THE EFFECT OF VOCABULARY TRAINING UPON THE DEVELOPMENT OF VOCABULARY, COMPREHENSION, TOTAL READING, AND RATE OF READING OF COLLEGE STUDENTS

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PREFACE

The basic objective of this study was to examine the possibility of helping students at the college level to improve their vocabularies. In working with students in the Reading Center and remedial classes, it was noted that vocabulary was an area where there appeared to be little growth, particularly with older students.

Extensive search of the literature revealed many successful vocabulary studies with younger students but few at the college level. Some basic ideas drawn from these studies led to the development of the method used in this program.

Results of this study suggest the program was successful, particularly with students enrolled in a reading improvement course. Apparently, students in these classes considered vocabulary an important goal in increasing their reading ability. Results also indicate teacher training and experience have a tremendous influence upon student achievement.

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CHAPTER I

THE PROBLEM

Introduction

This is a study of the effect of a vocabulary improvement program based on Dale's (1967) principle of word acquisition and various principles of learning.

Review of the literature indicates there is a definite relationship between vocabulary, intelligence scores, concept level, comprehension, language ability, and reading ability (Hunt, 1953; Casper, 1953; McDonald and Pauk, 1956; O'Donnell, 1962; Williams, 1963). At the elementary and secondary school level, studies indicate students vocabulary can be increased through direct instruction on specific words (Otterman, 1955; Reid, 1958; Eichholz and Barbe, 1961; Gray and Holmes, 1938).

However, there are few experimental studies on vocabulary improvement to indicate this is true at the college level. The question is, can colleges help students to improve their vocabulary? And, if so, does this also improve their reading ability? Thus, there is a need for additional testing of vocabulary improvement programs at the college level. It is hoped this present study will help to shed some light on the problem.

Need for the Study

Vocabulary studies indicate a definite relationship between vocabulary, intelligence scores, concept level, comprehension, language ability, and reading ability, all of which are highly correlated with success and achievement in school.

There are many experimental studies and research on vocabulary improvement at the elementary level. These studies indicate students can increase their vocabulary with direct and deliberate instruction. However, at the college level, there are too few experimental studies on vocabulary to say how successful a program at this level can be.

Previous studies, mostly at the elementary level suggest several techniques which were successful in helping students increase their vocabularies. These techniques include (1) wide experiences with objects and ideas, (2) spoken and written symbols for experiences, (3) intensive training on specific words, (4) the abundant use of audio and visual materials, and (5) the use of words in context rather than in isolation. How true these findings are at the college level is not known.

The few studies at secondary and college levels work with vocabulary lists, word parts, and grammar. These have been disappointing as only the more able students appear to gain in these programs. College students were also found to reject prepared lists, even when these were written into context. Students found word lists unsuccessful as the words were difficult and the students failed to remember the definitions later.

The methods in these studies fail to account for the individuality of students, their backgrounds of experiences, their interests, or their

present reading ability. Programs where students work on an individual basis are rare. However, because of the individual nature of vocabulary, methods which present all students with the same words are defeating their real purpose. It was, therefore, desirable to find a method where each student determined which words to learn, using his own interest and background as a guide.

Theoretical Background

The method used in this study is based on Edgar Dale's principle of word acquisition, which follows learning theory in helping students as individuals, rather than part of a group. Dale (1967) describes the process of learning words as a continuum. On one end are words as an individual first becomes aware of them; that is, cognizance of the word through hearing or seeing it. On the other end is word usage; that is, he can speak and/or write them when necessary. Between the ends is a "twilight zone", where the individual has some idea or feeling for the meaning. How clear these ideas are depend upon how far along the continuum they are. Words are constantly moving along this continuum, new words are added, and some are moved into the individual's usable vocabulary. Dale suggests the "twilight zone" as the place to work to improve vocabulary, for it is unique to each person and provides words he knows something about and, therefore, can recall later. By working in this area, one can speed up the acquisition of new words. This follows the learning principle of proceeding from the known to the unknown.

Other learning principles used in developing the method used in this study include student involvement, quick reinforcement, or

correction of response and learning in small steps. Student involvement was accomplished through each students' active selection of the words to study, independent of others and guided by his own interest, background, and reading ability. Learning in small steps was accomplished with a goal of only five words each session, especially since the words were not totally new. Reinforcement or correction of responses was accomplished by students checking their responses with the dictionary.

In addition to the principles of learning followed here, the context of words was considered. As words carry meaning only in relation to other words, it was decided students should select words already in context. Thus, they were forced to give the correct meaning of the word in a particular context.

Finally, this program attempted to establish habits and attitudes in dealing with words which would continue after college. Because students were quite adept at reading textbooks for concepts and ignoring unknown words, and because textbooks were generally read only on assignment, seldom reread and rarely touched after the courses were finished, the use of these books for vocabulary improvement was rejected. Instead, it was decided to use materials students read on their own time. Magazines and newspapers were chosen for the materials as it was observed students were always reading these before class and at odd times all over the campus.

Problem Statement

The present study was an investigation of the effect of a vocabulary program upon vocabulary, comprehension, reading ability, and rate of reading of college students. The program was designed to increase

students' awareness of words and word meanings in context by using basic learning principles and materials frequently used by college students.

Assumptions and Limitations

It is assumed the Nelson-Denny Reading Test used in this study gives an adequate measure for college students of the various reading skills for which it is intended.

It is also assumed the students in the Reading Improvement and Study Skills classes in this study are typical of Oklahoma State University students who have enrolled before and will enroll in following semesters for these courses. This sample is, therefore, considered representative of the population of Reading Improvement and Study Skills classes at Oklahoma State University. However, the results of this study must be considered in the light of certain limitations and should not be considered representative of all groups or schools.

The time used in this study limits the results. Five words, twice a week for twenty minutes for twelve weeks is equivalent to 120 words in eight hours of instruction. Absenteeism and failure of some students to finish the work in the required time reduces considerably the effect of the method.

There are also limitations due to the problem of leakage when using live data. On several occasions students from control groups asked when these words were due. Getting information from friends in other classes they decided they missed an assignment when absent.

The problem of being unable to randomly assign individual students to groups reduces the external validity of the experiment. Groups, therefore, cannot be assumed to be homogeneous. However, much of this

has been overcome by the use of analysis of covariance (see pp. 31-32).

The attrition rate for Reading Improvement classes was 38%, while it was only 9% for the Study Skills classes. This reduced the size of the 1220 control group considerably, which has had some affect on the results.

Therefore, the results of this study are only to be inferred or pertinent to future students in Reading Improvement and Study Skills classes at Oklahoma State University or similar schools.

Definitions of Terms

The following terms and symbols used in this paper are here defined and will retain the meaning set forth at this point.

1220 is a symbol representing Education 1220, the Reading Improvement classes at Oklahoma State University. This was a non-credit course which met three, fifty minute periods weekly. Some lectures and discussions of techniques were given, but most of the semester students worked in small groups and/or individually on skills found deficient during the initial testing periods.

1232 is a symbol representing Education 1232, a two-hour credit, Study Skills course at Oklahoma State University. This course also met three, fifty minute periods weekly. Students were instructed through lectures and discussions in the various techniques of study, test taking, and library usage. They were given opportunity to practice these techniques during laboratory sessions using textbooks from their other classes. In addition, students were informed of their deficient reading skills and shown ways to improve these skills.

Classification refers to the grade level or year of college credit

the student had obtained at the beginning of the semester.

Context refers to the sentence or part of a sentence necessary for understanding of a term used.

N-D is a symbol which designates the Nelson-Denny Reading Test. This is a test for high school and college students covering ninth to fourteenth grade level of reading ability. The four separate raw scores obtained from the test are vocabulary, comprehension, total reading, and rate. There are two alternate forms, each consists of 100 vocabulary items, and 36 comprehension items. All items are simple multiple choice. This is a timed test, allowing 10 minutes for the vocabulary portion and 20 minutes for the comprehension and rate portion. The first minute of the comprehension portion is used to determine rate.

Standardization of the N-D was made first on a stratified random sampling at the high school level of 8,000 cases at each grade level ninth through twelfth. This sampling was based on secondary school enrollment by region and community size within a region. This information was taken from the Statistical Abstracts of the United States 1956. Second, a sample of college and university level population was selected, based on Fall 1955 enrollment figures in five different kinds of institutions of higher education. Institutions were chosen by random selection within each category, and a per cent of cases from each taken. In grades 13 and 14, 4,000 cases were used. In grades 15 and 16, 3,500 cases were used. This is 500 less, due to the drop of junior colleges at this level.

A total of 152 schools in 38 states were used at the secondary level; and 33 junior colleges, universities, liberal arts colleges, teachers' colleges, and state teachers' colleges in 21 states and

District of Columbia were used at the higher level.

Form A and B were alternately distributed to students in the testing, which was under the supervision of local school administration. Complete directions for test administration were given to the examining schools.

Townsend (1968) questions any reliable use of the grade norms as the passages are of college level difficulty and urges care in interpretation of rate, as rate based on less than four minutes, and not on word count, is not accurate.

Orr (1968) criticizes the comprehension passages as difficult, involved, and essentially poor writing. However, as a whole, he still considers it a good test, stating the standardization was good, although small groups were used.

Reliabilities for vocabulary, rate, and total reading are high, ranging from .92 to .93. Comprehension has only a .81 realiability.

Pre-test scores are scores students earned on Form B of the Nelson-Denny Reading Test. This form was given at the beginning of the semester. In the statistical analysis, X represents the pre-test scores.

Post-test scores are scores students earned on Form A of the Nelson-Denny Reading Test. This form was administered at the completion of the study. In the statistical analysis, Y represents the post-test scores.

Operational definitions of vocabulary, comprehension, total reading, and rate are the comparable portions on the Nelson-Denny Reading Test.

Statistical Exploration and Hypotheses Testing

In this study, a factor analysis was first run on 13 variables. This procedure allowed for a better understanding regarding the relationships between the N-D test scores and the other variables. It was also used to identify factors underlying the variables (Kerlinger, 1965).

Analysis of covariance tests followed by t-tests were used to test the hypotheses in this study. The adjusted means from the N-D raw scores were used for the independent variable. The dependent variables used were (1) treatment groups, (2) control groups, (3) Reading Improvement classes, (4) Study Skills classes, (5) teacher training, and (6) teacher experience.

The following hypotheses were formulated for this research. The hypotheses are stated in null form.

Hypothesis 1. There is no significant difference in the adjusted means of vocabulary scores on the N-D between 1220 and 1232 groups.

Hypothesis 2. There is no significant differences in the adjusted means of vocabulary scores on the N-D between treatment and control groups.

Hypothesis 3. There is no significant difference in the adjusted means of vocabulary scores on the N-D between 1220 treatment and 1220 control groups.

Hypothesis 4. There is no significant difference in the adjusted means of vocabulary scores on the N-D between 1220 control and 1232 control groups.

Hypothesis 5. There is no significant difference in the adjusted

means of vocabulary scores on the N-D between 1220 treatment and 1232 treatment groups.

Hypothesis 6. There is no significant difference in the adjusted means of vocabulary scores on the N-D between 1232 treatment and 1232 control groups.

Hypothesis 7. There is no significant difference in the adjusted means of comprehension scores on the N-D between 1220 and 1232 groups.

Hypothesis 8. There is no significant difference in the adjusted means of comprehsnion scores on the N-D between treatment and control groups.

Hypothesis 9. There is no significant difference in the adjusted means of comprehension scores on the N-D between 1220 treatment and 1220 control groups.

Hypothesis 10. There is no significant difference in the adjusted means of comprehension scores on the N-D between 1220 control and 1232 control groups.

Hypothesis 11. There is no significant difference in the adjusted means of comprehension scores on the N-D between 1220 treatment and 1232 treatment groups.

Hypothesis 12. There is no significant difference in the adjusted means of comprehension scores on the N-D between 1232 treatment and 1232 control groups.

Hypothesis 13. There is no significant difference in the adjusted means of total reading scores on the N-D between 1220 and 1232 groups.

Hypothesis 14. There is no significant difference in the adjusted means of total reading scores on the N-D between treatment and control groups.

Hypothesis 15. There is no significant difference in the adjusted means of total reading scores on the N-D between 1220 treatment and 1220 control groups.

Hypothesis 16. There is no significant difference in the adjusted means of total reading scores on the N-D between 1220 control and 1232 control groups.

Hypothesis 17. There is no significant difference in the adjusted means of total reading scores on the N-D between 1220 treatment and 1232 treatment groups.

Hypothesis 18. There is no significant difference in the adjusted means of total reading scores on the N-D between 1232 treatment and 1232 control groups.

Hypothesis 19. There is no significant difference in the adjusted means of rate scores on the N-D between 1220 and 1232 groups.

Hypothesis 20. There is no significant difference in the adjusted means of rate scores on the N-D between treatment and control groups.

Hypothesis 21. There is no significant difference in the adjusted means of rate scores on the N-D between 1220 treatment and 1220 control groups.

Hypothesis 22. There is no significant difference in the adjusted means of rate scores on the N-D between 1220 control and 1232 control groups.

Hypothesis 23. There is no significant difference in the adjusted means of rate scores on the N-D between 1220 treatment and 1232 treatment groups.

Hypothesis 24. There is no significant difference in the adjusted means of rate scores on the N-D between 1232 treatment and 1232 control

groups.

Hypothesis 25. There is no significant difference in the adjusted means of vocabulary scores on the N-D due to amount of teacher training.

Hypothesis 26. There is no significant difference in the adjusted means of vocabulary scores on the N-D due to amount of teacher experience.

Hypothesis 27. There is no significant difference in the adjusted means of comprehension scores on the N-D due to amount of teacher training.

Hypothesis 28. There is no significant difference in the adjusted means of comprehension scores on the N-D due to amount of teacher experience.

Hypothesis 29. There is no significant difference in the adjusted means of total reading scores on the N-D due to amount of teacher training.

Hypothesis 30. There is no significant difference in the adjusted means of total reading scores on the N-D due to amount of teacher experience.

Hypothesis 31. There is no significant difference in the adjusted means of rate scores on the N-D due to amount of teacher training.

Hypothesis 32. There is no significant difference in the adjusted means of rate scores on the N-D due to amount of teacher experience.

CHAPTER II

REVIEW OF THE LITERATURE

Introduction

Literature contains numerous research studies on college reading improvement programs. Most of these are general in nature, concerning the results of these reading improvement programs, speed reading or adult literacy. Few of these studies deal directly with vocabulary improvement.

Even though sufficient research on vocabulary is lacking at this level, teachers and administrators of secondary schools and colleges list vocabulary as one of the vital aspects of remedial and corrective reading programs (Schleich, 1967). In looking at the high school and elementary levels, there have been numerous studies dealing directly with vocabulary and methods of improving students vocabulary.

Therefore, this review of literature will first focus on studies at the college level. Then, studies at the secondary and elementary levels will be discussed. The parallel findings from all the levels will be discussed in the summary.

Literature at the College Level

Blair (1941) made a study of vocabulary improvement, with extensive use of a dictionary and word lists. In this study, he used junior and

senior class college students in educational psychology and secondary education classes. The experimental group consisted of 101 subjects; the control group consisted of 136 subjects. The vocabulary portion of the Nelson-Denny Reading Test was used for measuring gains. The experimental group discussed the importance of improving vocabulary, and decided to use the dictionary to look up each new word they found during the semester. Each week, they turned in a list of new words and where they were found, giving the context and meaning. This information was recorded in a notebook, reviewed periodically, and turned in to the instructor at the end of the semester. Students turned in an average of 119.3 words for the semester. Results of the post-tests show the experimental group gained an average of 3.6 points, while the controls gained only 1.0 points. However, when groups were matched for initial scores, there was only .8 points difference. Class examination revealed students doing more words gained more.

Westfall (1951) describes a vocabulary improvement course at Colorado A and M, and gives results for six quarters. A vocabulary test, used in the courses, was based on the Webster's Collegiate Dictionary. This was a 100 word, multiple-choice test, with five possible synonyms. Students averaged 50.49% of words at the beginning of the course.

In the program, students were required to keep a vocabulary notebook, accumulating a minimum of 300 words during the semester. Final tests show a gain of 4.54% in vocabulary. In relation to the number of words the test covers, this would be an increase of 4,994 words in three months. Besides the tremendous increase in words, students also gained in their ability to deal with words. There were also gains in GPA

scores.

Hunt (1953) studied the relationship of vocabulary, structural analysis, and reading at the college level. Using 168 students from the University of California, he ran correlations on various scores from reading tests given to the group. Results indicate all were moderately interrelated. Structural analysis related somewhat lower to vocabulary and reading than vocabulary and reading correlated with each other. Also, the more intelligent subjects were better with structural analysis of words.

Young (1953) used words from the Cooperative Vocabulary Test in a pre- and post-test experiment to compare the vocabulary growth of college students, using three different methods. Each of the groups had 150 students. Group one read the selections orally. Group two listened to the stories on tape. Group three read the stories silently. Using chi-square and the significance of mean differences, he found all subjects had a significant gain in vocabulary scores after the presentation of words. The group listening to the tapes made the lowest gain scores. The oral reading group showed the largest gain, but this was not significantly greater than the silent reading group.

Casper (1953) reports on a reading improvement program at Purdue. Pre- and post-test of classes show students had significant gains on all tests on speed and comprehension. He states vocabulary seems to be an important factor in comprehension; however, when does vocabulary end and comprehension start? Comprehension involves the understanding of language, but words alone do not give exact meaning.

McDonald and Pauk (1956) describe the results of a reading improvement program at the college level. The experimental group consisted of

116 students taking college reading improvement. The control group was 142 students who wanted the course, but could not enroll due to limited facilities. These students agreed to come for the testing. Vocabulary scores from the Cooperative Reading Test were used for pre- and post-tests. The program used machines and speed devices. Achievement of the two groups were compared using analysis of covariance. Results indicate a significant gain in speed of comprehension at the .01 level of confidence for the experimental group. This group also exceeded the control group on first semester GPA, and on cumulative GPA's after two and three semesters. In addition, a significantly smaller portion of experimental group dropped from school.

Brown (1959), in his book on communication, states word power is reading power. Words are important to understand textbooks. Working with college students in an earlier dictionary study, he developed a master list of 14 words. Each master word had a prefix, root, and suffix. Students learned these words, their parts, and various spellings of these, and their meanings. They were then expected to apply this knowledge to other terms they met, in order to discover the meanings of the new words.

These vocabulary improvement studies and programs at the college level indicate a high correlation between vocabulary, structural analysis, comprehension, and reading ability (Hunt, 1953; Casper, 1953; McDonald and Pauk, 1956; Brown, 1959).

A few studies indicate college students can increase their vocabulary through an intensive program working on specific words (Blair, 1941; Westfall, 1951; Young, 1953; Brown, 1959).

Literature at the Secondary School Level

Dunkel (1944) studied the ability to use the precise meaning of words in grades 10, 12, and 14. This study used a vocabulary test in which words were written into paragraphs. Following the paragraphs, five sentences were given. Subjects were to mark the sentence with the same meaning as the word used in the paragraph. Results indicate the ability to determine the precise meaning was related to the ability to read with comprehension. Education and maturity led to the development of this ability.

Anderson (1949) made a factor analysis study of reading ability. He used 500 randomly selected fifth and sixth year secondary school students. Results indicate one main factor, and that is reading comprehension ability. However, vocabulary contributed 57.6% of the total variance. Intelligence scores contributed 13.2%, and grammar and spelling contributed 29.2% of the total variance.

Hage and Stroud (1959) studied the relationship between verbal and nonverbal intelligence scores and reading proficiency with 800 ninth graders. Using scores from the Lorge-Thorndike, Pressey Reading Rate and Comprehension, and the Iowa Tests of Basic Skills, partial and multiple correlations were run on various parts. Subjects were divided into four groups by the reading test scores. Top and bottom groups were compared. Results indicate reading ability was highly correlated to intelligence scores. The verbal intelligence had the highest correlation to school achievement, which increased when math scores were removed. This study also questions the use of the Lorge-Thorndike Intelligence Test as a measure of a student's ability, as the verbal

portion requires reading ability, and this probably is being measured rather than intellectual ability.

Ramsey (1960), in a study of 138 eleventh grade students, attempted to find which variables were the best predictors of success in improving reading ability. The highest relationship was between intelligence scores and reading ability.

O'Donnell (1962) studied the relationship between awareness of grammatical structure and reading comprehension with 101 high school seniors. Using the structural linguistics approach to English grammar, the author compiled a list of basic structural relationships, and then constructed a test to measure this ability. He ran a correlation between scores on the structural test, Cooperative Test of Reading Comprehension, and the Iowa Grammar Information Test. Results show a correlation of .44 between level of comprehension and awareness of structure; .46 between level of comprehension and knowledge of grammar; .46 between vocabulary and structure scores; .90 between vocabulary and grammar; .76 between vocabulary and level of comprehension. In this study, vocabulary is indicated to be the most important factor in reading comprehension.

These studies on vocabulary improvement at the secondary school level indicate a high correlation between vocabulary, comprehension, intelligence scores, and structure of language (Dunkel, 1944; Anderson, 1949; Hage and Stroud, 1959; Ramsey, 1960; O'Donnell, 1962). This is precisely what was indicated by studies on vocabulary improvement at the college level.

Literature at the Elementary School Level

Otterman (1955) made a study with seventh grade students using word parts. In this study, 220 students were in control groups and 220 students were in experimental groups. Students were matched on sex, age, MA, average reading scores, and spelling. Thirty lessons, lasting ten minutes each day, were held for six weeks. In each lesson, one prefix or root word was taught. A total of 250 words were used as illustrations in the lessons. These words were not new to the students. Students were tested before and after the experiment. Results indicated only students with the highest intelligence scores showed a significant gain in interpretation of new words. All experimental students improved in spelling, particularly those with initial low scores, low MA's, and boys. There was no significance between groups on improvement of general vocabulary, reading comprehension, and speed.

Eichholz and Barbe (1961), using Dale's principle of word acquisition, developed a self-checking device designed to improve the general vocabulary of students. This study involved four self-contained classrooms of seventh graders for eight weeks. The device consisted of a series of 20 multiple-choice word tests, each with three forms. The correct answer was the same on each, but different distractors were given. The forms fit a self-checking board which students punched. The words were written into a story. Once each week, the experimental groups were given 30 minute, informal talks to stimulate and improve their vocabulary. Words on the test were not taught or used as examples. At the same period, students were given two practice forms of the test and the story. They were asked to do this as homework. The

third form was given the following week for evaluation. The control groups were given no talks or practice material, but were given three forms of the test each week. At the end of eight weeks, a final multiple-choice test of 60 words, used in the first three lessons, was given. Results showed the experimental group had a retention rate of 79.5% of the words. They had learned 5.6 words on the final test. The control group had learned only 1.0 words. The conclusion drawn was that the only difference between groups was the number of times words were seen in context. Informal interviews revealed this device had the greatest appeal for the average student.

Hillard (1924) attempted to find a single factor which might contribute to low comprehension scores. With 166 students at fifth grade level, he gave four different tests on comprehension, and correlated each part of the tests. Results indicated intelligence and vocabulary had the highest correlations with comprehension on all the tests.

Films were used by Reid (1958), in a study with fifth graders, to increase their knowledge of technical and general terms. The films were introduced by setting a purpose in looking for new ideas and words. Following the film, a discussion period was utilized to clarify how and where terms were used, and their meanings. The teacher took notes on the discussion. After several weeks, 25 words were written on the board, and the children were asked their meanings. Without comment, the teacher wrote down their suggestions. Later, a test was made using these same words. The children's suggestions were included in the multiple-choice answers. Results of the tests indicate children learned many new words and extended their levels of word meanings.

Gray and Holmes (1938), in their classic studies on the development of meaning vocabularies, stress the importance of experience, directly and indirectly, with objects and ideas, along with the spoken and written symbols for these experiences. These studies consisted of a series of experiments at the fourth grade level to discover methods of developing a meaningful vocabulary in reading. All experimental groups were given specific help to form clear, vivid associations between word meanings and their written symbols. Control groups had no guidance, except as individuals asked. Results show specific help, frequent use of definitions, illustrations, and discussions helped students gain uniformly in verbs, nouns, and adjectives. Control groups gained mostly in nouns and verbs. Help was particularly useful for pupils with limited vocabularies, achievements, or abilities. Pupils also developed greater accuracy in word recognition, fluency, and comprehension in silent reading.

Braun (1963) studied concept formation as related to reading ability in a random selection of 139 boys in grades 3, 5, and 7. All children in these classes who were reported as either over-achievers or under-achievers were used as a special control group. Subjects were individually tested on a concept test, developed by the author, and on the appropriate WISC subtests. Reading and achievement test scores for all subjects were also used in analysis of the profiles. The concept-formation test consisted of 20 concepts.

Results indicate there is a significant correlation between reading ability and concept formation, which increases with age. Also the over-achievers had better concept formation.

Williams (1963) measured the comprehensive vocabulary of 216

children, ranging from 6 to 15 years of age. Vocabulary was measured through a dictionary sample to find the growth of vocabulary over a period of years. It was felt a vocabulary measure would give an index of expected standards for children. Results of the testing indicate a rapid development of word recognition between the reading ages of 7 and 8. There was a relatively slow rate of growth in word recognition at higher reading ages. Williams suggests the optimum level of word recognition may be set by the level of language understanding of the student.

Using 134 children in grades 3, 5, 7, and 8, plus 15 college graduates, Kruglov (1953) ran a study to determine if vocabulary can show the level of conceptual thinking. The author devised a ten-item test. Each item had five multiple-choice answers, all of which were correct. Subjects were to choose the best answer in five minutes. Results indicate subjects chose answers at their own conceptual level, rather than a higher, more abstract level. Younger subjects chose more descriptive answers; whereas, older ones chose more synonyms. He suggests vocabulary can be used to understand the conceptual level of children.

Vocabulary studies at the elementary level suggest vocabulary is highly related to concept formation, understanding of language, intelligence scores, and comprehension (Hillard, 1924; Kruglor, 1953; Braun, 1963; and Williams, 1963). These findings are the same as those for secondary and college level students.

These studies also indicate elementary students can increase their vocabulary by direct and indirect experiences with objects, ideas, and words. Students improved in vocabulary through the use of intensive training on specific words; exposure to the spoken and written symbols

for these words; using the words in context; and by using audio-visual materials (Otterman, 1955; Eichholz and Barbe, 1961; Reid, 1958; Gray and Holmes, 1938).

Otterman (1955) found students with high intelligence scores gained significantly in reading ability through the study of word parts, but for the average student there was no significant gain in reading ability.

Summary

There are numerous vocabulary studies, most of these are at the elementary level. There are few vocabulary studies at the college level. At this level, most studies have been on reading improvement programs. However, teachers and administrators of secondary schools and colleges have stated their concern about vocabulary improvement. Many of these people consider vocabulary as one of the vital aspects of remedial and corrective reading.

Studies at all levels indicate vocabulary, concepts, intelligence scores, comprehension and reading ability are highly correlated. These studies suggest that achieving a large vocabulary is essential to success as a reader. Perhaps as factorial studies suggest, vocabulary, intelligence scores, reading ability, and concept formation are part of one common factor .. that of verbal language (Thurstone, 1946; Anderson, 1949).

CHAPTER III

DESIGN, METHODOLOGY, AND PROCEDURES

Introduction

This study was made to investigate the effectiveness of a vocabulary improvement program with college students. The subjects were 407 students who completed Reading Improvement and Study Skills classes in the fall 1971 semester at Oklahoma State University.

A method was developed to increase students participation and interest in building their vocabulary. This method was an individualized approach based on principles of learning and word acquisition. Materials were chosen on the basis of interest and accessibility to the students.

This study used a pre-test, post-test, control group design. The Nelson-Denny Reading Test was used for evaluation of the program. Statistical analysis of the data included a factor analysis and analysis of covariance.

Sample

The population for this study includes all students who enroll in Reading Improvement (1220) and Study Skills Class (1232) at Oklahoma State University. All students in these classes who completed the fall 1971 semester comprised the sample population. This included 179 students from Reading Improvement classes and 236 students from Study

Skills classes. This gave a total sample population of 415. From this total, four students were dropped because they were in both treatment and control groups, due to the fact they were enrolled in both classes. Therefore, the study actually involves 175 students from 1220 classes and 232 students from 1232 classes, giving a total sample population of 407 students. Of these, 318 were in treatment groups, and 89 were in control groups.

Students were assigned to control and experimental classes by groups, rather than individuals. Extraneous factors such as history, maturation, and election, cannot be assumed the same for all groups. The groups also varied considerably in size. Therefore, analysis of covariance was used. This method adjusts initial scores to equalize groups, and then compares the adjusted means of the groups.

Classes were predominately freshman and sophomore students with a sprinkling of upper classmen and graduate students. Students were drawn from all colleges at the university. These subjects were chosen due to their accessibility to the experimenter. (See Appendix C, columns 16-18.)

Instructors consisted of nine graduate teaching assistants with a wide range of experience and background. Some were working on a master's degree with no previous experience at this level, and others were close to finishing a doctorate with several years working experience at this level.

Site and Duration of the Study

This study was conducted in the Reading Center at Oklahoma State University. The center was stocked with a wealth of materials at the college level; a good library of books on reading and study techniques,

specific skill development materials, paper backs, dictionaries (including unabridged), newspapers, magazines, films, pacing machines and devices, tapes, records and individual carrels. Students checked out books for home use, and were encouraged to work in the center any time it was open for additional practice. This was from 7:30 A.M. to 9:30 P.M. on most days.

This program ran for twelve weeks. Subjects worked twenty minutes, twice each week. This totals 480 minutes or 8 hours of work with approximately 120 words.

Data Gathering Procedures

Each instructor administered and scored the N-D tests for their own groups in class during the first week. Each subject's test results, sex, classification, teacher, age, college, and section were then coded onto master sheets to later facilitate the use of computer cards.

Following the testing period, all instructors were given a basic vocabulary improvement outline to guide their instruction in vocabulary improvement. Lectures stressed various methods found in literature, to improve vocabulary, including the method used in this study. No attempt was made to have instructors follow the outline, however, the method used in this study had to be thoroughly covered. It was expected that greater reliability of results would be obtained if different instructors presented the method using their own lecture method and background of experience. (Kerlinger, 1965, pp. 444-459.)

The remainder of the first two weeks students spent in acquainting themselves with materials in the center and in working with their

instructors developing individual improvement programs based on skills found deficient during the initial testing program.

At the end of the second week, 1220 sections were listed consecutively 11, 12, 13, etc. Then, by use of a table of random numbers, three were designated control groups. This same procedure was used for 1232 classes (Popham, 1967). Instructors were then informed of the results and given materials for all treatment groups.

At the beginning of the third week all subjects in treatment groups were instructed to bring a collegiate dictionary to class for vocabulary study. Then they were given printed instruction sheets which described the steps in this method. They were also given a folder for filing their individual word sheets (see Appendix A). Instructors reviewed the procedures with classes the first two sessions, and then periodically checked student papers for completeness and accuracy. When necessary, the procedure was again explained. Students were encouraged to continue their work and to use the words they were writing outside the classroom. They were also encouraged to guess at meanings using the context for clues.

The control groups received no additional vocabulary instruction. Although material with vocabulary instruction was available, it was not emphasized, nor attention called to its use in these classes. Instructors were to watch for students who would take the initiative to work in this area, however, none was reported in the control group.

The program lasted for twelve weeks. The fourteenth week of the semester, the folders were collected and form A of the Nelson-Denny was administered in class by the instructors. Test results, number of words completed in the program, total time used in the program, and the

number of sessions worked for each student was then coded onto master sheets for use in typing computer cards.

Computer cards were made, and programs written for factor analysis and analysis of covariance. Results were then recorded and interpreted, and conclusions drawn.

The Program

After the initial vocabulary lectures, students in the treatment groups were given printed instruction sheets which described the steps of the method used in this study (see Appendix A).

Students were to skim articles rapidly and identify five words in their twilight zone. These words were written on a word sheet along with the context in which they were found, and underlined. In parenthesis following the context, they wrote their guess of the word meaning. After completing five words, students used the dictionary to check the definitions. If their guess was correct, it was left; if incorrect, the definition was crossed out and a correct one written using the dictionary as a guide.

Students worked twice each week for twenty minutes. They could stop after finishing five words, or they could continue until the twenty minutes had lapsed. No one was allowed additional time, even if five words had not been completed. Many students regularly finished eight to ten words, while others completed just two or three words. (Students averaged 67.62 words in 14.26 sessions. The mean number of words completed each work session was 4.67.) Each session a word sheet was completed, dated, and filed until the end of the semester.

Periodically instructors checked student's work, encouraging their

efforts and questioning them on some words to keep motivation and interest high.

Materials Used

Materials used were current news articles from magazines and newspapers popular with college students. These news materials covered a large range of reading ability and interests. Sufficient quantity of papers and magazines were provided in the classroom. A weekly clean-out of old magazines and newspapers kept the material current. Students were also allowed to bring their own magazines. The students were expected to seek their own level of reading and use materials of interest to them.

Instrument Used

The Nelson-Denny Reading Test was used in this study. It is a test for high school and college students covering ninth to fourteenth grade level reading ability. Four separate raw scores are given: vocabulary, comprehension, total reading, and rate. There are two alternate forms, each consists of 100 vocabulary items, and 36 comprehension items. All items are simple multiple choice. Although the raw comprehension score is doubled, the test remains weighted in favor of the vocabulary score. The entire test is a timed experience, rather than a power test. The working time for the vocabulary portion of the test is 10 minutes; for the comprehension and rate portion it is 20 minutes.

Form B was used as a pre-test as many students had been exposed to Form A in Freshman Orientation during the previous weeks. Form A was used for the post-test.

Procedures for Coding Data

After initial testing, each student's pre-test scores, sex, classification, age, and teacher were coded onto master sheets by class sections. No special order was given students within a class, but each was assigned the number of his group and a student number according to his position on the master sheet. Class and student number remained the same throughout the study. Missing numbers in the raw data lists are students dropped from the study.

Word sheets used in the study kept score of the number of words studied and time used. Each session, a new word sheet was used. At the end of the study the words, time, and sessions for each student were tallied and coded onto the master sheets.

After the post-tests, the raw scores from these were also coded onto the master sheets for each student.

The coded master sheets were used to facilitate punching of computer cards. After all the data was coded, one computer card was punched for each student in the sample. Only students where all information was recorded remained in the study. Most were dropped due to incomplete data. However, four were dropped because they were taking both courses, and were in control groups in one class and treatment groups in the other class.

1220 classes were assigned group numbers from 11 to 27. 1232 classes were assigned group numbers, 51 to 63. All teachers were randomly assigned numbers 1 to 9. Age was recorded in the nearest whole number. Sex was assigned 1, male; and 2, female. Class designations were: 1, Freshman; 2, Sophomore; 3, Junior; 4, Senior; 5, Special student; and 6, Graduate student. Nelson-Denny numbers are the raw

scores for each part of the test. Words, time, and sessions were the actual number tallied from the word sheets.

Computer cards were designed using columns of three for easier reading of printouts. Missing numbers are students dropped from the study. Some variables gathered have not been utilized in this study, as they did not bear on the particular problem. However, they are available for further study. Coded raw data printout is in Appendix C.

All cards were punched and verified, and then computer programs for statistical analysis were written.

Statistical Procedures

Factor Analytic Technique

The basic assumption behind most achievement testing is that the tests used are themselves unitary measures of the achievement in question. According to Kerlinger (1965, p. 681), this assumption is quite probably false. Kerlinger suggests that psychological-educational research areas be proceeded by factor analytic exploration of the variables in that area. With the availability of a modern high speed digital computer such exploration is a practical preliminary step in educational research.

A factor analysis was run to gain a better understanding regarding the relationships between the N-D test scores and between these test scores and the other variables. The factor analysis was also used to identify the factors underlying the variables.

Analysis of Covariance

The analysis of covariance was made because subjects were not

randomly assigned to treatment and control groups, but rather the groups were assigned to treatment and control. Therefore, the groups in this study cannot be considered homogeneous. Analysis of covariance adjusts for initial differences by equalizing the means of the groups. It then compares these adjusted means of the groups. The statistical procedures followed are those described by Snedecor and Cochran (1967, pp. 419-446).

Statistical Analysis

The analysis of the data was carried out in two phases utilizing the 360-65 IBM computer located in the Computer Center of Oklahoma State University. The computer programs used are given in Appendix D.

The first phase of the analysis was to make a factor analysis and correlations for the following variables: (1) age, (2) classification, (3) pre-test vocabulary, (4) pre-test comprehension, (5) pre-test total reading, (6) pre-test rate, (7) post-test vocabulary, (8) post-test comprehension, (9) post-test total reading, (10) post-test rate, (11) words, (12) time, (13) sessions (see Appendix D, program one). This program yielded the means and standard deviations of each of the variables, a 13 variable correlation matrix (Table II), as well as the findings from the factor analysis (Tables III to V).

The second phase was the statistical testing of the hypotheses. Program two given in Appendix D is the computer program which was written in order to compute the various statistics needed for calculating the analysis of covariance described in Chapter IV. These were the pre- and post-test mean scores, standard deviations, Pearson product moment correlation between scores of the two tests; pre- and post-test sum of squares, sum of the cross products, and slope of the Beta

lines. The F ratios and t-ratios needed for testing the hypotheses were computed with the aid of an electronic calculator. The exact proabilities of no difference between groups as determined by the hypotheses were calculated using computer program three in Appendix D.

Summary

A pre-test, post-test control group was the design used in this study. There were two control groups and two treatment groups. A total of 407 subjects who completed Reading Improvement and Study Skills classes in the fall 1971 semester at Oklahoma State University were used in the study. Of these, 318 were in the treatment groups, and 89 in the control groups. Classes were randomly assigned to treatment or control groups rather than individual students.

A plan was devised to increase students participation and interest in building their vocabulary. Using various principles of learning and Dale's description of word acquisition, basic criterions were established for a method. These included student involvement, quick reinforcement or correction of responses, learning in small steps, and attaching new ideas to old.

Materials were chosen on the basis of high interest and accessibility to college students. Printed news media was chosen for this. Materials were provided and changed frequently to keep the articles current.

The Nelson-Denny Reading Test was used for evaluation of the program because it is considered as one of the better standardized measurements at this level and is easy to administer and score.

The method of word study required students to quickly skim articles

and identify five words in their twilight zone. These were recorded in context on word sheets along with definitions of words. The definitions were checked with a dictionary and corrected if wrong. Students worked twenty minutes twice a week for twelve weeks.

Statistical analysis consisted of factor analysis to find the correlation between pre- and post-test scores on vocabulary, comprehension, total reading and rate, age, classification, words, time; and analysis of covariance because subjects were assigned to treatment and control groups as classes rather than individuals. Analysis of covariance eliminates any initial differences in groups which may occur, and then compares the adjusted means for the groups. All statistical data was made through computer programs (Appendix D).

CHAPTER IV

STATISTICAL ANALYSIS

Introduction

A factor analysis was first run on 13 variables listed in Table I. Four factors, accounting for 83% of the variance, were extracted. These four factors were named: (1) reading ability, (2) effort, (3) maturity, and (4) rate of reading (Kerlinger, 1965, p. 681).

Tests of analysis of covariance were then run to examine the adjusted means of various groups on the four portions of the N-D test (Snedecor and Cochran, 1967, pp. 419-446). This technique adjusts post-test results to remove pre-test differences and gives a lower experimental error, allowing for more precise comparison of various groups. If the F ratio from the analysis of covariance gave a probability of no difference between means of .1 or higher, the hypotheses were not rejected.

If the probability of no difference between means was less than .1, it was considered significant and t-tests were run to locate the source of the difference. If the t-ratio gave a probability of no difference between means of .05 or higher, the hypothesis was not rejected. If the probability of no difference between means was lower than .05, the hypothesis was rejected.

Factor Analysis

Procedures

A factor analysis was made to identify factors which underlie variables and the relationships which exist among these variables. Thirteen variables were included in the analysis. These variables are listed in Table I.

TABLE I

NAME AND PER CENT OF COMMUNALITY OF VARIABLES USED IN FACTOR ANALYSIS

Variable Number	Variable	Per Cent of Communality
1	Age	81.97
2	Classification	80.98
3	Pre-test vocabulary score	82.21
4	Pre-test comprehension score	66.28
5	Pre-test total reading score	88.02
6	Pre-test rate score	80.60
7	Number of words completed	94.65
8	Time used in study in minutes	95.67
9	Post-test vocabulary score	77.53
10	Post-test comprehension score	68.46
11	Post-test total reading score	91.02
12	Post-test rate score	73.15
13	Number of sessions student worked in treatment	98.46

TABLE II

CORRELATION MATRIX

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13
1	1.000	0.614	0.227	0.110	0.185	-0.043	-0.016	0.043	0.219	0.170	0.219	0.090	0.022
2	0.614	1.000	0.312	0.186	0.272	0.002	-0.176	-0.151	0.279	0.178	0.261	1.142	-0.155
3	0.227	0.312	1.000	0.650	0.906	0.326	-0.097	-0.099	0.803	0.608	0.794	0.376	-0.103
4	0.110	0.186	0.650	1.000	0.906	0.357	-0.121	-0.117	0.521	0.571	0.607	0.369	-0.118
5	0.185	0.272	0.906	0.906	1.000	0.375	-0.121	-0.119	0.725	0.647	0.768	0.411	-0.122
6	-0.043	0.002	0.326	0.357	0.375	1.000	0.017	-0.034	0.221	0.216	0.246	0.549	-0.002
7	-0.016	-0.176	-0.097	-0.121	-0.121	0.017	1.000	0.910	-0.101	-0.067	-0.096	-0.045	0.954
8	0.043	-0.151	-0.099	-0.117	-0.119	-0.034	0.910	1.000	-0.076	-0.084	-0.090	-0.062	0.967
9	0.219	0.279	0.803	0.521	0.725	0.221	-0.101	-0.076	1.000	0.596	0.908	0.343	-0.088
10	0.170	0.178	0.608	0.571	0.647	0.216	-0.067	-0.084	0.596	1.000	0.875	0.337	-0.064
11	0.219	0.261	0.794	0.607	0.768	0.246	-0.096	-0.090	0.908	0.875	1.000	0.381	-0.087
12	0.090	0.142	0.376	0.369	0.411	0.549	-0.045	-0.062	0.343	0.337	0.381	1.000	-0.038
13	0.022	-0.155	-0.103	-0.118	-0.122	-0.002	0.954	0.967	-0.088	-0.064	-0.087	-0.038	1.000

Program three was used to run the factor analysis. This program can be found in Appendix C. First, a correlation matrix was constructed in which each variable was correlated with each other variable. This is found in Table II. Next, the principal axis method of factor analysis was used to obtain factor loadings. The size of the minimum eigenroot extracted was 1.0. Using this procedure, four factors, accounting for 83.01% of the variance, were extracted. The size of the eigenroot and the percentage of the variance extracted by each factor is given in Table III.

TABLE III

EIGENROOTS AND PER CENT OF VARIANCE BEFORE AND AFTER VARIMAX ROTATION

Factor	Eigenroot	Per Cent Variance Principal Axis Method	Per Cent Variance Varimax Rotation
1	5.280	40.61	35.30
2	2.830	21.77	22.39
3	1.547	11.90	12.76
4	1.133	8.71	12.54

The varimax rotation of the principal axis factor loading matrix was then made. The last column of Table III gives the per cent of variance extracted by each factor after the varimax rotation was made. The last column of Table I gives the percentage of communality for each variable used in the factor analysis.

Variable loadings on each factor after using varimax rotation, are given in Table IV. No ambiguous variables were found as each variable loaded on one and only one factor. The lowest significant loading was .750. The highest nonsignificant loading was .305.

TABLE IV

FACTOR LOADINGS AFTER VARIMAX ROTATION

Variable	Factor 1	Factor 2	Factor 3	Factor 4
1	.121	.060	.895	-.022
2	.173	-.143	.870	.042
3	.868	-.042	.169	.194
4	.750	-.079	.009	.305
5	.888	-.068	.098	.276
6	.184	.020	-.081	.874
7	-.063	.969	-.055	.002
8	-.056	.975	-.003	-.042
9	.863	-.028	.158	.057
10	.823	-.015	.044	.061
11	.943	-.025	.118	.067
12	.277	-.014	.105	.801
13	-.060	.990	-.019	.009

Factor Names:
Factor 1: Reading Ability
Factor 2: Effort
Factor 3: Maturity
Factor 4: Rate of Reading

Note: Loadings considered significant are underlined.

The correlations between the variables with significant loadings on each factor were examined. The procedure used for calculating correlation confidence limits about ρ is given in Snedecor and Cochran (1967, 185 f.).[1] First, z, which is later converted to r, was calculated. Calculations:

$N = 407$ $\sigma_z = .0497519$

t_{tab} (two tailed) at .05 level is equal to 1.96.
t_{tab} (two tailed) at .01 level is equal to 2.5758.
t_{tab} (two tailed) at .001 level is equal to 3.2905.

$z = \sigma_z t_{tab \infty df}$

At the .05 level of significance $z = .0497519 \times 1.96 = .09751$.
At the .01 level of significance $z = .0497519 \times 2.5758 = .12815$.
At the .001 level of significance $z = .0497519 \times 3.2905 = .16370$.

The table used for converting z to r was found in Blalock (1960, 456 f.).

At the .05 level of significance, the confidence limit around zero ρ indicating no significant correlation equals ±.0972.[2]

At the .01 level of significance, the confidence limit around zero ρ indicating no significant correlation equals ±.1286.

At the .001 level of significance, the confidence limit around zero ρ indicating no significant correlation equals ±.1623.

Although significant, correlations ranging between ±.0972 and ±.4 are of low order.

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[1]The formula for z is: $z = \sigma_z t_{tab \infty df}$. The formula for calculating is: $\sigma_z = \frac{1}{\sqrt{(N-3)}}$. t_{tab} is found on page 549 of Snedecor and Cochran.

[2]This means that all correlations which are more than +.0972 as well as those which are less than -.0972 are significant.

A correlation of ±.0972 between two variables accounts for less than 1% of the total variation. Even when the correlation is ±.4, the shared variance is still only 16%.

Results of Factor Analysis

Results of the factor analysis shows each of the 13 variables loaded onto one of four factors. There were no ambiguous variables. The four factors were named (1) reading ability, (2) effort, (3) maturity, and (4) rate of reading.

Factor One. Factor one named "reading ability" consisted of six variables considered significant. These are pre-test N-D scores for (1) vocabulary, (2) comprehension, and (3) total reading; and post-test N-D scores for (4) vocabulary, (5) comprehension, and (6) total reading. All correlations between these variables listed in the correlation matrix (Table II) were found to be significant. The correlation and per cent of common variance are given in Table V.

Although some variables are higher than others, all these variables have high correlations to each other.

Factor Two. Factor two is named "effort". Three variables are considered to be significant. These are (1) number of words a student completed, (2) time spent on the study, and (3) number of sessions a student worked. Extremely high significant correlations were found between these variables. A correlation of .910 was found between number of words completed and time spent in the program. A correlation of .954 was found between number of words completed and number of sessions worked. A correlation of .967 was found between time spent in

TABLE V

CORRELATION AND PER CENT OF COMMON VARIANCE BETWEEN SIGNIFICANT VARIABLES OF FACTOR ONE

Variables	r	Common Variance
Pre-test N-D vocabulary scores correlated with:		
Pre-test comprehension	.650	42%
Pre-test total reading	.906	83%
Post-test vocabulary	.803	64%
Post-test comprehension	.608	37%
Post-test total reading	.794	62%
Pre-test N-D comprehsnsion scores correlated with:		
Pre-test total reading	.906	83%
Post-test vocabulary	.521	27%
Post-test comprehension	.571	32%
Post-test total reading	.607	37%
Pre-test N-D total reading scores correlated with:		
Post-test vocabulary	.725	52%
Post-test comprehension	.647	41%
Post-test total reading	.768	58%
Post-test N-D vocabulary scores correlated with:		
Post-test comprehension	.596	35%
Post-test total reading	.908	83%
Post-test N-D comprehension scores correlated with:		
Post-test total reading	.875	76%

the program and number of sessions worked. Almost 83% of the variance of variables 7 and 8 is common variance, 90% of the variance of variables 7 and 13 is common variance, and 92% of the variance of variables 8 and 13 is common variance.

Factor Three. Factor three is named "maturity". Two variables are considered to be significant. These are students' age and grade classification. There was a high significant correlation of .614 between these two variables. This is shown in the correlation matrix given in Table II. Almost 38% of the variance of each of the variables is variance held in common.

Factor Four. Factor four is named "rate of reading". Two variables are considered to be significant. These are pre-test N-D rate scores and post-test N-D rate scores. A significant correlation of .549 was found between these two variables. This is shown in the correlation matrix given in Table II. About 30% of the variance of each of the variables is variance held in common.

Analysis of Covariance

Justification for Technique

In this study, the N-D pre-test taken of each subject before the treatments were applied predicts to some degree the final response on the post-test by each subject. This was indicated by the extremely high correlation obtained between pre-test and post-test scores when the factor analysis was run. (See Appendix D and Factor 1, Table II.)

By using analysis of covariance, one can adjust the post-test

results so as to remove pre-test differences and also obtain a substantially lower experimental error. This allows for more precise comparisons among the treatments. This technique has the further advantage of adjusting for biases. In this study, students were not randomly assigned to classes, used in this study, but rather allowed to select their own. These classes, rather than individual students, were randomly assigned to treatment or control groups. Analysis of covariance adjusts for any bias which may have resulted from this procedure (Snedecor and Cochran, 1967, pp. 419-446).

Procedure

In describing the procedures used, Table VI and Table VII will be referred to. Similar procedures are followed in the other Tables VIII to XIX.

The first step was to compute the means, standard deviation, sums of squares, and products shown in Table VI. Computer program two was used for this purpose. The within groups (error) degrees of freedom are found by subtracting the between groups degrees of freedom from the total degrees of freedom. In similar manner, the sum of x^2, the sum of the xy, and the sum of y^2 are obtained.

The within groups (error) sum of products (Σxy) is the quantity called Exy. The within groups (error) sum of squares of X (Σx^2) is called Exx. The reduction due to regression is Exy^2/Exx with one degree of freedom. By subtracting this quantity from the within groups (error) sum of y^2, the deviations from regression are obtained. This quantity is then divided by the degrees of freedom to obtain the deviation mean square. The next step is to compute β and the adjusted means.

TABLE VI

ANALYSIS OF COVARIANCE, VOCABULARY: GROUPS

1220		1232		Overall
$\underline{T}$(N = 142)	$\underline{C}$(N = 33)	$\underline{T}$(N = 176)	$\underline{C}$(N = 56)	$\underline{(N = 407)}$
$\underline{X}$ = 33.887	$\underline{X}$ = 36.485	$\underline{X}$ = 33.830	$\underline{X}$ = 38.000	$\underline{X}$ = 34.639
$\underline{Y}$ = 37.873	$\underline{Y}$ = 38.303	$\underline{Y}$ = 34.875	$\underline{Y}$ = 39.518	$\underline{Y}$ = 36.838
SDX = 12.013	SDX = 11.117	SDX = 9.227	SDX = 11.834	SDX = 10.898
SDY = 12.978	SDY = 12.636	SDY = 9.793	SDY = 11.729	SDY = 11.633

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	48,337.94	41,120.19	55,073.31
Between Groups	3	940.50	762.67	1,303.28
Within Groups (Error)	403	47,397.44	40,357.52	53,770.03
Reduction due to Regression	1			34,363.23
Deviations from Regression	402			19,406.79

Deviations mean square = 48.2756 b = .8515

$\overline{Y}_1 = 37.873 - (.8515)(33.887-34.639) = 38.513$

$\overline{Y}_2 = 38.303 - (.8515)(36.485-34.639) = 36.731$

$\overline{Y}_3 = 34.875 - (.8515)(33.830-34.639) = 35.563$

$\overline{Y}_4 = 39.518 - (.8515)(38.000-34.639) = 36.656$

$F = \frac{228.7774}{48.2756} = 4.73899$

$p = 0.003$ significant since $p < .1$

Note: X = pre-test score
Y = post-test score
T = treatment
C = control
N = number of subjects
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1$ = adjusted mean of 1220 T
$\overline{Y}_2$ = adjusted mean of 1220 C
$\overline{Y}_3$ = adjusted mean of 1232 T
$\overline{Y}_4$ = adjusted mean of 1232 C

TABLE VII

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
VOCABULARY: GROUPS

Groupings	Degrees of Freedom	Weighted Adjusted Mean of First Group	Weighted Adjusted Mean of Second Group	t-Ratio	Probability
$(\overline{Y}_1 + \overline{Y}_2) - (\overline{Y}_3 + \overline{Y}_4)$	405	38.177 (N = 175)	35.828 (N = 232)	3.36533	0.001
$(\overline{Y}_1 + \overline{Y}_3) - (\overline{Y}_2 + \overline{Y}_4)$	405	36.881 (N = 318)	36.684 (N = 89)	0.23565	0.808
$\overline{Y}_1 - \overline{Y}_2$	173	38.513 (N = 142)	36.731 (N = 33)	1.32299	0.184
$\overline{Y}_2 - \overline{Y}_4$	87	36.731 (N = 33)	36.656 (N = 56)	0.04903	0.959
$\overline{Y}_1 - \overline{Y}_3$	316	38.513 (N = 142)	35.563 (N = 176)	3.75099	<0.001
$\overline{Y}_3 - \overline{Y}_4$	230	35.563 (N = 176)	36.656 (N = 56)	1.02122	0.308

Note: $\overline{Y}_1$ = adjusted mean of 1220 treatment groups
$\overline{Y}_2$ = adjusted mean of 1220 control groups
$\overline{Y}_3$ = adjusted mean of 1232 treatment group
$\overline{Y}_4$ = adjusted mean of 1232 control group
N = number of subjects

Significant level $\leq .05$

$$b = Exy/Exx.$$

The adjusted means are calculated by the following formula as illustrated in the table:

$$\overline{Y}.-b(\overline{X}_1 . - \overline{X}..).$$

This procedure reduces the error term and also adjusts post-test results by pre-test scores.

An F test for significance of difference was computed on the adjusted means. The numerator for the F ratio is obtained by using the formula $Eyy-Exy^2/Exx$, where Eyy is the symbol for deviations from regression. The denominator for the F ratio is deviation mean square. The F ratio and degrees of freedom were used in computer program three to compute the exact probability of no difference, represented by ρ on Table VI.

If the probability of no difference was less than .1, a t-test was run to test the differences between various groupings of the adjusted means. The results are given in Tables VIII to XIX.

In calculating the t-test, a weighting procedure was used to obtain the harmonic mean. This was done because of the complication introduced by the fact groups and classes were of unequal sizes which required that the means being pooled be weighted (Blalock, 1960, p. 61). The weighing was accomplished by the following technique: Suppose the F test called for a test of the difference between groups one and two; three and four:

Y_1 = the adjusted mean for group one

N_1 = the number of subjects in group one

The formula used was:

$$D = \frac{Y_1 N_1 + Y_2 N_2}{N_1 + N_2} - \frac{Y_3 N_3 + Y_4 N_4}{N_3 + N_4} .$$

The results are the numerator for the t-ratio. The denominator for the t-ratio is the deviation mean square. The following formula was used:

$$S_D = \sqrt{\frac{Sy \cdot x^2 \left(1 + \frac{txx}{Exx}\right)}{N_1} + \frac{Sy \cdot x^2 \left(1 + \frac{txx}{Exx}\right)}{N_2}}$$

$Sy \cdot x$ = deviations mean square

txx = treatments mean square for X

$t = \frac{D}{S_D}$

Degrees of Freedom = $N_1 + N_2 - 2$

The exact probability of no difference between the means ($D = 0$) was then computed using computer program three (Snedecor and Cochran, 1967, pp. 419-446).

Results of Analysis of Covariance

Four separate analysis of covariance tests were run to compare the ajusted means of various groups on vocabulary, comprehension, total reading, and rate. Each test used a two by two grouping for comparison. These groups were (1) 1220 treatment, (2) 1220 control, (3) 1232 treatment, and (4) 1232 control.

If the results from this procedure showed the probability of no difference was greater than .1, the null hypothesis was not rejected. If the results showed that the probability of no difference was less than .1, the difference was considered significant. In that case,

t-tests were run to find the source of difference. Six groupings were used in running the t-tests, (1) 1220 groups to 1232 groups, (2) treatment groups to control groups, (3) 1220 treatment to 1220 control, (4) 1220 control to 1232 control, (5) 1220 treatment to 1232 treatment, and (6) 1232 treatment to 1232 control. In using the t-test, a probability of no difference of .05 or less was considered significant and in those cases the null hypothesis of no difference was rejected.

Vocabulary: Groups. An analysis of covariance was run on the pre-test and post-test scores from the vocabulary portion of the N-D. The four groups included were (1) 1220 treatment, (2) 1220 control, (3) 1232 treatment, and (4) 1232 control.

The adjusted mean yielded an F ratio of 4.73899. The probability of no difference between means was 0.003 (see Table VI). This difference was considered significant. Therefore, as it was decided to run t-tests for all probabilities of no difference of .1 or less, six t-tests were run for further analysis to locate the source of difference.

Hypothesis 1 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 and 1232 groups. The harmonic mean of the first group (1220) was 38.177 and for the second group (1232) was 35.828. This is a difference of 2.349 in favor of the 1220 group. The t-test between these two groups yielded a t-ratio of 3.36533. This gave a probability of no difference between means of 0.001 (see Table VII). As this is less than the rejection level of .05, Hypothesis 1 was rejected.

Hypothesis 2 states that there is no significant difference in adjusted mean of vocabulary scores on the N-D between treatment and control groups. The harmonic mean of the first group (treatment) was

36.881 and for the second group (control) was 36.684. This is a difference of .197 in favor of the treatment group. The t-test between these two groups yielded a t-ratio of 0.23565. This gave a probability of no difference between means of 0.808 (see Table VII). As this is higher than the rejection level of .05, Hypothesis 2 was not rejected.

Hypothesis 3 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 treatment and 1220 control groups. The adjusted mean of the first group (1220 treatment) was 38.513 and for the second group (1220 control) was 36.731. This is a difference of 1.782 in favor of the treatment group. The t-test between these two groups yielded a t-ratio of 1.32299. This gave a probability of no difference between means of 0.184 (see Table VII). As this is higher than the rejection level of .05, Hypothesis 3 was not rejected.

Hypothesis 4 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 control groups and 1232 control groups. The adjusted mean of the first group (1220 control) was 36.731 and for the second group (1232 control) was 36.656. This is a difference of .075 in favor of the 1220 control group. The t-test between these two groups yielded a t-ratio of 0.04903. This gave a probability of no difference between means of 0.959 (see Table VII). As this is higher than the rejection level of .05, Hypothesis 4 was not rejected.

Hypothesis 5 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean of the first group (1220 treatment) was 38.513 and for the second group (1232 treatment) was

35.563. This is a difference of 1.092 in favor of the 1220 groups. The t-test between these two groups yielded a t-ratio of 3.75099. This gave a probability of no difference between means of <0.001 (see Table VII). As this is less than the rejection level of .05, Hypothesis 5 was rejected.

Hypothesis 6 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1232 treatment and 1232 control groups. The adjusted mean of the first group (1232 treatment) was 35.563 and for the second group (1232 control) was 36.656. This is a difference of 1.092 in favor of 1232 control. The t-test between these two groups yielded a t-ratio of 1.02122. This gave a probability of no difference between means of 0.308 (see Table VII). As this is higher than the rejection level of .05, Hypothesis 6 was not rejected.

Comprehension: Groups. An analysis of covariance was run on the pre-test and post-test scores from the comprehension portion of the N-D. The four groups included were (1) 1220 treatment, (2) 1220 control, (3) 1232 treatment, and (4) 1232 control.

The adjusted means of group one was 45.101, of group two was 44.443, of group three was 44.990, and of group four was 45.082. The adjusted means yielded an F ratio of 0.05703. The probability of no difference between means was 0.981 (see Table VIII). Hypotheses 7, 8, 9, 10, 11, and 12 stated there is no significant difference in adjusted means of comprehension scores on the N-D between various groups. (See Hypotheses 7-12, p. 10.) As the probability of no difference between means was higher than the rejection level of .1, Hypotheses 7, 8, 9, 10, 11, and 12 were not rejected.

TABLE VIII

ANALYSIS OF COVARIANCE, COMPREHENSION: GROUPS

1220		1232		Overall
$\underline{T}$(N = 142)	$\underline{C}$(N = 33)	$\underline{T}$(N = 176)	$\underline{C}$(N = 56)	(N = 407)
$\underline{X}$ = 36.718	$\underline{X}$ = 43.091	$\underline{X}$ = 37.500	$\underline{X}$ = 41.071	$\underline{X}$ = 38.172
$\underline{Y}$ = 44.408	$\underline{Y}$ = 46.788	$\underline{Y}$ = 44.670	$\underline{Y}$ = 46.464	$\underline{Y}$ = 44.998
SDX = 10.914	SDX = 13.646	SDX = 10.830	SDX = 12.030	SDX = 11.460
SDY = 9.945	SDY = 11.441	SDY = 8.821	SDY = 11.155	SDY = 9.829

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	53,456.00	25,382.75	39,319.25
Between Groups	3	1,648.71	689.43	294.43
Within Groups (Error)	403	51,807.29	24,693.32	39,024.82
Reduction due to Regression	1			11,769.77
Deviations from Regression	402			27,255.04
Deviations mean square = 67.7986		b = .4766		

Adjusted Means

$\overline{Y}_1$ = 44.408 = (.4766)(36.718-38.172) = 45.101
$\overline{Y}_2$ = 46.788 - (.4766)(43.091-38.172) = 44.443
$\overline{Y}_3$ = 44.670 - (.4766)(37.500-38.172) = 44.990
$\overline{Y}_4$ = 46.464 - (.4766)(41.071-38.172) = 45.082

$F = \frac{3.8664}{67.7986} = 0.05703$

p = 0.981 not significant since p > .1

Note: X = pre-test score
Y = post-test score
T = treatment
C = control
N = number of subjects
SD = standard deviations
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1$ = adjusted mean of 1220 T
$\overline{Y}_2$ = adjusted mean of 1220 C
$\overline{Y}_3$ = adjusted mean of 1232 T
$\overline{Y}_4$ = adjusted mean of 1232 C

Total Reading: Groups. An analysis of covariance was run on the pre-test and post-test scores from the total reading portion of the N-D. The four groups included were (1) 1220 treatment, (2) 1220 control, (3) 1232 treatment, and (4) 1232 control.

The adjusted means of group one was 83.959, of group two was 80.169, of group three was 80.628, and of group four was 81.601. The adjusted means yielded an F ratio of 2.10574. The probability of no difference between means was 0.097 (see Table IX). This difference was considered significant. Therefore, as it was decided to run t-tests for all probabilities of no difference of .1 or less, six t-tests were run for further analysis to locate the source of difference.

Hypothesis 13 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1220 and 1232 groups. The harmonic mean of the first group (1220) was 83.245 and for the second group (1232) was 80.863. This is a difference of 2.381 in favor of the 1220 group. The t-test between these two groups yielded a t-ratio of 1.89475. This gave a probability of no difference between means of 0.055 (see Table X). This is exactly the rejection level of .05. Hypothesis 13 was, therefore, not rejected.

Hypothesis 14 states that there is no significant difference in adjusted means of total reading scores on the N-D between treatment and control groups. The harmonic mean of the first group (treatment) was 82.116 and for the second group (control) was 81.070. This is a difference of 1.045 in favor of the treatment group. The t-test between these two groups yielded a t-ratio of 0.69447. This gave a probability of no difference between means of 0.505 (see Table X). As this is higher than the rejection level of .05, Hypothesis 14 was not rejected.

TABLE IX

ANALYSIS OF COVARIANCE, TOTAL READING: GROUPS

1220		1232		Overall
T(N = 142)	C(N = 33)	T(N = 176)	C(N = 56)	(N = 407)
$\bar{X}$ = 70.373	$\bar{X}$ = 79.576	$\bar{X}$ = 71.307	$\bar{X}$ = 79.071	$\bar{X}$ = 72.720
$\bar{Y}$ = 82.275	$\bar{Y}$ = 85.091	$\bar{Y}$ = 79.614	$\bar{Y}$ = 86.161	$\bar{Y}$ = 81.887
SDX = 20.964	SDX = 22.700	SDX = 18.132	SDX = 21.677	SDX = 20.349
SDY = 20.636	SDY = 22.539	SDY = 16.488	SDY = 19.812	SDY = 19.156

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	168,535.00	120,130.00	149,353.00
Between Groups	3	4,944.44	2,681.56	2,292.24
Within Groups (Error)	403	163,590.56	117,448.44	147,060.76
Reduction due to Regression	1			84,321.10
Deviations from Regression	402			62,739.66

Deviations mean square = 156.1688 b = .7179

Adjusted Means

$\bar{Y}$ = 82.275 - (.7179)(70.373-72.720) = 83.959
$\bar{Y}$ = 85.091 - (.7179)(79.576-72.720) = 80.169
$\bar{Y}$ = 79.614 - (.7179)(71.307-72.720) = 80.628
$\bar{Y}$ = 86.161 - (.7179)(79.071-72.720) = 81.601

$F = \frac{328.6399}{156.0688} = 2.10574$

$p = 0.097$ significant since $p < .1$

Note: X = pre-test score
Y = post-test score
T = treatment
C = control
N = number of subjects
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\bar{Y}_1$ = adjusted mean of 1220 T
$\bar{Y}_2$ = adjusted mean of 1220 C
$\bar{Y}_3$ = adjusted mean of 1232 T
$\bar{Y}_4$ = adjusted mean of 1232 C

TABLE X

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
TOTAL READING: GROUPS

Groupings	Degrees of Freedom	Weighted Adjusted Mean of First Group	Weighted Adjusted Mean of Second Group	t-Ratio	Probability
$(\overline{Y}_1 + \overline{Y}_2) - (\overline{Y}_3 + \overline{Y}_4)$	405	83.245 (N = 175)	80.863 (N = 232)	1.89475	0.055
$(\overline{Y}_1 + \overline{Y}_3) - (\overline{Y}_2 + \overline{Y}_4)$	405	82.116 (N = 318)	81.070 (N = 89)	0.69447	0.505
$\overline{Y}_1 - \overline{Y}_2$	173	83.959 (N = 142)	80.169 (N = 33)	0.56242	0.115
$\overline{Y}_2 - \overline{Y}_4$	87	80.169 (N = 33)	81.601 (N = 56)	0.52000	0.610
$\overline{Y}_1 - \overline{Y}_3$	316	83.959 (N = 142)	80.628 (N = 176)	2.35275	0.018
$\overline{Y}_3 - \overline{Y}_4$	230	80.628 (N = 176)	81.601 (N = 56)	0.50530	0.620

Note: $\overline{Y}_1$ = adjusted mean of 1220 treatment groups
$\overline{Y}_2$ = adjusted mean of 1220 control groups
$\overline{Y}_3$ = adjusted mean of 1232 treatment groups
$\overline{Y}_4$ = adjusted mean of 1232 control groups
N = nunber of subjects

Significant level $\leq .05$

Hypothesis 15 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1220 treatment and 1220 control groups. The adjusted mean of the first group (1220 treatment) was 83.959 and for the second group (1220 control) was 80.169. This is a difference of 3.790 in favor of the 1220 treatment group. The t-test between these two groups yielded a t-ratio of 1.56242. This gave a probability of no difference between means of 0.115 (see Table X). As this is higher than the rejection level of .05, Hypothesis 15 was not rejected.

Hypothesis 16 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1220 control and 1232 control groups. The adjusted mean of the first group (1220 control) was 80.169 and for the second group (1232 control) was 81.601. This is a difference of 1.432 in favor of the 1232 control group. The t-test between these two groups yielded a t-ratio of 0.52000. This gave a probability of no difference between means of 0.610 (see Table X). As this is higher than the rejection level of .05, Hypothesis 16 was not rejected.

Hypothesis 17 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean for the first group (1220 treatment) was 83.959 and for the second group (1232 treatment) was 80.628. This is a difference of 3.331 in favor of the 1220 treatment group. The t-test between these two groups yielded a t-ratio of 2.35275. This gave a probability of no difference between means of 0.018 (see Table X). As this is lower than the rejection level of .05, Hypothesis 17 was rejected.

Hypothesis 18 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1232 treatment and 1232 control groups. The adjusted mean for the first group (1232 treatment) was 80.628 and for the second group (1232 control) was 81.601. This is a difference of .973 in favor of the 1232 control group. The t-test between these two groups yielded a t-ratio of 0.50530. This gave a probability of no difference between means of 0.620 (see Table X). As this is higher than the rejection level of .05, Hypothesis 18 was not rejected.

Rate of Reading: Groups. An analysis of covariance was run on the pre-test and post-test scores from the rate portion of the N-D. The four groups included were (1) 1220 treatment, (2) 1220 control, (3) 1232 treatment, and (4) 1232 control.

The adjusted means of group one was 357.625, of group two was 364.386, of group three was 337.505, and of group four was 348.953. The adjusted means yielded an F ratio of 2.39769. The probability of no difference between means was 0.066 (see Table XI). This difference was considered significant. Therefore, as it was decided to run t-tests for all probabilities of no difference of .1 or less, six t-tests were run for further analysis to locate the source of difference.

Hypothesis 19 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 and 1232 groups. The harmonic mean of the first group (1220) was 358.900 and for the second group (1232) was 340.268. This is a difference of 18.631 in favor of the 1220 group. The t-test between these two groups yielded a t-ratio of 2.43722. This gave a probability of no difference between

TABLE XI

ANALYSIS OF COVARIANCE, RATE OF READING: GROUPS

1220		1232		Overall
$\underline{T}$(N = 142)	$\underline{C}$(N = 33)	$\underline{T}$(N = 176)	$\underline{C}$(N = 56)	(N = 407)
$\underline{X}$ = 222.880	$\underline{X}$ = 213.242	$\underline{X}$ = 242.324	$\underline{X}$ = 250.268	$\underline{X}$ = 234.275
$\underline{Y}$ = 349.831	$\underline{Y}$ = 350.000	$\underline{Y}$ = 343.011	$\underline{Y}$ = 359.893	$\underline{Y}$ = 348.280
SDX = 64.998	SDX = 60.513	SDX = 71.360	SDX = 90.148	SDX = 72.346
SDY = 87.300	SDY = 84.438	SDY = 87.119	SDY = 106.718	SDY = 90.088

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	2,130,208.0	1,414,976.0	3,303,168.0
Between Groups	3	58,128.0	-2,256.0	12,093.0
Within Groups (Error)	403	2,072,080.0	1,417,232.0	3,291,075.0
Reduction due to Regression	1			969,338.3
Deviations from Regression	402			2,321,736.6

Deviations mean square = 5775.4644 b = .6840

Adjusted Means

$\overline{Y}$ = 349.831 - (.6840)(222.880-234.275) = 357.625
$\overline{Y}$ = 350.000 - (.6840)(213.242-234.275) = 364.386
$\overline{Y}$ = 343.011 - (.6840)(242.324-234.275) = 337.505
$\overline{Y}$ = 359.893 - (.6840)(250.268-234.275) = 348.953

$F = \frac{13,847.7500}{5,775.4640} = 2.39769$

p = 0.066 significant since p < .1

Note: X = pre-test score
Y = post-test score
T = treatment
C = control
N = number of subjects
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1$ = adjusted mean of 1220 T
$\overline{Y}_2$ = adjusted mean of 1220 C
$\overline{Y}_3$ = adjusted mean of 1232 T
$\overline{Y}_4$ = adjusted mean of 1232 C

means of 0.014 (see Table XII). As this is lower than the rejection level of .05, Hypothesis 19 was rejected.

Hypothesis 20 states that there is no significant difference in adjusted means of rate scores on the N-D between treatment and control groups. The harmonic mean of the first group (treatment) was 346.489 and for the second group (control) was 354.676. This is a difference of 8.186 in favor of the control group. The t-test between these two groups yielded a t-ratio of 0.89410. This gave a probability of no difference between means of 0.624 (see Table XII). As this is higher than the rejection level of .05, Hypothesis 20 was not rejected.

Hypothesis 21 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 treatment and 1220 control groups. The adjusted mean of the first group (1220 treatment) was 357.625 and for the second group (1220 control) was 364.386. This is a difference of 6.761 in favor of the 1220 control group. The t-test between these two groups yielded a t-ratio of 0.45695. This gave a probability of no difference between means of 0.653 (see Table XII). As this is higher than the rejection level of .05, Hypothesis 21 was not rejected.

Hypothesis 22 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 control and 1232 control groups. The adjusted mean for the first group (1220 control) was 364.386 and for the second group (1232 control) was 348.953. This is a difference of 15.432 in favor of the 1220 control group. The t-test between these two groups yielded a t-ratio of 0.92106. This gave a probability of no difference between means of 0.637 (see Table XII). As

TABLE XII

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
RATE OF READING: GROUPS

Groupings	Degrees of Freedom	Weighted Adjusted Mean of First Group	Weighted Adjusted Mean of Second Group	t-Ratio	Probability
$(\overline{Y}_1 + \overline{Y}_2) - (\overline{Y}_3 + \overline{Y}_4)$	405	358.900 (N = 175)	340.268 (N = 232)	2.43722	0.014
$(\overline{Y}_1 + \overline{Y}_3) - (\overline{Y}_2 + \overline{Y}_4)$	405	346.489 (N = 318)	354.676 (N = 89)	0.89410	0.624
$\overline{Y}_1 - \overline{Y}_2$	173	357.625 (N = 142)	364.386 (N = 33)	0.45695	0.653
$\overline{Y}_2 - \overline{Y}_4$	87	364.386 (N = 33)	348.953 (N = 56)	0.92106	0.637
$\overline{Y}_1 - \overline{Y}_3$	316	357.625 (N = 142)	337.505 (N = 176)	2.33610	0.018
$\overline{Y}_3 - \overline{Y}_4$	230	337.505 (N = 176)	348.953 (N = 56)	0.97731	0.669

Note: $\overline{Y}_1$ = adjusted mean of 1220 treatment groups
$\overline{Y}_2$ = adjusted mean of 1220 control groups
$\overline{Y}_3$ = adjusted mean of 1232 treatment groups
$\overline{Y}_4$ = adjusted mean of 1232 control groups
N = number of subjects

Significant level $\leq .05$

this is higher than the rejection level of .05, Hypothesis 22 was not rejected.

Hypothesis 23 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean for the first group (1220 treatment) was 357.625 and for the second group (1232 treatment) was 337.505. This is a difference of 20.119 in favor of the 1220 treatment group. The t-test between these two groups yielded a t-ratio of 2.33610. This gave a probability of no difference between means of 0.018 (see Table XII). As this is lower than the rejection level of .05, Hypothesis 23 was rejected.

Hypothesis 24 states that there is no significant difference in adjusted means of rate scores on the N-D between 1232 treatment and 1232 control groups. The adjusted mean for the first group (1232 treatment) was 337.505 and for the second group (1232 control) was 348.953. This is a difference of 11.448 in favor of the 1232 control group. The t-test between these two groups yielded a t-ratio of 0.97731. This gave a probability of no difference between means of 0.669 (see Table XII). As this is higher than the rejection level of .05, Hypothesis 24 was not rejected.

Vocabulary: Teacher. An analysis of covariance was run on the pre-test and post-test scores from the vocabulary portion of the N-D using the classes from the nine different teachers.

The adjusted means for teacher one was 38.624, for teacher two was 36.121, for teacher three was 38.004, for teacher four was 34.597, for teacher five was 44.559, for teacher six was 34.839, for teacher seven was 37.216, for teacher eight was 34.962, and for teacher nine was

38.650. The adjusted means yielded an F ratio of 5.98777. This gave a probability of no difference between means of <0.001 (see Table XIII). This difference was considered significant. Therefore t-tests were made to locate the source of difference.

Hypothesis 25 states that there is no significant difference in adjusted means of vocabulary scores on the N-D due to the amount of teacher training. Therefore, teachers were divided into two groups by training: group one consisted of teachers working toward a master's degree and group two consisted of teachers working toward a doctoral degree. A t-test was run to compare these two groups. Teachers four, seven, and eight were included in group one and teachers one, two, three, five, six, and nine were included in group two. The harmonic mean of group one was 35.075, of group two was 38.127. This is a difference of 3.052 in favor of group two (doctoral students). The t-test between these two goups yielded a t-ratio of 4.51761. This gave a probability of no difference between means of <0.001 (see Table XIV). As this is lower than the rejection level of .05, Hypothesis 25 was rejected.

Hypothesis 26 states that there is no significant difference in adjusted means of vocabulary scores on the N-D due to the amount of teacher experience. Therefore, teachers were divided into two groups by experience. Group one included teachers just beginning and group two those with one or more years teaching experience at this level. A t-test was run to compare these two groups. Teachers one, two, three, four, and eight were included in group one. Teachers five, six, seven, and nine were included in group two. The harmonic mean of group one was 36.134 and for group two was 38.271. This is a difference of 2.136 in

TABLE XIII

ANALYSIS OF COVARIANCE, VOCABULARY: TEACHER

Teacher	N	$\overline{X}$	$\overline{Y}$	SDX	SDY
T_1	47	35.128	39.043	12.132	13.908
T_2	27	31.556	33.481	8.604	9.315
T_3	46	35.674	38.891	14.053	13.402
T_4	64	34.453	34.438	8.913	9.674
T_5	16	28.438	39.250	8.617	11.355
T_6	31	35.806	35.839	11.784	12.498
T_7	19	35.000	37.526	8.013	10.689
T_8	89	33.921	34.348	10.149	10.692
T_9	68	36.765	40.471	10.875	10.473
Overall	407	34.639	36.838	10.898	11.633

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	48,337.94	41,120.19	55,073.31
Between Groups	8	1,332.52	869.63	2,677.19
Within Groups (Error)	398	47,005.42	40,250.56	52,396.12
Reduction Due to Regression	1			34,466.39
Deviations From Regression	397			17,929.72

Deviations Mean Square = 45.1630 b = .8563

TABLE XIII (Continued)

ADJUSTED MEANS

$\overline{Y}_1 = 39.043 - (.8563)(35.128 - 34.639) = 38.624$

$\overline{Y}_2 = 33.481 - (.8563)(31.556 - 34.639) = 36.121$

$\overline{Y}_3 = 38.891 - (.8563)(35.674 - 34.639) = 38.004$

$\overline{Y}_4 = 34.438 - (.8563)(34.453 - 34.639) = 34.597$

$\overline{Y}_5 = 39.250 - (.8563)(28.438 - 34.639) = 44.559$

$\overline{Y}_6 = 35.839 - (.8563)(35.806 - 34.639) = 34.839$

$\overline{Y}_7 = 37.526 - (.8563)(35.000 - 34.639) = 37.216$

$\overline{Y}_8 = 34.348 - (.8563)(33.921 - 34.639) = 34.962$

$\overline{Y}_9 = 40.471 - (.8563)(36.765 - 34.639) = 38.650$

Note: N = number of subjects
$\overline{X}$ = mean of pre-test scores
$\overline{Y}$ = mean of post-test scores
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1 - \overline{Y}_9$ = adjusted mean of groups for teachers 1-9

$F = \frac{270.4258}{45.1630} = 5.98777$

$p = 0.0000077$

significant since $p < .1$

TABLE XIV

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
VOCABULARY: TEACHER

Groupings	Degrees of Freedom	Weighted Adjusted Means of First Group	Weighted Adjusted Means of Second Group	t-Ratio	Probability
$(\overline{Y}_4+\overline{Y}_7+\overline{Y}_8) - (\overline{Y}_1+\overline{Y}_2+\overline{Y}_3+\overline{Y}_5+\overline{Y}_6+\overline{Y}_9)$	405	35.075 (N = 172)	38.127 (N = 235)	4.51761	<0.001
$(\overline{Y}_1+\overline{Y}_2+\overline{Y}_3+\overline{Y}_4+\overline{Y}_8) - (\overline{Y}_5+\overline{Y}_6+\overline{Y}_7+\overline{Y}_9)$	405	36.134 (N = 273)	38.271 (N = 134)	3.00887	0.003

Note: $\overline{Y}_1-\overline{Y}_9$ = adjusted mean of groups for teachers 1-9

N = number of subjects

Significance level $\leq .05$

favor of group two (more experience). The t-test between these two groups yielded a t-ratio of 3.00887. This gave a probability of no difference between means of 0.003 (see Table XIV). As this is lower than the rejection level of .05, Hypothesis 26 was rejected.

Comprehension: Teacher. An analysis of covariance was run on the pre-test and post-test scores from the comprehension portion of the N-D using the classes from the nine different teachers.

The adjusted mean for teacher one was 46.185, for teacher two was 42.459, for teacher three was 44.947, for teacher four was 44.714, for teacher five was 47.104, for teacher six was 44.566, for teacher seven was 44.507, for teacher eight was 45.017, and for teacher nine was 45.494. The adjusted means yielded an F ratio of 0.57449. This gave a probability of no difference between means of 0.800 (see Table XV).

Hypotheses 27 and 28 stated there was no significant difference in adjusted means of comprehension scores on the N-D due to the amount of teacher training or experience. (See Hypotheses 27 and 28, p. 12.) As the probability of no difference between means was higher than the rejection level of .1, Hypotheses 27 and 28 were not rejected.

Total Reading: Teacher. An analysis of covariance was run on the pre-test and post-test scores from the total reading portion of the N-D using the classes from the nine different teachers.

The adjusted mean for teacher one was 84.480, for teacher two was 77.670, for teacher three was 83.858, for teacher four was 80.401, for teacher five was 92.288, for teacher six was 79.094, for teacher seven was 81.643, for teacher eight was 79.789, and for teacher nine was 84.816. The adjusted means yielded an F ratio of 3.71536. This gave a

TABLE XV

ANALYSIS OF COVARIANCE, COMPREHENSION: TEACHER

Teacher	N	$\overline{X}$	$\overline{Y}$	SDX	SDY
T_1	47	38.468	46.043	10.488	9.403
T_2	27	40.444	43.556	10.475	9.496
T_3	46	36.478	44.130	11.588	10.652
T_4	64	39.281	45.250	10.573	8.189
T_5	16	32.000	44.125	10.909	13.009
T_6	31	39.806	45.355	14.559	10.733
T_7	19	38.211	44.526	9.105	8.101
T_8	89	38.764	45.303	11.532	9.808
T_9	68	37.088	44.971	11.471	10.114
Overall	407	38.172	44.998	11.460	9.829

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	53,456.00	25,382.75	39,319.25
Between Groups	8	1,157.60	133.99	179.99
Within Groups (Error)	398	52,298.40	25,248.76	39,144.26
Reduction Due to Regression	1			12,189.66
Deviations From Regression	397			26,954.60

Deviations Mean Square = 67.8957 b = .4828

TABLE XV (Continued)

ADJUSTED MEANS

$\overline{Y}_1 = 46.043 - (.4828)(38.468 - 38.172) = 46.185$

$\overline{Y}_2 = 43.556 - (.4828)(40.444 - 38.172) = 42.459$

$\overline{Y}_3 = 44.130 - (.4828)(36.478 - 38.172) = 44.947$

$\overline{Y}_4 = 45.250 - (.4828)(39.281 - 38.172) = 44.714$

$\overline{Y}_5 = 44.125 - (.4828)(32.000 - 38.172) = 47.104$

$\overline{Y}_6 = 45.355 - (.4828)(39.806 - 38.172) = 44.566$

$\overline{Y}_7 = 44.526 - (.4828)(38.211 - 38.172) = 44.507$

$\overline{Y}_8 = 45.303 - (.4828)(38.764 - 38.172) = 45.017$

$\overline{Y}_9 = 44.971 - (.4828)(37.088 - 38.172) = 45.494$

Note: N = number of subjects
$\overline{X}$ = mean pre-test score
$\overline{Y}$ = mean of post-test score
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1 - \overline{Y}_9$ = adjusted mean of groups for teachers 1-9

$F = \frac{39.0057}{67.8957} = 0.57449$

$p = 0.8001$

not significant since $p > .1$

probability of no difference between means of <0.001 (see Table XVI). This difference was considered significant. Therefore, t-tests were made to locate the source of difference.

Hypothesis 29 states that there is no significant difference in adjusted means of total reading scores on the N-D due to the amount of teacher training. Teachers were classified as previously: group one, those working toward a master's degree and group two, those working toward a doctorate. Group one consisted of teachers four, seven, and eight and group two consisted of teachers one, two, three, five, six, and nine.

A t-test was made to compare these two groups. The harmonic mean of group one was 80.221 and group two was 83.494. This is a difference of 3.272 in favor of group two (doctoral students). The t-test between these two groups yielded a t-ratio of 2.665. This gave a probability of no difference between means of 0.007 (see Table XVII). As this is lower than the rejection level of .05, Hypothesis 29 was rejected.

Hypothesis 30 states that there is no significant difference in adjusted means of total reading scores on the N-D due to the amount of teacher experience. As previously stated, teachers were classified as group one, beginning teachers, and group two, experienced teachers. Teachers one, two, three, four, and eight were included in group one. Teachers five, six, seven, and nine were included in group two.

A t-test was made to compare these two groups. The harmonic mean of group one was 81.216 and for group two was 83.935. This is a difference of 2.718 in favor of group two (experienced teachers). The t-test between these two groups yielded a t-ratio of 2.10679. This gave a probability of no difference between means of 0.033 (see Table XVII).

TABLE XVI

ANALYSIS OF COVARIANCE, TOTAL READING: TEACHER

Teacher	N	$\overline{X}$	$\overline{Y}$	SDX	SDY
T_1	47	73.553	85.085	20.719	21.370
T_2	27	72.000	77.148	18.020	17.460
T_3	46	71.478	82.957	24.151	21.706
T_4	64	73.703	79.688	17.036	15.376
T_5	16	60.438	83.375	17.783	21.613
T_6	31	75.613	81.194	24.202	22.148
T_7	19	73.211	82.000	15.175	15.788
T_8	89	72.685	79.764	20.018	17.882
T_9	68	73.824	85.618	20.288	18.837
Overall	407	72.720	81.887	20.349	19.156

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	168,535.00	120,130.00	149,353.00
Between Groups	8	2,940.61	-48.88	2,847.23
Within Groups (Error)	398	165,594.39	120,178.88	146,505.77
Reduction Due to Regression	1			87,218.91
Deviations From Regression	397			59,286.85

Deviations Mean Square = 149.3372 b = .7257

TABLE XVI (Continued)

ADJUSTED MEANS

$\overline{Y}_1 = 85.085 - (.7257)(73.553 - 72.720) = 84.480$

$\overline{Y}_2 = 77.148 - (.7257)(72.000 - 72.720) = 77.670$

$\overline{Y}_3 = 82.957 - (.7257)(71.478 - 72.720) = 83.858$

$\overline{Y}_4 = 79.688 - (.7257)(73.703 - 72.720) = 80.401$

$\overline{Y}_5 = 83.375 - (.7257)(60.438 - 72.720) = 92.288$

$\overline{Y}_6 = 81.194 - (.7257)(75.613 - 72.720) = 79.094$

$\overline{Y}_7 = 82.000 - (.7257)(73.211 - 72.720) = 81.643$

$\overline{Y}_8 = 79.764 - (.7257)(72.685 - 72.720) = 79.789$

$\overline{Y}_9 = 85.618 - (.7257)(73.824 - 72.720) = 84.816$

Note: N = number of subjects
$\overline{X}$ = mean of pre-test scores
$\overline{Y}$ = mean of post-test scores
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1 - \overline{Y}_9$ = adjusted mean of groups for teachers 1-9

$F = \frac{554.8411}{149.3372} = 3.71536$

$p < 0.001$

significant since $p < .1$

TABLE XVII

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
TOTAL READING: TEACHER

Groupings	Degrees of Freedom	Weighted Adjusted Means of First Group	Weighted Adjusted Means of Second Group	t-Ratio	Probability
$(\overline{Y}_4+\overline{Y}_7+\overline{Y}_8) - (\overline{Y}_1+\overline{Y}_2+\overline{Y}_3+\overline{Y}_5+\overline{Y}_6+\overline{Y}_9)$	405	80.221 (N = 172)	83.494 (N = 235)	2.66593	0.007
$(\overline{Y}_1+\overline{Y}_2+\overline{Y}_3+\overline{Y}_4+\overline{Y}_8) - (\overline{Y}_5+\overline{Y}_6+\overline{Y}_7+\overline{Y}_9)$	405	81.216 (N = 273)	83.935 (N = 134)	2.10679	0.033

Note: $\overline{Y}_1-\overline{Y}_9$ = adjusted mean of groups for teachers 1-9

N = number of subjects

Significance level $\leq$ .05

As this is lower than the rejection level of .05, Hypothesis 30 was rejected.

Rate of Reading: Teacher. An analysis of covariance was run on the pre-test and post-test scores from the rate portion of the N-D using the classes from the nine different teachers.

The adjusted mean for teacher one was 335.475, for teacher two was 387.281, for teacher three was 361.278, for teacher four was 343.610, for teacher five was 394.176, for teacher six was 355.202, for teacher seven was 354.330, for teacher eight was 340.686, and for teacher nine was 331.538. The adjusted means yielded an F ratio of 2.60948. This gave a probability of no difference between means of 0.008 (see Table XVIII). This difference was considered significant. Therefore, t-tests were made to locate the source of difference.

Hypothesis 31 states that there is no significant difference in adjusted means of rate scores on the N-D due to the amount of teacher training. Again, the groups used earlier for teacher training were employed. Group one consisted of teachers four, seven, and eight working toward a master's degree, and group two consisted of teachers one, two, three, five, six, and nine working toward a doctorate.

A t-test was made to compare these two groups. The harmonic mean of group one was 343.281 and for group two was 351.938. This is a difference of 8.656 in favor of group two (doctoral students). The t-test between these two groups yielded a t-ratio of 1.13976. This gave a probability of no difference between means of 0.253 (see Table XIX). As this is higher than the rejection level of .05, Hypothesis 31 was not rejected.

Hypothesis 32 states that there is no significant difference in

TABLE XVIII

ANALYSIS OF COVARIANCE, RATE OF READING: TEACHER

Teacher	N	$\bar{X}$	$\bar{Y}$	SDX	SDY
T_1	47	197.298	310.276	48.759	89.774
T_2	27	221.852	378.815	51.211	99.533
T_3	46	229.848	358.261	70.445	84.240
T_4	64	251.125	355.094	78.351	82.062
T_5	16	180.000	357.188	32.646	54.176
T_6	31	262.000	374.097	89.251	95.177
T_7	19	277.579	383.842	64.828	72.919
T_8	89	232.146	339.236	73.423	88.437
T_9	68	242.721	337.294	66.878	94.992
Overall	407	234.275	348.280	72.346	90.088

ANALYSIS OF SUMS OF SQUARES AND PRODUCTS

Source	df	Σx^2	Σxy	Σy^2
Total	406	2,130,208.00	1,414,976.00	3,303,168.00
Between Groups	8	198,711.00	98,746.00	160,998.00
Within Groups (Error)	398	1,931,497.00	1,316,230.00	3,142,170.00
Reduction Due to Regression	1			896,952.68
Deviations From Regression	397			2,245,217.31

Deviations Mean Square = 5655.4592 b = .6815

TABLE XVIII (Continued)

ADJUSTED MEANS

$\overline{Y}_1 = 310.276 - (.6815)(197.298 - 234.275) = 335.475$

$\overline{Y}_2 = 378.815 - (.6815)(221.852 - 234.275) = 387.281$

$\overline{Y}_3 = 358.261 - (.6815)(229.848 - 234.275) = 361.278$

$\overline{Y}_4 = 355.094 - (.6815)(251.125 - 234.275) = 343.610$

$\overline{Y}_5 = 357.188 - (.6815)(180.000 - 234.275) = 394.176$

$\overline{Y}_6 = 374.097 - (.6815)(262.000 - 234.275) = 355.202$

$\overline{Y}_7 = 383.842 - (.6815)(277.579 - 234.275) = 354.330$

$\overline{Y}_8 = 339.236 = (.6815)(232.146 - 234.275) = 340.689$

$\overline{Y}_9 = 337.294 = (.6815)(242.721 - 234.275) = 331.538$

Note: N = number of subjects
$\overline{X}$ = mean of pre-test scores
$\overline{Y}$ = mean of post-test scores
SD = standard deviation
df = degrees of freedom
b = slope of the regression line
p = probability of no difference in the population mean
$\overline{Y}_1 - \overline{Y}_9$ = adjusted mean of groups for teachers 1-9

$$F = \frac{14,757.8200}{5,655.4600} = 2.60948$$

$p = 0.008$

significant since $p < .1$

TABLE XIX

WEIGHTED MEANS, t-RATIO, AND PROBABILITY
RATE OF READING: TEACHER

Groupings	Degrees of Freedom	Weighted Adjusted Means of First Group	Weighted Adjusted Means of Second Group	t-Ratio	Probability
$(\overline{Y}_4 + \overline{Y}_7 + \overline{Y}_8) - (\overline{Y}_1 + \overline{Y}_2 + \overline{Y}_3 + \overline{Y}_5 + \overline{Y}_6 + \overline{Y}_9)$	405	343.281 (N = 172)	351.938 (N = 235)	1.13976	0.253
$(\overline{Y}_1 + \overline{Y}_2 + \overline{Y}_3 + \overline{Y}_4 + \overline{Y}_8) - (\overline{Y}_5 + \overline{Y}_6 + \overline{Y}_7 + \overline{Y}_9)$	405	348.552 (N = 273)	347.723 (N = 134)	0.10388	0.913

Note: $\overline{Y}_1 - \overline{Y}_9$ = adjusted mean of groups for teachers 1-9

N = nunber of subjects

Significance level $\leq .05$

adjusted means of rate scores on the N-D due to the amount of teacher experience. The groups used earlier for teacher experience were employed. Group one consisted of teachers one, two, three, four, and eight with no previous experience and group two consisted of teachers five, six, seven, and nine with one or more years experience at this level.

A t-test was run to compare these two groups. The harmonic mean of group one was 348.552 and for group two was 347.723. This is a difference of .829 in favor of group one (no experience). The t-test between these two groups yielded a t-ratio of 0.10388. This gave a probability of no difference between means of 0.913 (see Table XIX). As this is higher than the rejection level of .05, Hypothesis 32 was not rejected.

Summary

Thirteen variables (see Table I) were run in a factor analysis to find which ones correlated with each other. Each variable loaded onto one of four factors. These four factors, which accounted for 83% of the variance are (1) reading ability, (2) effort, (3) maturity, and (4) rate of reading.

Reading ability consisted on all pre- and post-tests of the N-D for vocabulary, comprehension, and total reading. Effort consisted of the number of words a student finished, the amount of time used, and the number of sessions he worked. Maturity consisted of age of students and grade classification. Rate of reading consisted of the pre- and post-test rate scores from the N-D.

Analysis of covariance tests were run to examine the adjusted means of various groups on the four portions of the N-D. This technique was used to adjust post-test scores for initial biases and to reduce

experimental error. When an F ratio yielded a probability of no difference between means of .1 or higher it was not considered significant and the hypotheses were not rejected. When probability of no difference between means was less than .1, t-tests were made between the various groups to locate the source of difference. A t-ratio yielding a probability of no difference between means of .05 was used as the level to reject hypothesis.

Hypotheses 1, 5, 17, 19, 23, 25, 26, 29, and 30 were all rejected at the .05 level of no difference between means. Table XX summarizes the statistical tests for the hypotheses.

TABLE XX

SUMMARY OF STATISTICAL TESTS OF HYPOTHESES

Grouping	Nelson-Denny Test			
	Vocabulary	Comprehension	Total Reading	Rate
1220 and 1232	HO_1 $p = 0.001$	HO_7 N.S.	HO_{13} N.S.	HO_{19} $p = 0.014$
Treatment and Control Groups	HO_2 N.S.	HO_8 N.S.	HO_{14} N.S.	HO_{20} N.S.
1220 Treatment and 1220 Control	HO_3 N.S.	HO_9 N.S.	HO_{15} N.S.	HO_{21} N.S.
1220 Control and 1232 Control	HO_4 N.S.	HO_{10} N.S.	HO_{16} N.S.	HO_{22} N.S.
1220 Treatment and 1232 Treatment	HO_5 $p < 0.001$	HO_{11} N.S.	HO_{17} $p = 0.018$	HO_{23} $p = 0.018$
1232 Treatment and 1232 Control	HO_6 N.S.	HO_{12} N.S.	HO_{18} N.S.	HO_{24} N.S.
Master's and Doctoral Teachers	HO_{25} $p < 0.001$	HO_{27} N.S.	HO_{29} $p = 0.007$	HO_{31} N.S.
Beginning and Experienced Teachers	HO_{26} $p = 0.003$	HO_{28} N.S.	HO_{30} $p = 0.033$	HO_{32} N.S.

N.S. = not significant

$\leq .05$ = level of significance

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Review of the Study

Reviewing literature and studies on reading improvement at the college level revealed a lack of substantial information on improvement in vocabulary. However, in working with college students, it was noted this area was unlikely to show significant improvement. Therefore, this study was conducted to test an educationally sound method of vocabulary improvement designed for college students.

This study was conducted during the fall semester of 1971 at Oklahoma State University using a sample population of 407 students from the Reading Improvement (1220) and Study Skills (1232) classes. Classes from both 1220 and 1232 were randomly assigned to experimental and control groups. All students were given vocabulary improvement instruction. Pre- and post-tests using the Nelson-Denny Reading Tests were given to all the students to allow analysis of adjusted means of the groups before and after treatment.

Students in experimental classes worked twice a week using periodical materials. They located words, guessed at the meaning, and used dictionaries to check the meaning. Each student chose his own words, based on his knowing something about the word and yet not actually being able to define it.

After the initial vocabulary instruction control groups received no

additional help with vocabulary unless they asked for it. (Note: no student in the control groups asked for help.)

A factor analysis was made on thirteen variables to investigate their interrelationships and to identify underlying factors. Four factors were identified. All the variables loaded heavily onto one of these four factors. These factors were named reading ability, effort, maturity, and rate of reading.

Analysis of covariance tests were made to analyze the adjusted means between the various groups. If results of the F ratio yielded a probability of no difference between means of less than .1, it was considered significant and t-tests were made to analyze groups more precisely to discover the source of difference. Results for all these tests are given in Chapter IV.

Nine hypotheses of no difference between adjusted means were rejected at the .05 level of probability of no difference between population means.

Conclusions

Factor Analytic Technique

The factor analysis made on the thirteen variables listed in Table I indicated that each of the variables loaded onto only one of four factors. These factors which accounted for 83% of the variance, were named (1) reading ability, (2) effort, (3) maturity, and (4) rate of reading.

Six tests loaded onto factor one, "reading ability". These were the pre-test and post-test scores for vocabulary, comprehension, and total reading on the N-D.

Although the amount of correlation varies, all six tests correlate highly with each other. One would expect pre- and post-test scores measuring the same skill to be highly correlated. This is true here. Also, as expected, vocabulary and comprehension correlate highly with total reading. However, the high correlations found between vocabulary and comprehension scores were not expected, as these are supposedly measuring different abilities.

This indicates that one common factor, here labeled "reading ability", underlies the comprehension and vocabulary portions of the N-D rather than two distinct reading abilities. This supports partially Thurstone's findings in reanalysis of the Davis' Reading Tests. One common factor was found to underlie all nine tests (Thurstone, 1946).

Three factors loaded onto factor two, named "effort". These were (1) number of words a student finished; (2) time, in minutes, spent on the study; and (3) number of sessions a student worked. Correlations between these variables were extremely high, all above .91. More than 83% of the variance of these variables was variance held in common.

This indicates that students who finished more words also spent more time working. Also, students who worked more, attended more sessions. This would indicate some students are willing to put forth more effort in their courses.

Two variables had significant loadings on factor three, named "maturity". These were students' age and students' grade classification. Almost 83% of the variance of these was common variance.

Although this may not always be true, factor three shows that for the sample used in this study freshmen tended to be younger than upper classmen.

Two variables loaded onto factor four, named "rate of reading". These were the pre-test and post-test rate scores from the N-D.

This indicates students who read faster at the beginning of the semester tend to end up faster readers at the end. This was definitely the case for the sample used in this study.

It is of interest that neither the pre-test nor post-test rate scores loaded on factor one "reading ability". Relatively low correlations in the .3 to .4 range were found when examining the correlation matrix and the six comprehension, vocabulary, and total reading variables. This data suggests a distinct ability, not highly related to other reading abilities, is measured when reading rate is measured. (Note: Davis' set of tests did not include a test for rate.) This finding certainly does not support many reading improvement programs which use rate as the core of their programs. This also supports Townsend's statement about using care in the interpretation of rate based on a test of less than four minutes and not on word count (Townsend, 1968).

Analysis of Covariance

Due to the high correlation between pre- and post-test scores and the lack of random assignment of students to classes, it was imperative to use analysis of covariance to compare the groups for hypotheses testing (Snedecor and Cochren, 1967). This procedure adjusts post-test scores to compensate for pre-test differences and lowers experimental error. Therefore, a more precise comparison of groups can be made.

Tests of analysis of covariance were run on the four portions of the N-D between various groups. The four portions were vocabulary,

comprehension, total reading, and rate. The groups were 1220 treatment, 1220 control, 1232 treatment, and 1232 control; beginning teachers, experienced teachers, master's level teachers, and doctoral level teachers. When the F ratio from the analysis of covariance yielded a probability of no difference between means of .1 or higher, hypotheses for these groups were not rejected. When the F ratio yielded a probability of no difference between means lower than .1, t-tests were run between all groups for that variable to locate the source of difference. When the t-ratio yielded a probability of no difference between means of .05 or higher, the hypothesis was not rejected. When the t-ratio yielded a probability of less than .05, the hypothesis was rejected. Therefore, Hypotheses 1, 5, 17, 19, 23, 25, 26, 29, and 30 were rejected at the probability of less than .05 level of no difference between means.

Hypothesis 1 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 and 1232 groups. The harmonic adjusted mean for the 1220 group was 38.177 and for the 1232 group was 35.828. The t-test of the difference between means, (2.349), resulted in a probability of no difference in the population mean of 0.001. Therefore, Hypothesis 1 was rejected. Reading Improvement, 1220 groups, did significantly better than Study Skills, 1232 groups, in vocabulary on the N-D.

Hypothesis 5 states that there is no significant difference in adjusted means of vocabulary scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean for the 1220 group was 38.513, and for the 1232 group was 35.563. The t-test of the difference between means, (2.949), resulted in a probability of no difference

in the population mean of <0.005. Therefore, Hypothesis 5 was rejected. Treatment groups of 1220 did significantly better than treatment groups of 1232 in vocabulary on the N-D.

Hypothesis 17 states that there is no significant difference in adjusted means of total reading scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean for the 1220 group was 83.959 and for the 1232 group was 80.628. The t-test of the difference between means, (3.331), resulted in a probability of no difference in the population mean of 0.018. Therefore, Hypothesis 17 was rejected. Treatment groups of 1220 did significantly better than treatment groups of 1232 in total reading on the N-D.

Hypothesis 19 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 and 1232 groups. The harmonic adjusted mean for the 1220 groups was 358.900 and for the 1232 groups was 340.268. The t-test of the difference between means, (18.631), resulted in a probability of no difference in the population mean of 0.014. Therefore, Hypothesis 19 was rejected. Reading Improvement, 1220 groups, did significantly better than Study Skills, 1232 groups, on rate on the N-D.

Hypothesis 23 states that there is no significant difference in adjusted means of rate scores on the N-D between 1220 treatment and 1232 treatment groups. The adjusted mean for the 1220 group was 357.625, and for the 1232 group was 337.505. The t-test of the difference between means, (20.119), resulted in a probability of no difference in the population mean of 0.018. Therefore, Hypothesis 23 was rejected. Treatment groups of 1220 did significantly better than treatment groups of 1232 in rate on the N-D.

Table XXI summarizes the means and exact probability of the rejected null hypotheses for groups.

TABLE XXI

SUMMARY OF MEANS AND EXACT PROBABILITY OF REJECTED GROUP HYPOTHESES

Hypothesis (Variable)	$\bar{X}$ Adjusted of Groups	Exact Probability
HO_1 (Vocabulary)	(1220) 38.177 (1232) 35.828	p = 0.001
HO_5 (Vocabulary	(1220T) 38.513 (1232T) 35.563	p < 0.005
HO_{17} (Total Reading)	(1220T) 83.959 (1232T) 80.628	p = 0.018
HO_{19} (Rate)	(1220) 358.900 (1232) 340.268	p = 0.014
HO_{23} (Rate)	(1220T) 357.625 (1232T) 337.505	p = 0.018

Note: T = treatment groups $\bar{X}$ = mean

Level of significance for $p \leq .05$

There is a significant difference in favor of 1220 classes for all the hypotheses rejected and this difference favors 1220 treatment groups. All 1232 and control groups fail to show any significant difference. This suggests that the treatment was successful with students enrolled in 1220, the Reading Improvement classes. Apparently, students

in these classes were concerened with improving their reading skills and accepted the importance of vocabulary; whereas, students enrolled in 1232, the Study Skills classes, did not accept vocabulary as an important goal for improvement of study techniques. This supports the idea of being sensitive to student goals when planning the objectives for a course. Although students appeared to be conscientiously working in all the classes, the findings of this study would indicate the procedure used was not profitable for the Study Skills classes.

However, it should also be noted here that the Reading Improvement, 1220, classes are non-credit and the attrition rate is high. Even with some students failing or dropping college, 1232 classes experienced a 9% drop while there was a 38% drop in 1220 classes. This accounts for part of the higher scores for the 1220 group, as only the most interested students finished the course. It would reduce the attrition rate and encourage students to finish if credit were given for this course.

All hypotheses concerning comprehension in this study failed to test statistically significant and so the null hypothesis of no difference between means was not rejected. Neither classes nor treatments nor teachers had a significant effect on comprehension in this study.

Hypotheses 25 to 32 tested teacher variable as to training and experience. Teachers were divided into two groups on training, those working on a master's degree in group one and those working on a doctor's degree in group two. Teachers were also divided into two groups on experience, those beginning work with college students in group one and those with one or more years of experience at this level in group two.

Hypothesis 25 states that there is no significant difference in

adjusted means of vocabulary scores on the N-D due to the amount of teacher training. The harmonic adjusted mean of group one, (master students), was 35.075 and for group two, (doctoral students), was 38.127. The t-test of the difference between means, (3.052), resulted in a probability of no difference in the population mean of <0.005. Therefore, Hypothesis 25 was rejected. Doctoral students did a significantly better job of teaching vocabulary than did master's students.

Hypothesis 26 states that there is no significant difference in adjusted means of vocabulary scores on the N-D due to amount of experience. The harmonic adjusted mean of group one, (beginning teachers), was 36.134 and for group two, (experienced teachers), was 38.271. The t-test on the difference between means, (2.136), resulted in a probability of no difference in the population mean of 0.003. Therefore, Hypothesis 26 was rejected. Teachers with one or more years experience did a significantly better job of teaching vocabulary than did inexperienced teachers.

Hypothesis 29 states that there is no significant difference in adjusted means of total reading scores on the N-D due to the amount of teacher training. The harmonic adjusted mean of the first group, (master's students), was 80.221 and for the second group, (doctoral students), was 83.494. The t-test on the difference between means, (3.272), resulted in a probability of no difference in the population mean of 0.007. Therefore, Hypothesis 29 was rejected. Doctoral students did a significantly better job of teaching reading than did master's students.

Hypothesis 30 states that there is no significant difference in adjusted means of total reading scores on the N-D due to the amount of

teacher experience. The harmonic adjusted mean of the first group, (beginning teachers), was 81.216 and for the second group, (experienced teachers), was 83.935. The t-test on the difference between means, (2.718), resulted in a probability of no difference in the population mean on 0.033. Therefore, Hypothesis 30 was rejected. Teachers with one or more years experience did a significantly better job of teaching reading than did inexperienced teachers.

Table XXII summarizes the means and exact probability of the rejected null hypotheses for teachers.

TABLE XXII

SUMMARY OF THE MEANS AND EXACT PROBABILITY OF REJECTED TEACHER HYPOTHESES

Hypothesis (Variable)	$\bar{X}$ Adjusted of Groups	Exact Probability
HO_{25} (Vocabulary)	(M) 35.075 (D) 38.127	$p < 0.005$
HO_{26} (Vocabulary)	(B) 36.134 (E) 38.271	$p = 0.003$
HO_{29} (Total Reading)	(M) 80.221 (D) 83.494	$p = 0.007$
HO_{30} (Total Reading)	(B) 81.216 (E) 83.935	$p = 0.033$

Note: $\bar{X}$ = mean

M = master's teachers

D = doctoral teachers

B = beginning teacher

E = experienced teacher

Level of significance $p \leq .05$

Teacher training and experience made an extremely significant impact on student achievement in this study, much more than class or treatment. Also, teacher training made more than ten times the impact of teacher experience on student achievement. This not only indicates the importance of these two variables, but strongly supports the importance of upgrading our schools. If teacher training has such a tremendous influence at this level where students are very much on their own, it should have an even greater effect with students in the lower levels of our schools. It would, therefore, be advisable to use every available resource to encourage teachers at all levels to acquire more training.

The difference between means of rate for groups taught by different teachers was not significant. This is quite interesting in view of the factor analysis findings of this study which indicates rate has little in common with the other parts of the test. This suggests rate scores, at least as far as this test, can be easily improved by the very inexperienced as readily as the experienced teacher. However, more experience and training enable a teacher to do a better job of teaching reading skills.

To summarize, there were several important conclusions of this study. One factor appears to underlie the vocabulary, comprehension, and total reading scores on the N-D. Rate was a factor by itself and appears to have little correlation to other reading abilities. The method used in this study was more effective for 1220 groups and 1220 treatment groups. A good part of this success, no doubt, is due to the goals students set for themselves in these classes. The last conclusion is that teacher training and experience has a tremendous influence upon

student achievement and it is, therefore, considered imperative to use all available resources to encourage teachers to continue their training after college.

Recommendations

Practical Recommendations

Results of this study strongly suggest several recommendations for educational institutions. First, Reading Improvement could be given status as a credit course to encourage students to finish, as it appears to fulfill its purpose. It could well be used as a prerequisite or concurrent course to Study Skills. Second, the method used in this study was effective in increasing vocabulary and, therefore, further possibilities of its use should be explored. Third, the method was mostly successful in the 1220 classes which suggests one look very closely to student rather than teacher goals for courses at this level. Finally, the extremely effective impact of teacher training on student achievement suggests one do all in his power to encourage and make available additional training for all teachers.

Methodological Recommendations

The use of a factor analytic technique appears to be a promising method in analyzing correlation of variables within a program and the amount of common variance between them. This could reduce duplication of effort and testing.

Analysis of covariance is a valuable method in education where groups are seldom equal in size and abilities and where complete

randomization of subjects is impossible This allows post-test scores to be adjusted to compensate for pre-test biases; lowering the experimental error and giving a more precise comparison between group means.

Theoretical Recommendations

The method developed here is based on the idea of improving vocabulary using words already partially known by working in materials students enjoy This is not only educationally sound, but in all probability will continue after the students are out of college. Although the method was successful, the study indicates that vocabulary should be developed on an individual basis, taking into account each students interest, background, and ability.

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APPENDIX A

INSTRUCTIONS

OUTLINE OF LECTURE TO TEACHERS

Vocabulary Improvement

I. Types of vocabulary.

A. Receptive: listening, reading
B. Expressive: writing, speaking

II. Growth of vocabulary: Edgar Dale

/_____/ continuum
Step 1. cognizant of word
Step 2. hazy area of "twilight zone"
Step 3. usable, can write or speak word

III. Why improve vocabulary?

A. Each year of college demands some 300-500 new technical terms in each area, plus a greater number of general terms. This gives a weekly load of 50-60 new words.
B. Reading quickly and effectively requires a large vocabulary.
C. Your vocabulary tells something about you.

IV. Ways to improve.

A. Underline words: books, magazines; focus your attention and guess at the meaning. Check your guess the next time you use the word. If necessary, check the dictionary.
B. Word file or lists: Collect from lectures, books, texts; file by subject; review daily, before written assignments, and tests.
C. First hand experiences: increases range and depth; movies, talking with others, exhibits, working, political activities, hikes, etc. Learn something new; cooking, football, gardening, etc.
D. Work a little each day: Set a goal of 5-10 new words.
E. Read More: gives variety of meanings.
F. Use the new words: in conversation or writing.
G. Read aloud: improves pronunciation and calls attention to the whole word.
H. Learn word parts: roots, prefixes, suffixes, and meanings.
I. Develop interest in word origins: Laird, The Miracle of Language; Funk, Word Beginnings and Their Romantic Stories; Myers, The Foundations of English; Funk, Thirty Days to a More Powerful Vocabulary.
J. Use the dictionary: Learn the diacritical markings and how to pronounce words. Learn a few rules to help here.

V. Summary:

Be aggressive, notice words and meanings, set a goal of the number of new words to add daily.

INSTRUCTION SHEET TO STUDENTS

Procedures:

1. Select a magazine or newspaper.
2. Skim quickly to identify five words in your "twilight zone".
3. Write the sentence or phrase the word appears in and underline the word.
4. In parenthesis after each sentence write your meaning of the word. If you do not know, put a question mark.
5. Check the meaning with your dictionary. If your guess is correct, leave it. If your guess is wrong, draw a line through it and write a correct definition in your own words using the dictionary as a guide.

Notes:

1. Write the time you begin and finish the exercise. After 20 minutes, time will be called and you must proceed to other material even if you have not finished five words. You may take less time.
2. You are to do this exercise two periods each week. Date each sheet you use.
3. You may use more than one word in a sentence.
4. Do not use names of people and organizations.
5. The meaning of your word must be correct for the context in which it is used.

Examples:

1. This documentary examines (~~program~~)(report based on actual data collected)
2. Sports are a reflection of American attitudes, values, and prejudices. (mirror-eg. to show what is true)

APPENDIX B

SAMPLE WORK SHEETS AS COMPLETED BY STUDENTS

Name: _____ Course & Section 11
Material Used Saturday Review Date Oct. 19, 1972
Beginning Time 1:30 Ending Time 1:45 Total Time 15 minutes.

1. a victory that led to a powerful conglomerate's losing the license for its television station. (opposition) a mass; a single mass

2. Washington lawyers, respectful of the UCC's dedication, sophistication, and clout, advise many licensees to negotiate & settle. (?) to strike; hit

3. Not for them the fervor of flag-waving and patriotic speeches. (excitement) ardor; zeal; great warmth of emotion.

4. But there is another dimension to this resurgent nationalism: fear. (upcoming) rising or tending to rise

5. On one side are the "nationalist" academics, a vociferous, loosely organized minority. (?) noisy, clamorous

~~Life - Sept 10, 1971~~ 1:30 October 26 11 1:45 15 min

1) organized labor has abandoned its initial ~~bellicosity~~ (rebellion)

2) liberal benefits and extra amenities ~~(allowances)~~
attractive features

3) help us solve our horrendous problem (horrible)

4) company reacted with exemplary candor ~~(understanding)~~
serving as a model or example

5) Even more vociferously anti-American candidate
~~(ferociously?)~~
noisily or clamorously

Name: _____ Course & Section: 032 sec. 7

Material Used: Time Date: 12/1/71

Beginning Time: 1:37 Ending Time: 1:55 Total Time: 18 min.

A. This fall some of the south's most recalcitrant school district, (radical, & seperate to race) not response of handleing.

B. whose two other children also attend bi-racial schools. (Black & white)

C. desegregation as palatable as possible. (quiet & quick) agreeable to Be mind.

D. White Exodus. (Activists)

A mass departure

E. A consortium of Mississippi Courts, (a not ending, lots, many) associate & society.

APPENDIX C

CODED COMPUTER PRINT-OUT OF RAW DATA

80/80 LIST PAGE 001

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     00000000011111111112222222222333333333344444444445555555555666666666677777777778
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0001 C  DATA DECK OF MINNIE GNEWUCH
0002 C  DATA ARRANGEMENT 1(F6),24(F3)
0003 C  CLASS AND STUDENT NUMBER
0004 C      COL.3&4=CLASS;NO.11-27=1220(READ.IMP),NO.51-63=1232(STUDY SKILLS)
0005 C      COL.5&6=STUDENT NO. IN a SECTION
0006 C  COL.7-9= TEACHER NUMBER
0007 C  COL.10-12=AGE
0008 C  COL.13-15=SEX; 1=M, 2=F
0009 C  COL.16-18=COLLEGE CLASS: 1=FROSH, 2=SOPH, 3=JR, 4=SR & OTHERS
0010 C  N-D PRETEST RAW SCORES
0011 C      COL.19-21=VOCABULARY
0012 C      COL.22-24=COMPREHENSION
0013 C      COL.25-27=TOTAL READING
0014 C      COL.28-30=RATE
0015 C  COL.31-33=NUMBER OF WORDS ATTEMPTED
0016 C  COL.34-36=TIME USED IN STUDY IN MINUTES
0017 C  N-D POSTTEST RAW SCORES
0018 C      COL.37-39=VOCABULARY
0019 C      COL.40-42=COMPREHENSION
0020 C      COL.43-45=TOTALREADING
0021 C      COL.46-48=RATE
0022 C  COL.49-51=COLLEGE; 1=AG, 2=AS, 3=BU, 4=ED, 5=EN, 6=HE, 7=VM, 8=GR, 9=TI
0023 C  COL.52-54=NO. OF SESSIONS STUDENT WORKED IN TREATMENT
0024 C  %TILE OF PRETEST SCORES
0025 C      COL.55-57=VOCABULARY
0026 C      COL.58-60=COMPREHENSION
0027 C      COL.61-63=TOTAL READING
0028 C      COL.64-66=RATE
0029 C  %TILE OF POSTTEST SCORES
0030 C      COL.67-69=VOCABULARY
0031 C      COL.70-72=COMPREHENSION
0032 C      COL.73-75=TOTAL READING
0033 C      COL.76-78=RATE
0034       1101  1 17  1  1 33 42 75235       41 46 87338  5     40 53 48 52 65 63 65 83
0035       1103  1 18  1  1 29 34 63129       29 44 73297  1     30 32 30  9 37 57 46 66
0036       1105  1 18  1  1 46 44 90177       49 52101298  2     73 59 68 21 80 78 80 70
0037       1106  1 18  1  1 45 42 87195       47 50 97407  2     71 53 64 31 77 74 76 93
0038       1107  1 18  2  1 24 50 74177       30 40 70287  3     19 74 46 21 39 45 42 66
0039       1108  1 18  2  1 31 32 63195       37 46 83318  2     34 28 30 31 57 63 60 78
0040       1109  1 17  1  1 24 46 70165       37 46 83238  5     19 64 40 17 57 63 60 44
0041       1110  1 18  1  1 59 46105269       71 60131639  2     91 64 83 65 98 92 96 99
0042       1111  1 18  1  1 52 58110188       55 64119298  2     84 88 87 26 89 97 93 70
0043       1112  1 18  1  1 28 32 60129       33 42 75298  1     27 28 26  9 47 51 49 70
0044       1114  1 17  1  1 29 44 73141       35 54 89262  2     30 59 45 11 52 82 68 56
0045       1116  1 18  1  1 28 46 74279       31 18 49338  5     27 64 46 69 42  5 16 83
0046       1201  1 18  2  1 30 30 60153110330 35 38 73250  4 22 32 23 26 14 52 40 46 50
0047       1202  1 18  1  1 31 18 49188 20 80 44 38 82396  3  4 34  6 14 26 71 40 59 92
0048       1203  1 18  2  1 27 34 61188110370 31 46 77226  2 22 25 32 28 26 42 63 52 38
0049       1204  1 18  1  1 30 34 64141 63333 47 44 91371  6 20 30 32 32 11 77 57 70 89
0050       1205  1 18  2  1 34 36 70245114277 32 54 86396  6 21 42 37 40 57 44 82 64 92
0051       1207  1 18  1  1 25 16 41129 41173 27 30 57207  2 10 20  5  9  9 31 21 25 26
0052       1208  1 18  1  1 40 46 86177 40135 38 50 88287  3  8 58 64 62 21 59 74 67 66
0053       1209  1 18  2  1 61 60121226 94339 80 68148396  4 19 93 90 93 48 99 99 99 92
0054       1210  1 18  1  1 11 26 35195 88355 20 36 56275  5 18  3 16  6 31 16 35 23 62
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      0000000001111111111222222222233333333334444444444555555555566666666677777777778
      1234567890123456789012345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0055    1211  1 18  2  1 27 26 53195 85245 28 40 68216  6 17 25 16 18 31 34 45 39 32
0056    1213  1 18  2  1 43 30 73257 99403 37 52 89275  6 22 66 23 45 61 57 78 68 62
0057    1214  1 24  1  3 35 40 75117 97295 39 44 83298  2 19 18 24 20  5 35 37 30 50
0058    1215  1 18  2  1 31 34 65195115366 34 48 82359  2 23 34 32 33 31 50 68 59 87
0059    1216  1 19  1  1 23 30 53269105310 25 40 65359  3 21 17 23 18 65 26 45 35 87
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0279    5410  8 17  2  1 16 24 40309 75210 12 36 48327  4 15  7 13  8 79  4 35 15 80
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0283    5415  8 19  1  2 42 48 90203104352 47 50 97275  2 21 47 58 53 30 62 59 60 50
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0378    5913  4 18  1  1 42 36 78245100119 37 54 91501  2 20 63 37 52 57 57 82 70 98
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0429    6218  8 18  1  1 25 28 53177 59290 26 48 74318  2 15 20 19 18 21 28 68 48 78
0430    6219  8 19  2  1 28 44 72235 91280 26 50 76275  2 19 27 59 43 52 28 74 51 62
0431    6220  8 20  1  3 46 50 96245 74300 50 52102359  2 15 47 54 50 45 62 62 62 76
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APPENDIX D

COMPUTER PROGRAMS

PROGRAM ONE

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                                        80/80 LIST                                                    PAGE 001

     00000000011111111112222222222333333333344444444445555555555666666666777777777 8
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0001  //MMG1   JOB (12133,499-34-9670,1),'MINNIE GNEWUCH'
0002  /*ROUTE  PRINT HOLD
0003  // EXEC FORTGCLG
0004  //FORT.SYSIN DD *
0005  C      FACTOR ANALYSIS PROGRAM
0006  C      INTERCORRELATION AND FACTOR ANALYSIS CONTROL PROGRAM
0007  C      PARAMETER CONTROL-CARD FIELDS.
0008  C      COL 1-5. NUMBER OF VARIABLES (MAX=12).
0009  C      COL 6-10. NUMBER OF SUBJECTS (MAX=30 FOR TORS OPTION ONLY).
0010         DIMENSION KF(20), R(40,40), V(40,40), W(40,40), X(40), Y(40),
0011        1 Z(40), KS(40), A(40),S(40)
0012         ND=40
0013       5 CALL CODS (KF, NV, NS, KA, KB, KC)
0014         K11=KA/10000
0015         K12= MOD (KA/1000,10)
0016         K13= MOD (KA/100,10)
0017         K14= MOD (KA/10,10)
0018         K15= MOD (KA,10)
0019         KEV=KB/1000
0020         K18= MOD (KB/100,10)
0021         K19= MOD (KB/10,10)
0022         K20= MOD (KB,10)
0023         K21= KC/10000
0024         K22= MOD (KC/1000,10)
0025         K23= MOD (KC/100,10)
0026         VN=NV
0027         CALL CORS (NS, NV, R, A, S, KF, ND)
0028         CALL PRTS (A, NV, 1, 'MEAN','S.__', ND)
0029         CALL PRTS (S, NV, 1, 'SIGM','AS._', ND)
0030         IF (K13 .EQ. 1) CALL PRTS (R, NV, NV,'R_MA','TRIX', ND)
0031  C      PRINCIPAL-AXIS ANALYSIS.
0032         NF=NV
0033         C=KEV
0034         IF (KEV .LE. 1) GO TO 90
0035         NF=KEV
0036         C= 0.0
0037      90 CALL SEVS (NV, NF, C, R, V, X, Y, ND)
0038         CALL PRTS (X, NF, 1, 'EIGN','ROOT', ND)
0039         CALL PRTS (Y, NF, 1, 'PC_T','RACE', ND)
0040         IF (K18 .EQ. 1)CALL PRTS(V, NV, NF, 'P_AX','LOAD', ND)
0041  C      COMPUTE PRINCIPAL-AXIS FACTOR-SCORE WEIGHTS.
0042         DO 95 J= 1,NF
0043         DO 95 I = 1,NV
0044      95 R(I,J)=V(I,J)/X(J)
0045         IF (K19 .EQ. 1) CALL PRTS (R, NV, NF, 'PRAX','_WTS', ND)
0046         IF (K19 .EQ. 1) CALL PRTS (R, NV, NF, 'PRAX','_WTS', ND)
0047  C      ADJUST PA WEIGHTS FOR MODIFYING VARIMAX LOADINGS
0048    130 DO 135 J = 1,NF
0049         DO 135 I = 1,NV
0050    135 R(I,J)=R(I,J)/X(J)
0051         CALL AXBS (R, V, W, NV, -NV, NF, ND)
0052  C      VARIMAX ROTATION OF PRINCIPAL AXES.
0053         CALL VORS (NV, NF, V, X, Y, Z, ND)
0054         CALL PRTS (X, NF, 1, 'PCT_','VAR.', ND)
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CARD
0055          CALL PRTS (Y, NV, 1, 'PCT_','COMM', ND)
0056          IF (K21 .EQ. 1) CALL PRTS (V, NV, NF, 'VMAX','LOAD', ND)
0057          IF (K22 .EQ. 1) CALL PRTS (R, NV, NF, 'VMAX','_WTS', ND)
0058  C       COMPUTE VARIMAX FACTOR-SCORE WEIGHTS AND FACTOR SCORES.
0059          CALL AXBS (W, V, R, NV, NF, NV, ND)
0060          GO TO 5
0061          STOP
0062          END
0063          SUBROUTINE CODS (KF,KI,KJ,KK,KL,KM)
0064          DIMENSION KF(20), KH(20)
0065          READ(5,5)KH
0066        5 FORMAT(20A4)
0067          IF (KH(1).EQ.KH(2)) STOP
0068          READ(5,10) KI,KJ,KK,KL,KM,KF
0069       10 FORMAT(5I5 / 20A4)
0070          WRITE(6,15)KH,KI,KJ,KK,KL,KM,KF
0071       15OFORMAT('1',20A4 // ' PARAMETERS'/ ' COL  1-5=', I5 /
0072       151 ' COL 6-10 =', I5 / ' COL 11-15 =', I5 / ' COL 16-20 =',
0073         2 I5 / ' COL 21-25 =', I5 // ' DATA FORMAT =',20A4)
0074          RETURN
0075          END
0076          SUBROUTINE SEVS (NV, NF, C, R, V, E, P, ND)
0077          DIMENSION R(ND,NV), V(ND,NF), E(NF), P(NV)
0078  C       COMPUTE TRACE.
0079          T=0.
0080          DO 5 I=1,NV
0081        5 T=T+R(I,I)
0082          DO 30 K=1,NF
0083  C       COMPUTE ROOT IN E(K) AND VECTOR IN V(.K).
0084          DO 10 I=1,NV
0085       10 P(I)=1.
0086          E(K)=1.
0087          DO 25 M=1,25
0088          DO 15 I=1,NV
0089       15 V(I,K)=P(I)/E(K)
0090          DO 20 I=1,NV
0091       20 P(I)=SCPF(R, V, -I, K, NV, ND)
0092          EE=SCPF(P, V, 1, K, NV, ND)
0093       25 E(K)=SQRT(ABS(EE))
0094          IF (EE.LT.C*C) GO TO 35
0095  C       DEFLATE R MARTRIX.
0096          DO 30 I=1,NV
0097          DO 30 J=1,NV
0098       30 R(I,J)=R(I,J)-V(I,K)*V(J,K)
0099          GO TO 40
0100       35 NF=K-1
0101  C       COMPUTE PERCENTS OF TRACE.
0102       40 DO 45 I=1,NF
0103       45 P(I)=E(I)/T*100.
0104          EV=SUMF(P, 1, NF, ND)
0105          WRITE(6,50) T, EV, NF
0106       50OFORMAT(// ' PRINCIPAL AXIS ANALYSIS.' // ' TRACE =', F10.4 //
0107         1 F7.2, ' PCT. OF TRACE WAS EXTRACTED BY', I3,' ROOTS.')
0108          RETURN
```

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     00000000011111111112222222223333333333444444444455555555556666666666777777777 8
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0109         END
0110         SUBROUTINE AXBS (A,B,C,KA,KB,N,ND)
0111         DIMENSION A(ND,1), B(ND,1), C(ND,1)
0112         K = IABS(KA)
0113         L = IABS(KB)
0114         IF (KA) 5,55,10
0115       5 IF (KB) 15,55,25
0116      10 IF (KB) 35,55,45
0117      15 DO 20 I = 1,K
0118         DO 20 J = 1,L
0119      20 C(I,J) = SCPF(A, B, I, -J, N, ND)
0120         RETURN
0121      25 DO 30 I = 1,K
0122         DO 30 J = 1,L
0123      30 C(I,J) = SCPF(A, B, I, J, N, ND)
0124         RETURN
0125      35 DO 40 I=1,K
0126         DO 40 J = 1,L
0127      40 C(I,J) = SCPF(A, B, -I, -J, N, ND)
0128         RETURN
0129      45 DO 50 I = 1,K
0130         DO 50 J = 1,L
0131      50 C(I,J) = SCPF(A, B, -I, J, N, ND)
0132      55 RETURN
0133         END
0134         FUNCTION SUMF  (X,KK,NN,ND)
0135         DIMENSION X(ND,1)
0136         SUMF = 0.0
0137         N=IABS(NN)
0138         K=IABS(KK)
0139         IF (NN) 5,55,10
0140       5 IF (KK) 15,55,25
0141      10 IF (KK) 35,55,45
0142      15 DO 20 I=1,N
0143      20 SUMF=SUMF+X(K,I)**2
0144         RETURN
0145      25 DO 30 I=1,N
0146      30 SUMF=SUMF+X(I,K)**2
0147         RETURN
0148      35 DO 40 I=1,N
0149      40 SUMF=SUMF+X(K,I)
0150         RETURN
0151      45 DO 50 I=1,N
0152      50 SUMF=SUMF+X(I,K)
0153      55 RETURN
0154          END
0155         SUBROUTINE CORS (NS,NV,R,A,S,KF,ND)
0156         DIMENSION R(ND,NV),A(NV),S(NV),KF(20)
0157         T=NS
0158         DO 5 I=1,NV
0159         A(I)=0.0
0160         DO 5 J=1,NV
0161       5 R(I,J)=0.0
0162         DO 10 K=1,NS
```

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      00000000011111111112222222222333333333344444444445555555556666666666777777777 8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0163        READ (5,KF) S
0164        DO 10 I=1,NV
0165        A(I)=A(I)+S(I)
0166        DO 10 J=I,NV
0167     10 R(I,J)=R(I,J)+S(I)*S(J)
0168        DO 15 I=1,NV
0169        A(I)=A(I)/T
0170     15 S(I)=SQRT(R(I,I)/T-A(I)**2)
0171        DO 25 I=1,NV
0172        DO 20 J=I,NV
0173        IF (S(I)*S(J) .EQ. 0.0) GO TO 20
0174        R(J,I)=(R(I,J)/T-A(I)*A(J))/(S(I)*S(J))
0175     20 R(I,J)=R(J,I)
0176     25 R(I,I)=1.0
0177        WRITE(6,30)
0178     30 FORMAT (//' INTERCORRELATION ANALYSIS')
0179        RETURN
0180        END
0181        SUBROUTINE VORS (NV, NF, V, A, B, C, ND)
0182        DIMENSION V(ND,NF), A(NV), B(NV), C(NV)
0183        T = NV
0184        DO 5 I = 1,NV
0185        B(I) = SQRT(SUMF(V, -I, -NF, ND))
0186        DO 5 J = 1,NF
0187      5 V(I,J) = V(I,J) / B(I)
0188     10 KR = 0
0189        DO 40 M = 1,NF
0190        DO 40 N = M,NF
0191        IF (M .EQ. N) GO TO 40
0192        DO 15 I = 1,NV
0193        A(I) = V(I,M)**2 - V(I,N)**2
0194     15 C(I) = 2.0 * V(I,M) * V(I,N)
0195        AA = SUMF(A, 1, NV, ND)
0196        BB = SUMF(C, 1, NV, ND)
0197        CC = SUMF(A, 1, -NV, ND) - SUMF(C, 1, -NV,NO)
0198        DD = SCPF(A, C, 1, 1, NV, ND) * 2.0
0199        XN = DD - 2.0 * AA *BB / T
0200        XD = CC - (AA**2 - BB**2) / T
0201        Y = ATAN(XN / XD)
0202        IF (XO .GE. 0.0) GO TO 20
0203        IF (XN .GE. 0.0) Y = Y + 6.2832
0204        Y = Y - 3.1416
0205     20 Y = Y / 4.0
0206        IF (ABS(Y) .LT. 0.0175) GO TO 40
0207        CY = COS(Y)
0208        SY = SIN(Y)
0209        KR = 1
0210        DO 35 I = 1,NV
0211        Q = V(I,M) * CY + V(I,N) *SY
0212        V(I,N) = V(I,N) * CY - V(I,M) * SY
0213     35 V(I,M) = Q
0214     40 CONTINUE
0215        IF (KR .GT. 0) GO TO 10
0216        DO 50 J = 1,NF
```

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     00000000011111111112222222222333333333344444444455555555556666666667777777778
     12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0217         DO 45 I = 1,NV
0218      45 V(I,J) = V(I,J) * B(I)
0219      50 A(J) = SUMF(V, J, -NV, ND) / T * 100.0
0220         DO 55 I = 1,NV
0221      55 B(I) = B(I)**2 * 100.0
0222         WRITE (6,60)
0223      60 FORMAT (//' VARIMAX ROTATION ANALYSIS.')
0224         RETURN
0225         END
0226         FUNCTION SCPF (X, Y, KX, KY, N, ND)
0227         DIMENSION X(ND,1), Y(ND,1)
0228         SCPF = 0.0
0229         J = IABS(KX)
0230         K = IABS(KY)
0231         IF (KX) 5,55,10
0232       5 IF (KY) 15,55,25
0233      10 IF (KY) 35,55,45
0234      15 DO 20 I = 1,N
0235      20 SCPF = SCPF + X(J,I) * Y(K,I)
0236         RETURN
0237      25 DO 30 I = 1,N
0238      30 SCPF = SCPF + X(J,I) * Y(I,K)
0239         RETURN
0240      35 DO 40 I = 1,N
0241      40 SCPF = SCPF + X(I,J) * Y(K,I)
0242         RETURN
0243      45 DO 50 I = 1,N
0244      50 SCPF = SCPF + X(I,J) * Y(I,K)
0245      55 RETURN
0246         END
0247         SUBROUTINE PRTS(X,N,M,KH,KJ,ND)
0248         DIMENSION X(ND,M)
0249         IF (M.GT.1) GO TO 20
0250         WRITE(6,15)
0251         DO 10 I=1,N,10
0252         J=MINO(I+9,N)
0253         WRITE(6,5)KH,KJ,(K,K=I,J)
0254       5 FORMAT(2X,2A4,10I11)
0255      10 WRITE(6,15)(X(K,1),K=I,J)
0256      15 FORMAT(10X,10F11.4)
0257         RETURN
0258      20 DO 25 K=1,M,10
0259         WRITE(6,15)
0260         L=MINO(K+9,M)
0261         WRITE(6,5)KH,KJ,(J,J=K,L)
0262         DO 25 I=1,N
0263      25 WRITE(6,30)I,(X(I,J),J=K,L)
0264      30 FORMAT(I6,4X,10F11.4)
0265         RETURN
0266         END
0267  //GO.SYSIN DD *
0268  MINNIE GNEWUCHS FACTOR ANALYSIS OF DATA
0269     13  4071110001110110
0270
```

PROGRAM TWO

```
                                        80/80 LIST                                                    PAGE 001

      00000000011111111112222222223333333333444444444455555555556666666666777777777 8
      12345678901234567890123456789012345678901234567890123456789012345678901234567890
CARD
0001  $JOB  12133,499-34-9670  MINNIE GNEWUCH
0002        DIMENSION X(450),Y(450)
0003  C     TEACHER 9=SECTIONS 55,56,61,63
0004        NS=68
0005        READ (5,5) (X(I),Y(I),I=1,NS)
0006     5  FORMAT (18X, 1F3.0,15X,1F3.0)
0007        FS=NS
0008        AX=0.
0009        AY=0.
0010        SX=0.
0011        SY=0.
0012        R=0.
0013        SXY=0.
0014        SXQ=0.
0015        SYQ=0.
0016        B=0.
0017        DO 10 I=1,NS
0018        AX=AX+X(I)
0019        AY=AY+Y(I)
0020        SX=SX+X(I)**2
0021        SY=SY+Y(I)**2
0022     10 R=R+X(I)*Y(I)
0023        SXY=R-(AX*AY)/FS
0024        SXQ=SX-AX*AX/FS
0025        SYQ=SY-AY*AY/FS
0026        B=SXY/SXQ
0027        AX=AX/NS
0028        AY=AY/NS
0029        SX=SQRT(SX/FS-AX*AX)
0030        SY=SQRT(SY/FS-AY*AY)
0031        R=(R/FS -AX*AY)/(SX*SY)
0032  C AX,AY= MEANS; SX,SY= STD DEVIATION;  R= PRODUCT MOMENT CORRELATION
0033  C  SXQ,SYQ= SUM OF LITTLE X AND Y SQUARED; SXY= SUM OF LITTLE CROSS PRODUCTS;
0034  C  B= SLOPE OF THE REGRESSION LINE,Y ON X
0035        WRITE(6,15)AX,AY,SX,SY,R,SXQ,SYQ,SXY,B
0036     15 FORMAT(/' AX=',F9.3,'  AY=',F9.3,'  SX=',F8.3,
0037       1'  SY=',F8.3,'  R=',F8.4//'  SXQ=',F10.2,'  SYQ=',F10.2,'  SXY=',
0038       2F10.2,'   B=',F8.4//)
0039        STOP
0040        END
0041  $ENTRY
0042  $IBSYS
```

PROGRAM THREE

```
     $JOB  ****************,TIME=30   MINNIE GNEWUCH
     C PROGRAM F RATIO PROBABILITY
 1         DIMENSION  C(12,12)
 2         I=24
 3         DO 7 MM=1,I
 4         READ (5,6)DA,DB,FRU,FRL
 5       6 FORMAT (3X, 2F5.0,2F12.4)
 6         FR=FRU/FRL
 7         TTR=FR
 8         FR=FR**2
 9         P=PRBF (DA,DB,FR)
10       7 WRITE(6,11)MM,DA,DB,FRU,FRL,FR,P,TTR
11      11 FORMAT(//' PROBLEM',I3,'  DA=',F3.0,' DB=',F4.0,' FRU=',F12.4,
          1'  FRL=',F12.4,/'  F RATIO=',F9.5,'   P='F9.7,'T RATIO=',F9.5/)
12         STOP
13         END

14         FUNCTION PRBF (DA,DB,FR)
15         PRBF=1.
16         IF (DA*DB*FR.EQ.0.) RETURN
17         IF (FR.LT.1.) GO TO 5
18         A=DA
19         B=DB
20         F=FR
21         GO TO 10
22       5 A=DB
23         B=DA
24         F=1./FR
25      10 AA=2./(9.0*A)
26         BB=2./(9.0*B)
27         Z=ABS(((1.-BB)*F**(1./3.)-1.+AA)/(BB*F**(2./3.)+AA)**.5)
28         IF(B.LT.4.)Z=Z*(1.+.08*Z**4./B**3.)
29         PRBF=.5/(1.+Z*(.196854+Z*(0.115194+Z*(0.000344+Z*0.019527))))**4
30         IF (FR.LT.1.) PRBF=1.-PRBF
31         RETURN
32         END
```

VITA

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Candidate for the Degree of

Doctor of Education

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