6	-3	-4	3	2	-2	2	13	8
10	-10	-15	-6	-2	1	-19	-10	-4	-7	-11	13
11	-10	-1	9	11	14	13	4	3	2	-2	6
12	0	2	-2	3	-5	-6	-3	-4	-1	0	-4
13											
14	-5	-3	-5	0	0	-11	-10	-20	-16	-15	-10
15	1	3	-7	0	3	-1	-1	2	-4	-3	0
16	6	-1	3	-10	-7	-5	3	2	5	11	-2
17	0	3	5	0	0	2	2	0	-4	1	2

4. College Algebra: Announced Examination Section

1	7	-8	2	-8	1	-5	1	-8	-17	-12	-16
2	4	-9	9	-19	-6	-16	3	-15	6	-15	-21
3	5	0	3	1	-7	-3	1	5	-7	-3	-5
4	-10	2	6	-7	-3	-9	-4	-2	0	3	3
5	2	1	5	7	8	0	-2	-14	-5	6	-1
6	7	7	7	-1	-2	10	15	12	10	4	18
7	10	-1	-3	0	-3	-1	-5	6	-3	7	7
8	3	-2	2	11	-2	-4	1	1	-16	-3	0
9	2	2	-6	2	-5	0	-10	-8	-6	6	-3
10	14	-6	4	-15	0	8	4	-5	-2	-5	-5
11	15	-8	9	3	5	4	-3	5	4	6	7
12	-5	-7	-3	-30	-7	0	-9	-14	-11	4	0
13	-6	-7	-1	14	1	6	-5	5	-6	-5	-10

4. College Algebra (Cont.)

Concepts

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
14	-6	1	-3	-6	-4	-3	4	4	-2	7	-2
15	0	8	-7	-14	-7	11	-2	5	8	-13	-7

4. College Algebra: Unannounced Examination Section

Student	Oscar Rose Junior College	Particular Course	Mathematics	My Success in Mathematics	Myself as a Mathematics Student	My Understanding of Mathematics	Mathematics Teacher	Mathematics Textbook	Mathematics Assignments	Preparation for Mathematics Examinations	Mathematics Examinations
1	-15	-12	7	-4	-5	7	-5	-25	4	-6	-1
2	5	2	9	7	12	2	2	1	7	-11	2
3	13	4	2	14	-10	5	3	-1	14	5	32
4	2	7	2	1	3	5	-8	-13	7	9	-4
5	-11	-2	-1	5	-1	0	5	0	-9	0	8
6	0	10	-7	1	1	2	-7	-1	12	7	10
7	4	5	-4	-1	-3	-5	-7	-2	-1	3	-1
8	-3	-10	8	-6	-11	-13	-13	-24	-14	-11	-19
9	-4	-15	-20	11	2	5	8	-11	-1	-6	0
10	-11	9	-3	-6	-4	1	2	-4	7	13	7
11	2	-5	19	-2	0	-3	1	-12	-9	-6	-2
12	10	4	4	0	11	8	3	3	-3	9	1
13	-12	-3	14	-6	-6	-3	-12	-10	-13	-2	0
14	4	-5	6	-4	1	3	10	17	17	7	-2
15	2	7	-2	-4	6	1	6	-11	4	0	-1
16	-3	5	-7	-11	0	5	8	4	-2	1	4
17	-13	-16	3	-16	-9	-13	-21	14	5	-3	14
18	5	-7	5	3	-3	2	8	-27	-1	0	1
19	1	-7	-2	5	0	1	-1	3	-3	2	4
20	12	9	9	-1	7	11	6	-18	13	2	4
21	9	10	5	1	9	8	1	6	4	2	4
22	-9	-9	1	-7	-4	2	-5	-8	6	3	3
23	-12	7	-10	-10	-4	-1	12	4	1	6	6

APPENDIX I

WILCOXON TEST

To apply the Wilcoxon matched pairs signed ranks test, the observed differences are ranked according to their absolute values, then the sign of the difference, positive or negative, is assigned to the rank. Differences equal to zero are eliminated. The signed ranks are then summed. The smaller sum of like signed ranks is then compared to the critical value of *T*, the test statistic for the Wilcoxon test. If the smaller sum is less than the critical value of *T*, then the hypothesis being tested is rejected.