Learning experiment: effectiveness of controlling environmental distractions

Paul Edward Sumter

Iowa State University

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1970
LEARNING EXPERIMENT:
EFFECTIVENESS OF CONTROLLING ENVIRONMENTAL DISTRACTIONS

by

Paul Edward Sumter

A Dissertation Submitted to the Graduate Faculty in Partial Fulfillment of The Requirements for the Degree of DOCTOR OF PHILOSOPHY

Major Subject: Education

Approved:

Signature was redacted for privacy.

In Charge of Major Work

Signature was redacted for privacy.

Head of Major Area

Signature was redacted for privacy.

Dean of Graduate College

Iowa State University Of Science and Technology Ames, Iowa

1969
# TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>METHOD</td>
<td>5</td>
</tr>
<tr>
<td>REVIEW OF LITERATURE</td>
<td>13</td>
</tr>
<tr>
<td>PROCEDURE</td>
<td>17</td>
</tr>
<tr>
<td>FINDINGS</td>
<td>24</td>
</tr>
<tr>
<td>DISCUSSION</td>
<td>102</td>
</tr>
<tr>
<td>SUMMARY AND RECOMMENDATIONS</td>
<td>114</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>125</td>
</tr>
<tr>
<td>APPENDIX A</td>
<td>126</td>
</tr>
<tr>
<td>APPENDIX B</td>
<td>128</td>
</tr>
<tr>
<td>APPENDIX C</td>
<td>137</td>
</tr>
<tr>
<td>APPENDIX D</td>
<td>144</td>
</tr>
<tr>
<td>APPENDIX E</td>
<td>150</td>
</tr>
<tr>
<td>APPENDIX F</td>
<td>157</td>
</tr>
<tr>
<td>APPENDIX G</td>
<td>165</td>
</tr>
<tr>
<td>APPENDIX H</td>
<td>171</td>
</tr>
<tr>
<td>APPENDIX I</td>
<td>176</td>
</tr>
<tr>
<td>APPENDIX J</td>
<td>183</td>
</tr>
<tr>
<td>APPENDIX K</td>
<td>191</td>
</tr>
<tr>
<td>APPENDIX L</td>
<td>195</td>
</tr>
<tr>
<td>APPENDIX M</td>
<td>200</td>
</tr>
<tr>
<td>APPENDIX N</td>
<td>207</td>
</tr>
</tbody>
</table>
INTRODUCTION

In recent years, considerable research effort has been extended in the areas of teaching and educational psychology. Special attention has been directed to teaching techniques, methods of presentation, repetitions, timing, and the roles of various training schools, programs, and theories of learning.

Educational psychologists have studied the problem of environmental physical conditions in the classroom by analyzing conditions and recommending solutions for temperature control, lighting, etc. Classroom psychology at the group level has been studied; approaches to apply educational group psychology have been recommended. Mencke\(^1\) said, "In the educational world of today, there is probably much less room than in any previous era for teaching which is based on tradition and stereotyping rather than the realities of behavior".

However, little attention seems to have been given to observing students in their environment to see the effects of controlling their various senses from distractions and to see if such shielding of the senses will affect learning. There seems to be a paucity of data available which can be applied to help students learn printed and graphical matter more effectively.

In the learning climate, students still give up before finishing high school. With the present emphasis on education, more individuals aspire to an education, and the proportion of graduates to non-graduates has risen. But, many still fail to attain minimal levels of proficiency to enter and to continue given courses of education. Many still are not motivated
by the success of achievement in given courses of study to encourage them to continue. Especially in technical and science studies a minimum level of achievement seems necessary to encourage individuals to succeed in given courses.

Innovations are needed to increase learning efficiency. With success in achievement at various stages in his learning, an individual can usually be motivated toward continued success.

Need

If control of a subject's environment, at the individual's level, by shielding him from distractions is effective to enhance learning, attention can be directed to increase the individual's learning efficiency. Considering the student in a classroom, is the nature of learning such that the student will retain more, as revealed on such a criterion as a post-test, by shielding him from environmental distractions? Considering the present high enrollments and large classes, it is not practical to try to physically isolate individuals from each other while observing the effects of shielding upon learning.

If visual shielding, or audio shielding, or visual-audio shielding, or any combination is effective to increase retention as measured on a criterion, innovations can follow to motivate students along their learning paths. There are several problem-areas wherein such attention is needed. The student who diverts from a science course-subject to a "general" science course because of lack of motivational success, the high achievement student who wishes to attain higher, the culturally deprived, and students in the more modest mentality groupings are examples. A single broad area of
need is the technical and vocational fields where students need to comprehend and retain maximally from the material which they study.

Purpose

The study involved conducting a controlled experiment in the Iowa public schools. Technical, vocational, science, and academic fields were selected for observation of effects upon students. Questions of experimental interest were: could student learning be significantly improved by effective shielding of a subject from random visual stimuli? By effective shielding of a subject from random audio stimuli? Could such learning be significantly improved either by blocking the input of audio-stimuli to a subject or by providing him with a protective "audio-blanket"?

This experiment looked into such learning and into the effectiveness of controls to determine whether a student in the technical, science, or academic classroom can be helped. The effects of shielding were observed while controlling on the student's native capacity to achieve, the duration of learning time, the type of material which he studied, his prior knowledge, and the type of shielding used.

The purpose of the study was to examine by experimentation the effects of controlling environment of a subject by shielding him from random visual and audio stimuli, determine which type of shielding is more effective, and recommend methods to increase learning efficiency.

Problem

Not much data is available which can be applied to help students learn printed/graphical matter more effectively. Under present cultural conditions, there exists a need to increase learning efficiency of
individuals, not only the modest- and low-achievers, but all students, including the high-ability/high-achievers. This experiment project observed the effects of shielding individual subjects from random, unwanted stimuli to see if their learning was increased. Nine hundred three subjects were observed in technical, science, and academic classes to obtain data for the solution of this problem. If shielding of a subject is effective, as measured by such a criterion as a post-test, student learning-efficiency can be improved.

Hypotheses

The null hypotheses were formulated:

1. There is no difference in achievement between the experimental group using visual shielding and the control group as measured by the gain in scores from a pre- to a post-test.

2. There is no difference in achievement between the experimental group using audio blocking and visual shielding and the control group as measured by the gain in scores from a pre- to a post-test.

3. There is no difference in achievement between the experimental group using a sound input "blanket" and visual shielding and the control group as measured by the gain in scores from a pre- to a post-test.

4. There is no interaction between treatments and the levels of mental ability.
METHOD

To collect data to apply to the hypotheses, it was decided the pretest, post-test, control group, and random choice design was best. Variations between schools, between grades, between classes, and in environmental differences could best be controlled with this method. Every trial involved a treatment group and a control group, both randomly chosen in a single environment.

Comparison

Comparison of performance between the treatment and control groups would not extend beyond a given trial period; e.g., subjects would be scored on their own pre- and post-tests, and a measure of gain would be calculated for a given trial. The net gain within three mental-ability categories of a group was of experimental interest. Performance in terms of gain could be compared between the treatment group and the control group for a trial period. Assuming proper design and administrative controls, any difference between the groups would be due to the effects of the treatment.

Analysis

Analysis of variance and analysis of covariance were used to analyze for significant differences between groups, controlling on mental ability groupings, types of treatments, fields of study, and lengths of the learning unit undertaken for each trial. The t-test for difference between two means was used to test the null hypothesis of some samples.
Scales

For ability grouping of individuals, the particular intelligence tests found in the school records were used for initial grouping. Each trial was conducted with subjects grouped in three mental categories, high, medium, and low. The medium category was a 10-point range about the class mean. The differences between the various scales used by the schools were leveled by equating them to a common scale. This leveling was done in final grouping of subjects before analysis.

Apparatus

A technique was needed to effectively isolate an individual subject, without removing him from his place in the classroom. An apparatus was developed and patented, in cooperation with the Iowa State University Research Foundation, to afford shielding for the subjects in the control groups. The apparatus are shown prior to a trial in Figure 1. The data-collection was conducted in three phases. In the first phase, subjects were shielded by restriction of vision to a certain section, see Figure 2. In the second phase, by restriction of vision and blocking of random sound, and in the third phase, the apparatus would afford restriction of vision and replace random sounds, with an audio-input. For this phase, an electrical system was developed and installed in the experimental units; the equipment included an oscillator, an audio amplifier, and a power supply mounted in the head-worn apparatus. In Figure 3, the subject studies with an auditory input of 100 cycles.
Figure 1. Experimental apparatus. This configuration has sound-input capability
Figure 2. The apparatus on the right is of the visual configuration. This trial was conducted in a library.
Figure 3. An electrical system is mounted in the apparatus. The white knob controls volume to the earphones.
Limitations

The criterion for learning was a score on a subject's post-test over reading material in a pre-determined learning unit. Specific tests were developed for each learning unit. The units were selected from the subject's regular curriculum in a subject-matter area of a regular course. A typical unit was a chapter in a science textbook. Units were chosen from chapters of the textbooks ahead of the progress of the class so as to minimize prior knowledge of the material in a given trial.

Considering the size of classes and since pre- and post-tests were used, thirty to eighty tests were used for each trial. One to four trials were conducted in each school. Schools of various sizes in a 150-mile radius of Iowa State University were selected. Forty-eight trials were conducted in thirteen schools including the Technical Institute of Iowa State University, a technical high school, nine high schools, and an area community college. Nine hundred three observations were made representing individual's pre-score and post-score over a learning treatment. The writer supervised each trial in the classroom of each school. Research assistants were trained to assist in the trials and to set up trials. Prior to a given trial, the subjects were grouped according to the controls to be used. A major expense of the project was the several trips necessary to a school to arrange with school officials for the details of the experiment and to obtain necessary information from the school records. The instructor and the class were oriented prior to each trial. Each trial utilized an entire class of students one to three hours.

The study was delimited to utilization of subjects in technical schools, area community colleges, and high schools with emphasis on 11th
and 12th grades and upon technical and science subject-matter in the high schools.

Samples

As indicated, schools were chosen within a radius of 150 miles of Iowa State University. From these schools, classes were drawn according to the classifications of fields of study, i.e., technical, vocational, science, and academic. Individuals were randomly chosen within the given class and within the categories of mental ability, for the treatment and control groups, in each trial.

Trials were conducted in repeat cycles at two schools, Marshalltown and Des Moines Technical, after invitation from the school officials. Two sets of observations were taken. The first observations were taken in the fall of 1968, then another set in the late spring of 1969 at these two schools.

Table 1 lists the schools, trials, and observations at the schools in the order of occurrence.
Table 1. Schools and observations by trial number

<table>
<thead>
<tr>
<th>School</th>
<th>Trial</th>
<th>Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td>The Technical Institute, ISU</td>
<td>1</td>
<td>20</td>
</tr>
<tr>
<td>Marshalltown</td>
<td>2-8</td>
<td>145</td>
</tr>
<tr>
<td>Fort Dodge</td>
<td>9, 10</td>
<td>69</td>
</tr>
<tr>
<td>Cedar Falls</td>
<td>11, 12</td>
<td>87</td>
</tr>
<tr>
<td>Price Laboratory School</td>
<td>13, 14</td>
<td>65</td>
</tr>
<tr>
<td>Des Moines North</td>
<td>15, 16, 17</td>
<td>33</td>
</tr>
<tr>
<td>Des Moines Technical</td>
<td>18, 19</td>
<td>66</td>
</tr>
<tr>
<td>Story City</td>
<td>20, 21</td>
<td>57</td>
</tr>
<tr>
<td>Roland</td>
<td>22</td>
<td>33</td>
</tr>
<tr>
<td>Gilbert</td>
<td>23, 24</td>
<td>50</td>
</tr>
<tr>
<td>South Hamilton</td>
<td>25-28</td>
<td>104</td>
</tr>
<tr>
<td>Marshalltown</td>
<td>32-35</td>
<td>63</td>
</tr>
<tr>
<td>Area XI Ankeny</td>
<td>36, 37</td>
<td>44</td>
</tr>
<tr>
<td>Des Moines Technical</td>
<td>29-31, 38-41</td>
<td>100</td>
</tr>
</tbody>
</table>
REVIEW OF LITERATURE

A survey of the literature reveals most to be in the class of "Audio-Visual Materials". There is considerable literature on the different modes and means of presentation. In educational literature, much has been written about electro-phonics, television, projections, graphics, etc. and their relative merits. Each medium has been researched. These, however, are not within the purview of this study.

The complexion of this study does include problems of embellishment of factors in the learning situation. Such embellishment might be in the form of too much visual focusing or too little. It may be in the form of too much ambient noise or irrelevant material. The basic question of the study, is learner efficiency degraded by environmental distractions such as those in a classroom or study hall, raises other related questions: e.g., are subjects adversely affected by redundant relevant information while they are trying to study? Or, what is the effect of irrelevant redundant information, visual or audio, upon a subject who is trying to study?

Some research has suggested that visual and auditory impingment upon a learner by random irrelevant stimuli affects concept-formation. The measurement of concept-formation is difficult; the author grants that a post-test is not the ultimate mode.

Haygood\(^2\) explored the effects of redundant auditory and visual information upon concept-formation. In an experiment conducted by Lordahl (1961), Haygood noted the effects on concept-formation of relevant and irrelevant information:

Lordahl found that as irrelevant visual information increased, performance decreased. However, increasing the amount of irrela-
vent auditory information had no significant effect. When the types of errors were analyzed, it was found that the tendency to ignore irrelevant auditory information was greater than the tendency to ignore irrelevant visual information. The finding that increasing the amount of irrelevant visual information increased the difficulty of the task was consistent with those of previous "visual only" concept-formation studies (e.g., Walker and Bourne, 1961), in which this relationship was firmly established.

But Haygood found, on further investigation, different effects of auditory irrelevancy upon auditory-concept formation. In another study by Bulgarella and Archer (1962), when only auditory stimuli was used, "Increasing the number of relevant dimensions increased problem difficulty significantly. Similarly, increasing the amount of irrelevant information degraded performance significantly."

Haygood's study involved trying to add redundant auditory information to visual-information problems and redundant visual information to auditory-information problems. He found no significant effects of redundancy in this experiment. Further, he explored several explanations for the insignificant results, including the possibility that Bulgarella and Archer were correct in concluding that "subjects tend to ignore auditory information when both auditory and visual information are present". Also, there may have been significant differences in his structure which were obscured by presence of inflated variance of groups presented with relevant auditory information. But his own conclusion is rather general:

If this finding can be shown to have generality, it will indicate that simultaneously presenting a portion of the relevant information in the visual mode and another portion in the auditory mode is an inefficient method of teaching. A complete presentation in either the visual or auditory mode is superior, as is a fully redundant audio-visual presentation.

Baker and Madell studied the susceptibility to distraction in academically underachieving and achieving male college students. In a reading
comprehension task using freshmen as subjects, the control group had an ordinary test environment, and the treatment group had an auditory background of humorous conversation. They hypothesized that underachievers and achievers would not differ in their performance under the normal conditions, but the performance of both groups would be impaired under the distractive conditions. Also, underachievers would show the greatest impairment under the distractive conditions.

According to the authors, performance on a reading comprehension task under ordinary test conditions is correlated with academic aptitude or intelligence. Their subjects did not differ significantly in intelligence as measured by the SAT.

Their results confirmed their experimental predictions. There was no statistical significance in any of the differences between the underachievers and the achievers under quiet test conditions. But the treatment resulted in a significant difference between the quiet and the distractive conditions. Toward a hypothesis dealing with the (subject-X-conditions) interaction, there was significance indicating that the distractive stimulation "did in fact have differential affect on the two kinds of subjects... it was the underachievers who suffered the greater impairment".

The Bedford, New York school system, stressing individual progress, concluded that a prime factor in the success of the instruction system was the study carrel. The study carrel is an individual booth with or without electronic equipment for taped presentations to students. Findings were:

1. The degree of isolation provided by these booth-like structures affords children the proper climate for concentration.

2. Carrels go a long way in teaching the children how to listen.
3. Several groups may be worked with at the same time involving different text materials since students are isolated.

4. The basic library carrel provides the child with an individual place to study by himself.

The apparatus, as it was used in this study, afforded the capacity to inexpensively isolate individual students from environmental distractions without necessitating removal from their regular seating arrangement.

Dr. R. C. Stauffer\(^5\) researched the impact of students' study-habits at the University of Delaware. In a study by the Reading Study Center, University of Delaware, he concluded:

1. Study skills are needed by students in all fields.

2. Study skills are essentially reading skills. They may enhance the quality of learning experience in study situations. These skills include effective attention to the written material being studied.

Researching the complexity and position of stimuli as they demand attention in retardates, Dr. G. L. Terdal\(^6\) studied behavior of normals and retardates. He varied position and complexity of the stimuli to see the behavioral effects on children:

1. All subjects were observed to have significantly longer fixation times for complex designs. This suggests an organismic tendency to be distracted from concentration.

2. The variable stimulus complexity may differentially affect the attending of subjects who differ in intelligence and/or age. Thus subjects may be expected to respond variably to distracting stimuli by IQ level.
PROCEDURE

The purpose of the study was to see if learning could be significantly improved by shielding subjects from environmental distractions and to see what type or combination of shielding is best. If such isolation techniques are effective, innovations can follow to increase learner efficiency.

Timetable

Initially the experimentation period was to be from April, 1968, to April, 1969. Data was to be collected during that time; analysis and recommendations were to be made by August, 1969. Some delay was encountered in the development and modification of the apparatus and in the orientation to the purposes of the experiment and selling of the idea to some schools for cooperation.

After dissemination of information about the project to the schools and orientation to its purpose, virtually all were ready to cooperate. However, by this time, the school year, 1968, was near ending. Most respondents requested the experiment be conducted in their school after the beginning of the next school year, 1968-69. This caused some delay in the collection of data. Most of the data from the high schools were collected during the 1968-69 school year; after June, emphasis was upon collection of data from the Area XI Community College. The timetable was extended to September, 1969.
Design

The design of the experiment incorporated pre-test post-test, control groups, and random choice. According to Campbell and Stanley, this is one of the "three true experimental designs". The design takes the form:

\[ R_0^1 \times O_2 \]
\[ R_0^3 \times O_4 \]

where: \( R = R_0^1 \) and \( R_0^3 \) represents the random choice of the treatment group and the control group, and the first set of observations, e.g., the pre-test.

\( X = \) the treatment administered to the treatment group
\( O_2 \) and \( O_4 \) = the second set of observations, e.g., the post-test.

According to Campbell, extraneous variables relevant to internal validity are controlled with this design when applied in educational-psychological research. The variables History, Maturation, Testing, Selection, Instrumentation, Regression, and Selection are involved:

Because the design so neatly controls for all of the seven rival hypotheses described so far, the presentations of it have usually not made explicit the control needs which it (has) met.

Controls

The definition of some terms as used seems appropriate. Each "trial" represents a set of observations in the experiment, taken under a given set of conditions, in a given classroom, using a class of 10th, 11th, or 12th grade students or a class in a post-high school.

A "treatment" group and a "control" group were randomly chosen from the single class by dividing the class for each trial. The treatment consisted of the reading of a pre-selected unit in the class's textbook, dur-
ing which the treatment group was isolated by wearing the apparatus. The control group read the same material at the same time but was not isolated by shielding. Only one type of shielding was used at a given time by the treatment group.

A "Sample" represents one or more like trials considered together. Either the same subjects were used in the trials of a sample, or the same learning unit and tests, or the same grade-level subjects were used in the same school with similar written material.

A "Classification" was used to group samples by three broad types or fields of study: technical, science, and academic.

Grouping

To see the effect of a type of isolation upon subjects in different mental ability categories, students were pre-grouped into high, medium, and low categories. To see if there would be variance due to longer or shorter learning units, 1 hour or 2 plus hours was used for grouping. The following basic 2 x 3- and 3 x 3-way arrangements were decided for analysis:

1. Treatment by category and length for each of the samples in each of the classifications. The questions of interest were: Is there a significant difference between groups in any of the categories? And, is there a significant difference between the two groups? Analysis of variance would be used.

2. Treatment type by category and length in each of the classifications. The questions of interest were: Is there a significant difference between any two groups in any of the categories? And is there a significant difference between any group combination?
In one set of observations, mental ability ratings were not available. Analysis for this group was by treatment and length of the unit and by type of treatment and length. Analysis of variance was used to test for differences.

Collection

The data were collected over a 12-month period. The experiment was conducted in the three stages: visual, audio visual, and audio visual with sound.

After a trial had been set up, a list of students in the class was obtained with their ratings from the school records. The class was grouped into an X and Y group, which divided the class in half. Within these groups, random choice was made in each of the three categories for the proper number of subjects for the treatment group. This choice was made for both the X and Y groups.

To form the categories, a 10-point range about the mean point was designated the Medium; all individual ratings above this range were High, and all below were Low. Where possible, equal numbers were chosen within each category for each trial. At the time the experiment was conducted, a random choice was made by the students by flipping a coin to see which group, whether X or Y, would be the treatment group. Whichever was chosen, the other became the control group. Since the number of apparatus available was from 10-15, due to repairs, modifications, etc., the entire remainder of the class, other than the 10-15 chosen in the treatment group, would function as the control group. It was learned early in the experiment the school officials and teachers did not take kindly to the idea of con-
ducting regular class activities for a few students after the experimenter had made choices and presented them with the remainder of the class. So the remainder of the class was always used as the control group after the treatment group had been chosen.

Before a given trial, copies of the textbooks were obtained from the school. Pre-tests and post-tests were developed over the learning unit. Prior to any choice of groups, the class was pre-tested. The subjects then read the subject-matter in the learning unit, with the treatment group wearing the appropriate apparatus. The students were not physically separated in any way. Figure 4 is an example. Some of the experimental trials were conducted in the study halls in an environment as shown in Figure 2. The same technique was used, except the entire class was dispersed randomly among the other students in the study hall.

After a 1-hour reading period or a two-or-more hour reading period, time was called, and the class was post-tested. The treatment group wore the apparatus during the post-testing. The data were then marked and the class and teachers deoriented. In this way, data were collected in the forty-one trials and nine hundred three observations.

Scoring of the tests was accomplished according to a set of instructions. Scoring was done by one person, without knowledge of the group to which a given test-sheet belonged. The data were transposed in the form of pre-test and post-test scored onto worksheets. All gains and percentages of gains were computed for individuals and groups in each category.

Since three scales were encountered in the schools, Otis, Lorge-Thorndike, and Kuhlmann-Anderson, the ratings were equated to the Otis level. All categories were then adjusted to the Otis level on the data
Figure 4. Treatment and control groups in a typical classroom environment
worksheets. The data were then coded according to Fortran computer
requirements, and data cards with their proper control decks of cards were
cut. Analysis of variance and printout of the associated means, summary,
tables, etc. was by computer, as well as printout of the t-tests.
FINDINGS

To test the effectiveness of visual and auditory control of ambient stimuli for students, trials were performed using entire classes. As stated previously, each trial utilized a given class of students in a single classroom or study hall. Random assignment was used to select individuals for the treatment group and control group from each class. The trials yielded ten to forty observations; about fifteen were typical.

In some cases, trials were combined to assure reasonably large cell numbers for the purpose of using analysis of variance in a two-way classification. With low cell numbers, a given analysis would require very large variations between groups or between categories before any significance would be detected. Larger variations than those normally found in observations of human behavior would be required.

The analysis of the data was based upon samples in the technical, science, and academic classes of the schools noted previously. A sample consisted of one or more like trials. The trials were combined on the bases of: the same individual performing in successive trials, the same pre- and post-tests utilized with like subjects, and subjects in the same classification, grade-level, and subject-material.

Since each trial utilized a treatment group with a control group, the level of the mean gains in different trials could vary without appreciable effect upon the results of analysis. Variations in test difficulty or in environmental conditions can cause this mean-level to vary. This condition did not present a structuring problem since each individual's pre-test
score was subtracted from his post-test score, and this unit of gain was used as the unit of entry in the AOV matrices and in the t-test matrices. Because cell frequencies were not equal, the usual AOV technique was not used. The computer used a technique of analysis referred to as the non-orthogonal mode. In this mode, multiple linear regression is used to compute the relative contributions of the variates. Sums of squares due to regression and sums of squares due to deviation from regression were computed for each variable. The relative contributions were printed out in the form of F-test values. A summary analysis of variance table was printed out for each analysis job.

Structure

The form of the analysis was a two-way classification. $A_1$ represented the treatment group and $A_2$ the control group. The mental categories were represented by $B_1$, $B_2$, and $B_3$. Since the grand means of the mental ability scores of the total samples was 107, fewer subjects in the low category were expected. Some samples had only a few individuals in that category, as did sample 1.

Table 2 is typical of the form used, except only two levels of $B$ were used.

Hypothesis I

Testing Hypothesis I, visual shielding is not effective in increasing learning, 78 observations were taken.
Table 2. Frequencies in each cell of sample 1, visual treatment

<table>
<thead>
<tr>
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<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
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<td>Sample 1</td>
<td>16</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>23</td>
<td>39</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>46</td>
<td>78</td>
</tr>
</tbody>
</table>

Sample 1

Sample 1 utilized subjects from the Marshalltown and Cedar Falls Community Schools.

Five trials were involved, three in the Marshalltown school and two in Cedar Falls. In each trial, the treatment control group experimental procedure was used. The subjects were pre-tested before the treatment was administered and before the group had been chosen. Prior to the trials, a random choice was made for the treatment group individuals on the basis of equal distribution in the three categories of mental ability. This choice was made for each half of the class. The class had been divided equally into "X" and "Y" groups previously. Then, after pre-testing, a random choice was made to see whether X or Y would be the treatment group, within which the individuals had previously been chosen to wear the apparatus.

In each trial, the reading time was one hour. The subject-material studied was mechanical principles and biology. After the reading, the subjects were post-tested. Gains, i.e., the difference between an individual's pre- and post-tests, are entered in Table 3. These gains were used for analysis testing Hypothesis I.
Table 3. Gain scores for sample 1 electronics students, visual treatment

<table>
<thead>
<tr>
<th>Grouping</th>
<th>Treatment group</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td>26.00</td>
<td>30.30</td>
<td>43.00</td>
</tr>
<tr>
<td>39.00</td>
<td>21.70</td>
<td>13.00</td>
</tr>
<tr>
<td>39.00</td>
<td>13.00</td>
<td>17.00</td>
</tr>
<tr>
<td>13.00</td>
<td>47.00</td>
<td>43.40</td>
</tr>
<tr>
<td>17.60</td>
<td>23.50</td>
<td>4.30</td>
</tr>
<tr>
<td>19.50</td>
<td>64.70</td>
<td>4.30</td>
</tr>
<tr>
<td>0.00</td>
<td>17.60</td>
<td>17.30</td>
</tr>
<tr>
<td>64.40</td>
<td>58.80</td>
<td>34.00</td>
</tr>
<tr>
<td>11.70</td>
<td>26.00</td>
<td>0.00</td>
</tr>
<tr>
<td>11.70</td>
<td>28.20</td>
<td>52.90</td>
</tr>
<tr>
<td>29.40</td>
<td>36.80</td>
<td>47.00</td>
</tr>
<tr>
<td>70.50</td>
<td>56.30</td>
<td>32.20</td>
</tr>
<tr>
<td>51.20</td>
<td>53.70</td>
<td>29.40</td>
</tr>
<tr>
<td>43.50</td>
<td>26.00</td>
<td>41.60</td>
</tr>
<tr>
<td>46.00</td>
<td>17.60</td>
<td>35.20</td>
</tr>
<tr>
<td>23.80</td>
<td>29.40</td>
<td>23.50</td>
</tr>
<tr>
<td>-17.30</td>
<td>52.90</td>
<td>38.40</td>
</tr>
<tr>
<td>26.00</td>
<td>11.60</td>
<td>43.50</td>
</tr>
<tr>
<td></td>
<td>23.80</td>
<td>47.00</td>
</tr>
<tr>
<td></td>
<td>15.10</td>
<td>53.70</td>
</tr>
<tr>
<td></td>
<td>21.70</td>
<td>38.40</td>
</tr>
<tr>
<td></td>
<td>43.40</td>
<td>19.50</td>
</tr>
<tr>
<td></td>
<td>6.50</td>
<td>28.20</td>
</tr>
</tbody>
</table>

*N = 78.

Analysis of Variance, Sample 1

Model

The mathematical model was:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

where \( \mu \) = the effects of the grand mean, \( A \) = treatment, \( B \) = mental ability, \( AB \) = interaction, and \( E_{ijk} \) = the effects of error.
Limits

Limits were:

\[ I = 2, J = 2, K = 23 \]

In the non-orthogonal mode, it is necessary to specify the number of observations in the largest cell, in this case \( K = 23 \).

Frequencies

Table 2 lists frequencies in each cell. Due to fewer individuals in the #3 (low ability) category, only two levels of B were used.

Means

Means for the main effects of sample 1 were:

\[ A_1 = 32.4806, A_2 = 24.7586, B_1 = 28.8421, B_2 = 26.9179 \]

Summary ANOV

The summary analysis of variance for sample 1 is shown in Table 4. Since cell frequencies were not equal, computation was by non-orthogonal analysis using multiple linear regression.

Conclusion

Testing the treatment mean square for significance, \( F_c \) was less than 1.00. Since the value of \( F_t \) with \( \alpha \) at .05, and 1, 75 degrees of freedom was 3.97, the calculated value was not significant. No significant difference was found between the experimental group and the control group.

Testing for significant difference between the levels of mental ability, the calculated value of \( F \) was less than 3.97. The difference was not significant.
Table 4. Summary analysis of variance for sample 1, visual treatment

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>112.7695</td>
<td>112.7695</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>383.4960</td>
<td>343.4960</td>
<td>1.10</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>114.7539</td>
<td>114.7539</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>74</td>
<td>25777.7851</td>
<td>348.3483</td>
<td></td>
</tr>
</tbody>
</table>

\[ ^a N = 78. \]

\[ ^b F\text{-value is less than 1.00.} \]

**t-test, Sample 1**

The *t*-test was used as a supplementary test to test the null hypothesis of no difference between the experimental and the control groups.

**Model**

Either the *t*-test for difference between two means with separate group variance and sample groups of unequal size could have been used or the *t*-test using pooled variance and sample groups of equal size. For degrees of freedom with which to determine the critical values, the median of the value at \( N_1 - 1 \) and \( N_2 - 1 \) applies for the former and the value at \( N_1 + N_2 - 2 \) for the latter.

To determine whether there was unequal variance between the two groups, the variance ratio formula was used:

\[
F = \frac{S_2^2}{S_1^2}
\]
Where $S^2_g$ was the sample group with the greater variance and $S^2_1$ was the lesser, the ratio became:

$$F = \frac{400.2673}{300.1984} = 1.33$$

Since $F_{31,45} = 1.72$, the ratio was not significant. The variances were considered to be equal, and the pooled variance model was used. Calculation was:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{\frac{1}{K_1} + \frac{1}{K_2}}}}$$

$$= \frac{7.0726}{\sqrt{700.4657 \frac{1}{32} + \frac{1}{46}}} = 1.66378$$

The value of $t_{32+46-2(N_1+N_2-2)}$ is 2.004. Since the calculated value was less than the table value with $\alpha$ at .05, the value was not significant. The $t$-test agreed with the $F$-test; no significant difference was found between the performance of the experimental group and the control group.

There was insufficient evidence to reject Hypothesis I. Learning was not improved. Visual shielding was not effective under these experimental conditions.

No observations were taken, in the visual configuration, with time exceeding one hour. It should be noted, therefore, that effects of increasing time on learning, using the visual control, were not investigated.
Hypothesis II

Whereas the apparatus used to control the subject's environment in those trials testing Hypothesis I was a visual shield only, commercial ear pads were used in the trials testing Hypothesis II. The subject's view was also restricted to a sector around the book, as in sample 1, and his reception of ambient sounds was also attenuated by commercial ear pads. The degree of attenuation ranges up to 50 decibels at 3K hertz. This effect does not completely block all sounds, but the subject can hear few sounds more than a few feet away. The effect was to render meaningless most ambient sounds. See Appendix A for the attenuation graph.

Analysis of Variance, Sample 2

Sample 2

In sample 2, there were 30 observations. Students from the Des Moines Technical High School were used as subjects. The subject-material was electronics and computer programming. The length of the trial was two hours.

Due to low cell-frequencies in categories 2 and 3, they were pooled, resulting in two levels of $B$.

Model

The mathematical model was again:

$$y_{ijk} = \mu + a_i + b_j + ab_{ij} + e_{ijk}$$

Limits

Limits were: $I = 2, J = 2, K = 10$ where $K$ is the number of observations in the largest cell.
Frequencies

Cell frequencies were unequal in sample 2. Only two levels of category were used. Again, the two-way classification utilized $A_1$ and $A_2$ as the levels of treatment and $B_1$ and $B_2$ as the levels of mental ability. Table 5 lists frequencies for the cells.

Table 5. Frequencies in each cell of sample 2, audio-visual treatment

<table>
<thead>
<tr>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>9</td>
<td>19</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Total</td>
<td>13</td>
<td>17</td>
</tr>
</tbody>
</table>

Means

Means for the factors of sample 2 were:

$$A_1 = 18.5615, A_2 = 2.8999, B_1 = 9.0210, B_2 = 10.8353$$

Summary ANOV

The summary analysis of variance for sample 2 is shown in Table 6. The computer used multiple linear regression for each factor as in sample 1.

Conclusion

Testing the treatment mean square for significance, $F_2$ was less than 1.00. Since table value of $F$ with $\alpha = .05$ and 1/26 degrees of freedom is 4.24, the calculated value of $F$ was not significant.
Table 6. Summary analysis of variance for sample 2, visual-audio treatment

<table>
<thead>
<tr>
<th>Source^a</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>209.6640</td>
<td>209.6640</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>934.8242</td>
<td>934.8242</td>
<td>1.77</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>1167.6953</td>
<td>1167.6953</td>
<td>2.21</td>
</tr>
<tr>
<td>Error</td>
<td>26</td>
<td>14994.6445</td>
<td>576.7170</td>
<td></td>
</tr>
</tbody>
</table>

^aFor N = 30.

^bF-values less than 1.00 not shown.

No significant difference was found between the treatment group and the control group. Insufficient evidence was available to reject Hypothesis II. Learning was not improved. Visual-audio shielding was not effective under these experimental conditions for the technical high school students, considering results of the analysis of variance.

t-test, Sample 2

The t-test was used as a supplementary test to test the null hypothesis of no difference between the experimental and the control groups. No blocking by mental ability was used for the t-test.

Sample 2 had 30 observations of students in the Des Moines Technical High School. The subject-material was electronics and computer programming. The length of the trial was two hours.
Model

To determine whether the pooled variance model could be used, a test of homogeneity of variance was used. The variance ratio formula was used:

\[ F = \frac{S^2}{S'^2} \]

where \( S^2 \) was the greater variance of the two groups and \( S'^2 \) was the lesser.

For sample 2, \( S'^2 \) was 538.1682 and \( S^2 \) was 455.4392. Therefore, the variance of subgroup 1 was the subgroup of the greater variance.

The formula became:

\[ F = \frac{538.1682}{455.4392} = 1.1816 \]

Since \( F_{12,13}(K_1+1 \text{ and } K_2-1) \) was 2.60 interpreted at the 10 percent level (\( \alpha = .05 \)), the calculated value was not significant. The variances were considered to be equal since the data tested homogeneous. The pooled variance model was used:

\[ t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S^2}{K_1} + \frac{1}{K_2}}} \]

The computation was:

\[ t = \frac{15.6615}{1.91854} = 1.91854 \]

Conclusion

The value of \( t_{15+17-2(K_1+K_2-2)} = 2.048 \) with \( \alpha \) at .05. Since the calculated value was less, the difference was not significant. The results of the t-test agreed with the F-test; no significant difference in performance was found between the experimental group and the control group.
Hypothesis II was not rejected on the basis of this experimental replication.

**Hypothesis II, Replication 1**

**Sample 3**

In this replication testing Hypothesis II, sample 3 utilized 30 observations of student performance. The students were post-high school in technical/vocational courses. Two trials were combined, one trial using mechanical technology students at Iowa State University and one trial using printing technicians at the Des Moines Area Community College. Each trial, as were the other trials, was conducted using the experimental group and control group, randomly chosen. Gains, of individuals, were also the units of entry for analysis.

Since mental ability records were not available for post-high school student-subjects, grouping by category was not used. Therefore, no IQ-vs-treatment interaction was tested. For convenience, the trials were placed at two levels of B, with one trial as B₁ and the other as B₂. The two levels of A again represent the experimental group and the control group in each trial.

**Analysis of Variance, Sample 3**

**Model**

The model for AOV was:

\[ Y_{ijk} = \mu + A_i + B_j + E_{ijk} \]

where the effects were: \( \mu \) = grand means, \( A \) = the groups, \( B \) = the two trials, and \( E \) = the error.
Limits

Limits for the model were: $I = 2, J = 2, K = 12$ where $K$ was the value of the largest cell number.

Frequencies

Table 7 lists frequencies for sample 3.

Table 7. Frequencies for sample 3, treatment audio-visual

<table>
<thead>
<tr>
<th>Trial No.</th>
<th>Treatment</th>
<th>Control</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$A_1$</td>
<td>$A_2$</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>6</td>
<td>4</td>
<td>10</td>
</tr>
<tr>
<td>7</td>
<td>12</td>
<td>8</td>
<td>20</td>
</tr>
<tr>
<td>Total</td>
<td>18</td>
<td>12</td>
<td>30</td>
</tr>
</tbody>
</table>

Means

Means were:

$A_1 = 21.9888$, $A_2 = 12.2083$, $B_1 = 8.0099$, $B_2 = 23.1099$

Summary ANOV

The results of analysis of variance of the data of sample 3 are shown in Table 8.

Conclusion

$F_c$ is 4.21 at 1,27 degrees of freedom with $\alpha$ at .05. The calculated value is less, therefore, any difference found was not significant. The experimental group did not benefit more than the control group from the
Table 8. Summary analysis of variance for sample 3. Treatment was audio-visual, subject-matter mechanical technology and printing

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>6.7031</td>
<td>6.7031</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>131.2070</td>
<td>131.2070</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>27</td>
<td>8830.8228</td>
<td>327.0695</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)N = 30.

\(^b\)F-values less than 1.00 are not shown.

treatment. Hypothesis II was not rejected on the basis of this analysis of sample 3.

t-test, Sample 3

Again, the t-test was used supplementary to the AOV for sample 3. There were 18 observations in the experimental group and 12 in the control group.

Model

To determine whether the pooled variance model could be used, the variance ratio formula was used as a test of homogeneity:

\[
F = \frac{S_g^2}{S_1^2}
\]

where \(S_g^2\) was the greater variance of the two groups and \(S_1^2\) was the lesser.

For sample 3, \(S_1^2\) was 260.5410 and \(S_2^2\) was 349.4667. Therefore, the variance of subgroup 2 was greater.
The formula became:

\[ r = \frac{349.4667}{260.5410} = 1.34131 \]

Since \( F_{11,17}(k_2-1 \text{ and } k_1-1) \) was 2.41 interpreted at the 10 percent level (\( \alpha = .05 \)), the calculated value was not significant. The variances were considered to be equal since the data tested homogeneous. The pooled variance model was used:

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{k_1} + \frac{1}{k_2}}} \]

The computation was:

\[ t = \frac{21.9889 - 12.2083}{\sqrt{\frac{610.0077}{18} + \frac{1}{12}}} = 1.52675 \]

Conclusion

The value of \( t_{18,12-2(K_1+K_2-2)} = 2.048 \) with \( \alpha \) at .05. Since the calculated value was less, the difference was not significant. The results of the \( t \)-test agreed with those of the \( F \)-test. No significant difference in performance was found between the experimental groups and the control groups. Visual-audio control under these conditions using commercial ear pads was not effective in increasing learning. The evidence was not sufficient to reject Hypothesis II on the basis of this experimental replication.
Hypothesis II, Replication 2
Analysis of Variance, Sample 4

Sample 4

The second replication toward Hypothesis II utilized 47 students from science classes at the Roland and Gilbert Community Schools. The subject-matter was biology. Three like trials were combined resulting in three levels of category with cells balanced within a 2:1 ratio of disparity. Length of the trials was two hours. Again, two-way classification was used; $A_1$ represented the treatment group, $A_2$ the control group, and $B_1$, $B_2$, and $B_3$ the categories of mental ability. It was decided to check for interaction between the groups and categories, which would indicate whether one or the other group operated differentially between the categories.

Model

The model used was:

$$ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} $$

where the effects were: $\mu$ = the grand mean, $A$ = the groups, $B$ = the levels of mental ability, $AB$ the interaction, and $E$ = error.

Limits

Limits were: $I = 2$, $J = 3$, $K = 10$ where $K$ is the value of the largest cell number.

Frequencies

Table 9 lists frequencies for sample 4.
Table 9. Frequencies for sample 4, treatment audio-visual

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High</td>
<td>7</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Medium</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Low</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>22</td>
<td>25</td>
<td>47</td>
</tr>
</tbody>
</table>

Means

Means of the main effects of sample 4 were:

$$A_1 = 17.3636, A_2 = 15.1039, B_1 = 14.1647,$$
$$B_2 = 22.0799, B_3 = 7.7199$$

Summary ANOV

The results of analysis of data of sample 4 are shown in Table 10. Effectivity of visual-audio shielding was analyzed. The computer used non-orthogonal calculations using multiple linear regression.

Conclusion

$F$ is 4.075 at 1, 41 degrees of freedom and 3.225 at 2 and 41 degrees of freedom. The calculated values of $F$ for the factors A and B are less than the table values. There were no significant differences between the groups or categories. Hypothesis II was not rejected on the basis of this replication. Under the experimental conditions, visual-audio shielding using commercial ear pads was not effective in increasing learning for students in these science classes.
Table 10. Summary analysis of variance for sample 4. Treatment was audio-visual, subject-matter biological science

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>353.9179</td>
<td>353.9179</td>
<td>1.04</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>868.2460</td>
<td>434.1230</td>
<td>1.28</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>354.4062</td>
<td>177.2031</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>41</td>
<td>13866.3476</td>
<td>338.2033</td>
<td></td>
</tr>
</tbody>
</table>

\( ^a N = 47. \)

\( ^b F\)-values less than 1.00 are not shown.

Since the \( F \) value for AB was insignificant, there was no interaction detected. The treatments did not operate differentially between the categories. There was no difference in gain in the levels of intelligence.

**t-test, Sample 4**

Sample 4 had 47 observations from science classes. In the F-test, there was no significant difference detected between the levels of A, i.e., between the treatment group and the control group.

Means for sample 4 were:

\[ A_1 = 17.3636, \ A_2 = 15.1040 \]

**Model**

The null hypothesis of no difference between the means of two groups was to be tested. To determine if there was unequal variance, the variance ratio formula was used:
where $S_g^2$ was the greater variance and $S_l^2$ was the lesser. For sample 4, $S_l^2 = 333.7495$ and $S_g^2 = 348.5466$. The $F$ value was then:

$$F = \frac{348.5466}{333.7495} = 1.04434$$

Since $F_{21,24} = 2.02$, the calculated value was not significant. The variances appeared to be equal. Therefore, the pooled variance model was used. The formula for solution was:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{n_1} + \frac{1}{n_2}}}$$

The computation was:

$$t = \frac{2.2596}{\sqrt{682.2961 \cdot \frac{1}{22} + \frac{1}{25}}} = 0.41820$$

Since this value was less than unity, it was obviously not significant at $N_1 + N_2 - 2$ degrees of freedom.

Conclusion

No significant difference was found between the treatment group and the control group. On the basis of the previous $F$-test and the $t$-test, the evidence was not sufficient to reject Hypothesis II. Visual-audio control under these conditions using commercial ear pads was not effective in increasing learning.
Hypothesis II, Replication 3

Sample 5

In this sample, 70 observations were used of student-subjects in the Des Moines North High School and the Gilbert Community School. The classification was academic. The subject-material was history. A control group was used with a treatment group, both randomly chosen as was the case in the other trials. Two-way classification was used, with treatment at two levels and category at three. Length of the trials was two hours.

Model

The model used was again:

\[ y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

Limits

Limits were: \( I = 2, J = 3, K = 14 \) where \( K \) is the value of the largest cell number.

Frequencies

Table 11 lists the frequencies for sample 5.

Table 11. Frequencies for sample 5, treatment audio-visual

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment ( A_1 )</th>
<th>Control ( A_2 )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, ( B_1 )</td>
<td>7</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td>Medium, ( B_2 )</td>
<td>14</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>Low, ( B_3 )</td>
<td>14</td>
<td>14</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>35</td>
<td>70</td>
</tr>
</tbody>
</table>
Means

Means of the main effects and interaction of sample 5 were:

\[ A_1 = 11.5142, A_2 = -3.6542, B_1 = 11.0071, \]
\[ B_2 = 3.6357, B_3 = 0.6857 \]

Summary ANOV

The results of analysis, using analysis of variance with unequal cells, are shown in Table 12.

Table 12. Summary analysis of variance for sample 5. Treatment was visual-audio, subject-matter history

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>332.1562</td>
<td>332.1562</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>841.7734</td>
<td>420.8867</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>178.5000</td>
<td>89.2500</td>
<td>-</td>
</tr>
<tr>
<td>Error</td>
<td>64</td>
<td>32327.6645</td>
<td>505.1193</td>
<td></td>
</tr>
</tbody>
</table>

\[^{a}\text{For } N = 70.\]
\[^{b}\text{F-values less than 1.00 are not shown.}\]

Conclusion

\[ T_c \text{ is 3.99 at } 1/64 \text{ degrees of freedom and 3.14 at } 2/64 \text{ degrees of freedom with } \alpha \text{ at .05. The computed F values were less than unity, therefore, the values were not significant. The } A \text{ factors represented the treatment and control groups. Since there were no significant differences between the levels of } A, \text{ the experimental group did not learn more according to the evidence. Visual-audio shielding was not effective.}\]
The factor B represented the levels of mental ability. Since there was no significant difference between the levels of B, the indication is that the high, medium, or low mental ability students did not benefit one category more than the others.

\textit{t-test, Sample 5}

Sample 5

Sample 5 had 70 sets of observations; the classification was academic. The null hypothesis of no difference between the experimental group and the control group was to be tested.

\textbf{Model}

To see if the pooled variance model could be used, the data were tested for homogeneity. The variance ratio formula was used:

\[
F = \frac{S_g^2}{S_1^2}
\]

where \( S_g^2 \) was the variance of the subgroup with the greater variance and \( S_1^2 \) was the lesser. For sample 5, subgroup number 1 had a variance value of 662.2934, and subgroup number 2 had 212.0614. Therefore, subgroup number 1 variance was used for the numerator. The solution was:

\[
F = \frac{662.2934}{212.0614} = 3.1231
\]

Since \( F_{34.34} = 1.78 \), the ratio was significant. The pooled variance formula was not used. The statistical model for testing the difference between two means with separate group variance was used, since the data had tested heterogeneous. The model used was:
where $S_{X_1}^2$ and $S_{X_2}^2$ are the squares of the standard errors of the means of the two subgroups and $S^2_x = S^2_2 / K$ where K is the number of observations of the subgroups.

The computation was:

$$S_{X_1}^2 = \frac{662.2934}{35} = 18.9226$$

and

$$S_{X_2}^2 = \frac{212.0614}{35} = 6.0588$$

Therefore:

$$t = \frac{11.5143 - (-3.6543)}{\sqrt{18.9226 + 6.0588}} = 3.0348$$

Conclusion

The table value of $t_{34(K-1)} = 2.034$ with $\alpha$ at .05. The obtained t-value of 3.0348 was, therefore, significant.

The results of the t-test do not agree with those of the ANOV. According to the t-test, there was a significant difference in performance between the experimental groups and the control groups. Visual-audio control using the commercial ear pads was effective in increasing learning. Hypothesis II was rejected for this replication on the basis of the t-test but was not rejected on the basis of the F-test.
Sample 6

Sample 6 consisted of 78 observations from subjects in technical field-courses at Marshalltown Community High School. The courses were electrical and shop. The length of the trial was one hour.

Model

The mathematical model was again:

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk}$$

Limits

Limits were: $I = 2$, $J = 3$, $K = 21$. Again, $K$ is the value of the largest cell frequency.

Frequencies

Table 13 lists the cell frequencies. With this model, $B$ has three levels. Interaction between groups and categories is considered.

Table 13. Frequencies in each cell of sample 6, treatment audio-visual

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, $B_1$</td>
<td>7</td>
<td>11</td>
<td>18</td>
</tr>
<tr>
<td>Medium, $B_2$</td>
<td>16</td>
<td>21</td>
<td>37</td>
</tr>
<tr>
<td>Low, $B_3$</td>
<td>9</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Total</td>
<td>32</td>
<td>46</td>
<td>78</td>
</tr>
</tbody>
</table>
Means

Means for the factors of sample 6 reflect a high category difference in Table 14.

Table 14. Means of sample 6

<table>
<thead>
<tr>
<th>Factor</th>
<th>Means</th>
</tr>
</thead>
<tbody>
<tr>
<td>A₁</td>
<td>20.8187</td>
</tr>
<tr>
<td>A₂</td>
<td>18.6630</td>
</tr>
<tr>
<td>B₁</td>
<td>24.5833</td>
</tr>
<tr>
<td>B₂</td>
<td>22.9559</td>
</tr>
<tr>
<td>B₃</td>
<td>10.1391</td>
</tr>
<tr>
<td>A₁B₁</td>
<td>27.3714</td>
</tr>
<tr>
<td>A₁B₂</td>
<td>23.0812</td>
</tr>
<tr>
<td>A₁B₃</td>
<td>11.6999</td>
</tr>
<tr>
<td>A₂B₁</td>
<td>22.8090</td>
</tr>
<tr>
<td>A₂B₂</td>
<td>22.8428</td>
</tr>
<tr>
<td>A₂B₃</td>
<td>9.1357</td>
</tr>
</tbody>
</table>

Summary ANOV

The summary analysis of variance for sample 6 is shown in Table 15.

Conclusion

Testing the treatment mean square for significance, F calculated is less than 1.00. The value of $F_e$ at the .05 level and 1.72 degrees of freedom is 3.98, therefore, the value was not significant.

No significant difference exists between the treatment group and the control group on the basis of the F-test.
Table 15. Summary analysis of variance for sample 6, history students

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>90.5117</td>
<td>90.5117</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>4741.8554</td>
<td>2370.9277</td>
<td>9.20**</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>100.4140</td>
<td>50.2070</td>
<td>a</td>
</tr>
<tr>
<td>Error</td>
<td>72</td>
<td>18552.3007</td>
<td>257.6706</td>
<td></td>
</tr>
</tbody>
</table>

\(^{a}\text{F-values less than 1.00 are not shown.}\)

\(^{**}\text{Significant beyond the .01 level.}\)

There was insufficient evidence to reject Hypothesis II. Visual and audio shielding using commercial ear pads was not effective under the experimental conditions of this replication.

Testing the category means for significance, the F-value calculated was 9.20. The $F_t$, with $\alpha$ at .01 and 2, 72 degrees of freedom is 4.93. This is a significant figure. A significant difference existed between the levels of mental ability. The mean of 27.3714 for the high mental category of the treatment group, $A_1B_1$ in Table 14, indicates the greater difference exists between category 1 & 2 and 3. Since the value is higher than the value of the mean for category 2 and 3, the mean of gains for the treatment group in this high ability category is significantly higher. Thus, under the experimental conditions, evidence indicates that the treatment had improved the mean level of scores for the treatment group in the high category.
t-tests of Sample 6

Sample 6

The null hypothesis of no difference between the experimental group and the control group was to be tested.

Model

Sample 6 had 78 observations from technical classes. Using the F-test, there was no significant difference detected between the levels of A, i.e., the treatment group and the control group, in sample 6. Computer analysis using the t-test was used. To determine whether there was unequal variance between the two groups, the variance ratio formula was used:

\[
F = \frac{S_g^2}{S_1^2}
\]

where \(S_g^2\) is the sample group of the greater and \(S_1^2\) the lesser.

For sample 6, \(S_1^2\) was 277.7703 and \(S_2^2\) was 327.4524. Therefore, the variance of subgroup 2 became the sample group of the greater variance. The formula was then:

\[
F = \frac{327.4524}{277.7703} = 1.178
\]

Since \(F_{45,31}(K_2-1 \text{ and } K_1-1) = 1.77\), the calculated value was not significant. Variances were considered to be equal, therefore, the pooled variance model was used. The formula was:

\[
t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{1}{K_1} + \frac{1}{K_2}}} = 0.53432
\]
The computation was:

\[ t = \frac{20.8187 - 18.6629}{\sqrt{605.2227 \frac{1}{32} + \frac{1}{46}}} = 0.53432 \]

**Conclusion**

Since the calculated value of \( t \) was less than 1.00, no significant difference was indicated between the treatment group and the control group. On the basis the two tests of replication 4 of Hypothesis II, i.e., the previous F-test and the \( t \)-test, the evidence was not sufficient to reject Hypothesis II. Visual-audio control, using commercial ear pads, was not effective in increasing learning for the technical students at Marshall-town. It is to be noted that the length of the trial was only one hour.

**Hypothesis II, Replication 5**
**Analysis of Variance, Sample 7**

**Sample 7**

In sample 7, 35 observations were used. Subjects were academic students at the Des Moines North High School and the Story City Community School. Subject-material was history and sociology. The high mental category had few observations, therefore, grouping was by only two mental categories. Again, \( A_1 \) and \( A_2 \) represented the experimental and control groups respectively.

**Model**

The model was again:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]
Limits

Limits were: \( I = 2, J = 2, K = 12 \). Again, \( K \) was the value of the entry in the largest cell.

Means

Means of the factors of sample 7 were:

\[
A_1 = 15.2650, A_2 = 1.3067, B_1 = 10.8928, B_2 = 6.9549
\]

Frequencies

Frequencies are listed in Table 16.

Table 16. Frequencies in each cell of sample 7, treatment audio-visual

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment ( A_1 )</th>
<th>Control ( A_2 )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, ( B_1 )</td>
<td>8</td>
<td>6</td>
<td>14</td>
</tr>
<tr>
<td>Low, ( B_2 )</td>
<td>12</td>
<td>9</td>
<td>21</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>15</td>
<td>35</td>
</tr>
</tbody>
</table>

Summary ANOV

Analysis of the trials in sample 7 is summarized in Table 17.

Conclusion

Testing the treatment mean square for significance, \( F \) calculated was less than 1.00. The value of \( F \) with 1, 31 degrees of freedom and \( \alpha \) at .05 is 4.16, therefore, the obtained value was not significant. No difference was found between the experimental groups and the control groups.
Table 17. Summary analysis of variance of sample 7. Treatment was visual-audio, subject-matter history and sociology

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>120.4296</td>
<td>120.4296</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>110.4804</td>
<td>110.4804</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>1166.5859</td>
<td>1166.5859</td>
<td>1.35</td>
</tr>
<tr>
<td>Error</td>
<td>31</td>
<td>26683.2968</td>
<td>860.7514</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)N = 35.
\(^b\)F-values less than 1.00 are not shown.

There was insufficient evidence to reject Hypothesis II on the basis of the results of analysis of variance of this replication.

**t-test, Sample 7**

For sample 7, N = 35, and the subject-classification was academic. The null hypothesis of no difference between the experimental group and the control group was to be tested.

**Model**

To see if the pooled variance model could be used, the data was tested for homogeneity. The variance ratio formula was used:

\[
F = \frac{S^2}{S^2_1}
\]
where $S^2_g$ was the variance of the subgroup with the greater variance and $S^2_1$ the lesser. For subgroup 1, the variance was 622.1435, and for subgroup 2, the variance was 1059.7600. Therefore, the variance of subgroup 2 became the numerator.

The values for testing were:

$$F = \frac{1059.7600}{622.1435} = 1.7034$$

$F_{14, 19}(K_2-1 \text{ and } K_1-1) = 2.26$ interpreted as the 10 percent level, with at .05. The obtained value of $F$ was, therefore, not significant. The variances were considered to be equal, and the pooled variance model was used:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S^2 \left( \frac{1}{K_1} + \frac{1}{K_2} \right)}}$$

The computation was:

$$t = \frac{1059.7600 - 622.1435}{\sqrt{1681.9035 \left( \frac{1}{20} + \frac{1}{15} \right)}} = 1.4378$$

**Conclusion**

$t_{20+15-2(K_1+K_2-2)} = 2.036$ with $\alpha$ at .05. The obtained $t$-value of 1.4378 was, therefore, not significant.

The results of the $t$-test agreed with those of the $F$-test. No significant difference was found between the performance of the experimental groups and the control groups. On the basis of the two tests, the evidence was insufficient to reject Hypothesis II.
Hypothesis II, Replication 6

Sample 8

The final replication toward Hypothesis II, sample 8 utilized 144 observations from the Des Moines Technical High School, Story City and Gilbert Community Schools. The subject-material was classification one and two, technical and science.

The purpose for combining the samples together was to see if the larger N would affect significance. Samples 3 and 5 were combined with a small trial (N = 5) sample from Des Moines North High School. For a more equal balance of cells, only two levels of mental ability were used.

Model

The model used was again:

\[ Y_{ij} = \mu + A_j + B_j + A_B_{ij} + E_{ijk} \]

Again, K is the number of entries in the largest cell.

Limits

Limits were: I = 2, J = 2, K = 45.

Means

Means of the factors of sample 8 were:

\[ A_1 = 13.0389, A_2 = 9.4517, B_1 = 17.1306, B_2 = 4.1724 \]

Summary ANOV

Analysis of the combined samples in sample 8, toward effectivity of visual-audio shielding, is shown in Table 18a.
Table 18a. Summary analysis of variance for the combined samples in sample 8. Treatment was visual-audio

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>17.4375</td>
<td>17.4375</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>890.3125</td>
<td>890.3125</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>441.0625</td>
<td>441.0625</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>140</td>
<td>295621.1875</td>
<td>2111.5798</td>
<td></td>
</tr>
</tbody>
</table>

aN = 144.

bF-values less than 1.00 are not shown.

Conclusion

Since the calculated values were less than unity, they were less than the critical value of F with α at .05 with 1 and 141 degrees of freedom.

There were no significant differences between the groups or categories. There was insufficient evidence to reject Hypothesis II in sample 8. Under these experimental conditions, visual-audio shielding is not effective in increasing learning for students in those technical and science classes.

\[ t\text{-test, Sample 8} \]

Sample 8 had utilized 144 observations from two samples combined. The classification was technical and science. The null hypothesis of no difference between the experimental group and the control group was to be tested.
Model

To see if the pooled variance model could be used, the two subgroups, i.e., the experimental group and the control group, were tested for equal variance. The variance ratio formula was used:

\[ F = \frac{S_2^2}{S_1^2} \]

where \( S_2^2 \) was the value of the greater variance of the subgroups and \( S_1^2 \) the lesser. The variance of subgroup 1 was 511.4423, and subgroup 2 was 3177.0950. Therefore, subgroup 2 was the greater, and the formula became:

\[ F = \frac{3177.0950}{511.4423} = 6.2120 \]

\( F_{84,58}(K_2-1 \text{ and } K_1-1) = 1.79 \) interpreted at the 2 percent level (with \( \alpha \) at .01). Therefore, the obtained value of 6.2120 was highly significant. The variances were unequal. The pooled variance model was not used. The statistical model for testing the difference between two means with separate group variance was used, since the data had not tested homogeneous.

The model used was:

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S_{\bar{x}_1}^2}{K_1} + \frac{S_{\bar{x}_2}^2}{K_2}}} \]

where \( S_{\bar{x}_1}^2 \) and \( S_{\bar{x}_2}^2 \) squares of the standard errors of the means of the two subgroups and \( S_{\bar{x}}^2 = \frac{S^2}{K} \) where \( K \) is the number of observations in a subgroup.

The computation was:

\[ t = \frac{13.0389 - 9.4517}{\sqrt{\frac{511.4423}{59} + \frac{3177.0950}{85}}} = 0.5286 \]
Conclusion

Since the obtained t-value was less than 1.00, it was obviously not significant. The results of the t-test agree with those of the ANOV. There was insufficient evidence to reject Hypothesis II. Visual-audio control using the commercial ear pads was not effective in increasing learning.

Hypothesis II, All Samples
Analysis of Variance

It was decided to test the cumulative effectiveness of the samples used toward Hypothesis II. The questions of experimental interest were whether the experimental groups learned significantly more than their respective control groups considering the samples of all classifications and whether individuals in a given mental category will perform differently than those of another category in the same treatment group.

Model

The model used was again:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

Limits

Limits were: \( I = 2, J = 3, K = 70 \).

Means

Means were:

\[ A_1 = 16.9805, A_2 = 8.8239, B_1 = 13.4934, \]
\[ B_2 = 15.5360, B_3 = 5.4032 \]
Summary ANOV

Analysis of the cumulative samples toward Hypothesis II is shown in Table 18b.

Table 18b. Summary analysis of variance of the cumulative sample toward hypothesis II, treatment audio-visual

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1161.2500</td>
<td>1161.2500</td>
<td>2.52</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>3087.1875</td>
<td>1543.5937</td>
<td>3.35</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>335.9375</td>
<td>167.9687</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>284</td>
<td>130845.5625</td>
<td>460.7236</td>
<td></td>
</tr>
</tbody>
</table>

aN = 290.
bF-value was less than 1.00.

Conclusion

Testing the factor A, the critical value of $F_{1,284} = 3.87$ with $\alpha$ at .05. Since the calculated value was 2.52, it was less than the critical value and was, therefore, not significant. No significant difference was detected between the performances of the experimental groups and the control groups. There was insufficient evidence to reject Hypothesis II on the basis of ANOV of the cumulative sample.

Testing the factor B, the critical value of $F_{2,284} = 3.03$ with $\alpha$ at .05, therefore, the calculated value of 3.35 was significant. The mean level of gain between the categories was significantly different. Since
the mean of $B_1$ and $B_2$ was 13.49 and 15.53, respectively, and the mean of $B_3$ was 5.40, the difference lies between $B_3$ and the other two mean levels.

Testing for interaction between the treatments and categories, the calculated value was less than 1.00, therefore, it was not significant. There was no significant difference detected between the performances of individuals of different mental categories but within the same treatment group. There was no interaction between the type of treatment and the mental ability of the students. There was insufficient evidence to reject Hypothesis IV, which stated there is no interaction between treatment and mental ability.

**t-test, All Samples Toward Hypothesis II**

The samples toward Hypothesis II were tested for cumulative effectiveness using the t-test. The null hypothesis of no difference between the experimental groups and the control groups was tested.

**Model**

To see if the pooled variance model could be used, the subgroups were tested for homogeneity of variance using the variance ratio formula:

$$F = \frac{S_g^2}{S_1^2}$$

where $S_g^2$ and $S_1^2$ were the subgroups having the greater and lesser variance. Subgroup 2 had 461.3967 and subgroup 1 had 452.5617, therefore, the ratio was found by setting the proportion:

$$F = \frac{461.3967}{452.5617} = 1.0195$$
Testing for equal variance, $F_{149,139} = 1.33$, therefore, the calculated value of 1.0195 was not significant. The variances were considered to be equal. The pooled variance model was used:

$$t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{S^2}{K_1} + \frac{1}{K_2}}}$$

The calculation was:

$$t = \frac{17.0971 - 8.8239}{\sqrt{9.13.9584 + \frac{1}{140} + \frac{1}{150}}} = 3.2927$$

**Conclusion**

Testing the levels of A, $t_{140+150-2(K_1+K_2-2)}$ is less than 2.70 with $\alpha$ at .01, therefore, the calculated value was highly significant. The t-test detected a significant difference between the means of the experimental group gains and those of the control group. The evidence was not sufficient to reject Hypothesis II on the basis of this t-test alone.

**Hypothesis II, Summary ANOV, and Summary t-tests**

**Cumulative summary ANOV**

The cumulative analyses of variance toward Hypothesis II was listed in Table 19.

**Summary of t-tests**

The t-test was used as a supplement to the AOV for the samples. Comparison of those means, for the A factors using the t-test, is shown in Table 20a.
Table 19. Summary analysis of variance for all samples toward hypothesis II

<table>
<thead>
<tr>
<th>Source sample</th>
<th>N</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>30</td>
<td>1</td>
<td>209.664</td>
<td>209.664</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>1</td>
<td>934.824</td>
<td>934.824</td>
<td>1.77</td>
</tr>
<tr>
<td>AB</td>
<td></td>
<td>1</td>
<td>1167.695</td>
<td>1167.695</td>
<td>2.21</td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>30</td>
<td>1</td>
<td>6.703</td>
<td>6.703</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td></td>
<td>1</td>
<td>131.207</td>
<td>131.207</td>
<td>a</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>47</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>353.917</td>
<td>353.917</td>
<td>1.04</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td></td>
<td>868.246</td>
<td>434.123</td>
<td>1.28</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td></td>
<td>354.406</td>
<td>177.203</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>332.156</td>
<td>332.156</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td></td>
<td>841.773</td>
<td>420.887</td>
<td>a</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td></td>
<td>178.500</td>
<td>89.250</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>78</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>90.511</td>
<td>90.511</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td></td>
<td>4741.855</td>
<td>2370.927</td>
<td>9.20**</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td></td>
<td>100.414</td>
<td>50.207</td>
<td>a</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>35</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>120.429</td>
<td>120.429</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td></td>
<td>110.480</td>
<td>110.480</td>
<td>a</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td></td>
<td>1166.585</td>
<td>1166.585</td>
<td>1.35</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>144</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>17.4375</td>
<td>17.4375</td>
<td>a</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td></td>
<td>890.312</td>
<td>890.312</td>
<td>a</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td></td>
<td>441.062</td>
<td>441.062</td>
<td>a</td>
</tr>
<tr>
<td>2-7</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>1</td>
<td></td>
<td>1161.250</td>
<td>1161.250</td>
<td>2.52</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td></td>
<td>3087.187</td>
<td>1543.543</td>
<td>3.35</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td></td>
<td>335.937</td>
<td>167.968</td>
<td>a</td>
</tr>
</tbody>
</table>

*Value was less than 1.00.

**Significant beyond the .01 level.
Table 20a. Comparisons of the means and t-test for samples 2-8

<table>
<thead>
<tr>
<th>Sample</th>
<th>N</th>
<th>A1</th>
<th>A2</th>
<th>F</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>30</td>
<td>18.5615</td>
<td>2.8999</td>
<td>_</td>
<td>a</td>
</tr>
<tr>
<td>3</td>
<td>30</td>
<td>21.9888</td>
<td>12.2083</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>4</td>
<td>47</td>
<td>17.3636</td>
<td>15.1039</td>
<td>1.04</td>
<td>_</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>11.5142</td>
<td>-3.6542</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>6</td>
<td>78</td>
<td>20.8187</td>
<td>18.6630</td>
<td>_</td>
<td>a</td>
</tr>
<tr>
<td>7</td>
<td>35</td>
<td>15.2650</td>
<td>1.3067</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>8</td>
<td>144</td>
<td>13.0389</td>
<td>9.4517</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>2-7</td>
<td>290</td>
<td>16.9805</td>
<td>8.8233</td>
<td>2.52</td>
<td>3.29</td>
</tr>
</tbody>
</table>

*Value was less than 1.00.
*Significant beyond the .05 level.

Cumulative summary, all tests

Table 20b lists the cumulative summary of all tests testing Hypothesis II.

Summary conclusions, hypothesis II

Hypothesis II stated, "Video and audio control of ambient stimuli is not effective in increasing learning for students". The audio control consisted of blocking ambient sounds to a subject's audio system by using commercial ear pads.
Table 20b. Cumulative summary of all tests testing hypothesis II

<table>
<thead>
<tr>
<th>Sample</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>_</td>
<td>1.77</td>
<td>2.21</td>
<td>1.91</td>
</tr>
<tr>
<td>3</td>
<td>a</td>
<td>_</td>
<td>b</td>
<td>_</td>
</tr>
<tr>
<td>4</td>
<td>1.04</td>
<td>1.28</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>5</td>
<td>a</td>
<td>_</td>
<td>_</td>
<td>_</td>
</tr>
<tr>
<td>6</td>
<td>_</td>
<td>9.20</td>
<td>a</td>
<td>a</td>
</tr>
<tr>
<td>7</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>a</td>
</tr>
<tr>
<td>8</td>
<td>_</td>
<td>_</td>
<td>_</td>
<td>a</td>
</tr>
<tr>
<td>2-7</td>
<td>2.52</td>
<td>3.35</td>
<td>a</td>
<td>3.29</td>
</tr>
</tbody>
</table>

Values less than 1.00 not shown.

Not tested.

**AOV**

In the analysis of variance, significance of difference was tested between the experimental groups and their respective control groups in each trial. The groups were designated A₁ and A₂. Significance of difference was tested between the levels of mental ability, usually three categories. The categories were designated as the levels of B. Interaction was tested between the groups and categories to see if the mental ability levels benefited differentially from a given treatment.

No significant difference was detected between the A groups. The experimental groups did not gain above the control groups in any sample.
In only one sample, number 6, was there significant difference found between the levels of mental ability, i.e., categories. In sample 6, there was a broad span between the mean IQs of levels $B_1$ and $B_3$. $B_1$ mean was 120, $B_3$ was only 93, a span of 27 points. The mean of gains in the two categories, i.e., the difference between the pre- and post-tests of individual subjects in a category, were greatly different. For the high category, i.e., $A_1B_1$ and $A_2B_1$, the means were 27.3714 and 22.8090 as compared to means in the low category, i.e., $A_1B_3$ and $A_2B_3$, of 11.6999 and 9.1357. Therefore, the low category individuals gained significantly less than the high and medium category individuals.

However, in sample 6, there was no interaction detected. This condition indicates that individuals in the different categories did not benefit differentially from a given treatment. Therefore, the significant difference mentioned was across both levels of A for the different levels of B.

**Hypothesis IV**

Hypothesis IV stated there is no effect of interaction between mental ability categories and the treatments. No interaction was detected in these samples toward Hypothesis II. Evidence was insufficient to reject Hypothesis IV.

**t-tests**

In only one sample, sample 5, was there significant difference found between the A groups. Therefore, in six out of seven samples, the experimental groups did no better than the respective control groups.

Sample 5 contained 70 observations of students in the Des Moines North High School and the Gilbert Community School in academic classes. Sample 5
had tested not significant with the analysis of variance, using stratification into three levels of mental ability.

In the test of the combined samples (samples 2-7), the means tested significantly different between the A levels, i.e., testing all observations without regard to individual differences within the groups, the treatment groups did significantly better than the control groups. However, the t-test is less sensitive in that it does not account for variance in the characteristics of individuals within a group.

The indication is, therefore, that there was variance due to individual characteristics of IQ, within the levels of A, which was effectively accounted for by the stratification into the three levels of category. The significant difference sensed by the t-test was apparently due to this within variance rather than due to the effects of the treatment.

Relating to Hypothesis II, the null hypothesis was not rejected on basis of results of analysis of variance and t-tests, under the experimental conditions. Video and audio control of ambient stimuli, using sound blocking at the subject's ear with commercial ear pads, is not effective in increasing student learning.

Hypothesis III

Hypothesis III stated ineffectiveness of controlling the video and audio stimuli to a student using a visual shield with sound input to the subject's earphones. During a treatment, the subjects studied the printed material of a learning unit, such as a chapter in a textbook, in the same manner as those for Hypothesis II. The experimental-group subjects wore the environment-control apparatus which restricted vision to a certain sec-
tor at the textbook and input a low-level, meaningless, 100-cycle tone to their earphones. The volume was adjusted to a level which blanketed, or masked, the usual classroom or study hall sounds. The control group studied in the usual manner. Both groups were together in the same classroom or study hall as in the trials toward Hypothesis II.

Random choice was made for the groups after pre-testing. As stated before, the criterion was the gain of individuals, i.e., the difference between their pre- and post-tests. Trials were administered in the same way as those toward Hypothesis II which used commercial ear pads for sound blocking.

Analysis of Variance, Sample 9

Sample 9

The first sample testing Hypothesis III, sample 9, contained 71 observations. These observations were taken in technical classes in the Des Moines Technical High School. The subject-matter was electronics.

Two like-trials were combined in this sample. Since virtually all, i.e., 28 of 31, subjects in one of the trials were in the medium category, the data were analyzed with two levels of category. The subject-matter was electrical and electronics. Length of the trials was two hours. Again, A represented the groups and B the categories.

Model

The model used for testing was again:

\[ Y_{ij} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]
Limits

Limits were: I = 2, J = 2, K = 23, the largest frequency in any cell.

Frequencies

Frequencies of the four cells are listed in Table 21.

Table 21. Frequencies for sample 9, audio-visual with sound

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment A₁</th>
<th>Control A₂</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, B₁</td>
<td>15</td>
<td>16</td>
<td>31</td>
</tr>
<tr>
<td>Low, B₂</td>
<td>23</td>
<td>17</td>
<td>40</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>33</td>
<td>71</td>
</tr>
</tbody>
</table>

Means

Means for the main effects of sample 9 were:

\[ A_1 = 25.3473, A_2 = 18.2272, B_1 = 30.6741, B_2 = 15.3449 \]

Data

Data for sample 9 are listed in Table 22.

Summary ANOV

The analysis for effectiveness of the shielding with sound input utilizing two-way classification is shown in Table 23.

Conclusion

The factor A was found to be significant. With \( \alpha \) at .01, the \( F_t \) at 1,69 degrees of freedom is 3.98. The \( F_c \) was 7.91, greater than the criti-
Table 22. Gains of the treatment group and the control group by trial for sample 9, electronics students

<table>
<thead>
<tr>
<th>Trial</th>
<th>Treatment group VAS**</th>
<th>Control group</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>A&lt;sub&gt;1&lt;/sub&gt;</td>
<td></td>
</tr>
<tr>
<td>48.10</td>
<td>0.00</td>
<td>35.10</td>
</tr>
<tr>
<td>46.60</td>
<td>30.70</td>
<td>13.40</td>
</tr>
<tr>
<td>35.50</td>
<td>20.00</td>
<td>36.60</td>
</tr>
<tr>
<td>41.00</td>
<td>36.60</td>
<td>11.00</td>
</tr>
<tr>
<td>B₁</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>48.80</td>
<td>6.60</td>
<td>35.50</td>
</tr>
<tr>
<td>52.50</td>
<td>47.00</td>
<td>42.10</td>
</tr>
<tr>
<td>10.00</td>
<td>0.00</td>
<td>42.10</td>
</tr>
<tr>
<td>9.00</td>
<td></td>
<td>39.40</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57.10</td>
<td>-9.20</td>
<td>-19.00</td>
</tr>
<tr>
<td>42.80</td>
<td>9.50</td>
<td>0.00</td>
</tr>
<tr>
<td>32.80</td>
<td>76.10</td>
<td>4.70</td>
</tr>
<tr>
<td>35.10</td>
<td>34.20</td>
<td>21.20</td>
</tr>
<tr>
<td>11.50</td>
<td>26.80</td>
<td>15.70</td>
</tr>
<tr>
<td>B₂</td>
<td></td>
<td></td>
</tr>
<tr>
<td>#9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30.50</td>
<td>27.70</td>
<td>12.90</td>
</tr>
<tr>
<td>32.80</td>
<td>57.10</td>
<td>20.80</td>
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<tr>
<td>14.50</td>
<td>52.30</td>
<td>8.30</td>
</tr>
<tr>
<td>2.00</td>
<td>0.00</td>
<td>-13.80</td>
</tr>
<tr>
<td>20.80</td>
<td>-20.40</td>
<td>15.50</td>
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<tr>
<td>2.30</td>
<td>25.40</td>
<td></td>
</tr>
<tr>
<td>-30.90</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*N = 72.

**Visual-audio with sound.

dical value. There was significant difference between the treatment group and the control group. Hypothesis III was rejected. It is evident from the means, A<sub>1</sub> = 25.3476 and A<sub>2</sub> = 17.635, the direction of difference is toward the treatment group. According to the experimental evidence, audio-visual shielding with sound input is effective in increasing learning for these students.
Table 23. Summary analysis of variance for sample 9, electronics students. Treatment was visual-audio with sound

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>4167.6523</td>
<td>4167.6523</td>
<td>7.91**</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>478.0195</td>
<td>478.0195</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>1</td>
<td>19.7343</td>
<td>19.7343</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>67</td>
<td>37688.3281</td>
<td>562.5122</td>
<td></td>
</tr>
</tbody>
</table>

aN = 71.

**Significant beyond the .01 level.

bF-value less than 1.00.

t-test, Sample 9

Sample 9 had 71 observations. Subjects were technical students, and the subject-material was electrical and electronics.

Model

The data were first tested for homogeneity to see if the pooled variance model could be used. The variance ratio formula was used:

\[ F = \frac{S_g^2}{S_l^2} \]

where \( S_g^2 \) and \( S_l^2 \) were the subgroups with the greater and the lesser variance. For subgroup 1, the variance was 542.9948 and for subgroup 2, 657.1840. Therefore, subgroup 2 was the greater. The solution was:

\[ F = \frac{657.184}{542.9448} = 1.2104 \]
\( F_{32, 37}(K_2 - 1 \text{ and } K_1 - 1) = 1.77 \) interpreted as the 10 percent level with \( \alpha \) at .05. The obtained value was, therefore, not significant. The variances were considered to be equal. The pooled variance model was used:

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s^2}{K_1} + \frac{1}{K_2}}}
\]

The computation was:

\[
t = \frac{25.3473 - 18.2272}{\sqrt{1200.1288 \frac{1}{38} + \frac{1}{33}}} = 1.2257
\]

**Conclusion**

The table value of \( t_{38+33-2(K_1+K_2-2)} = 1.99 \) with \( \alpha \) at .05. The obtained \( t \)-value of 1.22 was not significant. The results of ANOVA and the \( t \)-test did not agree.

**Partition and \( t \)-test of Sample 9**

**Partition**

After the analysis of variance and \( t \)-testing of sample 9, the results appeared to be contradictory. The \( F \)-test resulted in high significance of difference between the levels of \( A \), but the \( t \)-test sensed no significant difference. Of the 71 observations in sample 9, one trial contained 31 observations and the other 40 observations. It was noted that a one-hour trial with 31 observations had been combined with a two-hour trial. These two trials had been mistakenly combined initially.

It was decided at this point to partition the sample and see if the contradiction could be due to the different lengths of the trials. Com-
puter time was reprogrammed, the data cards were reordered in the proper decks, and t-tests were run on the two trials of sample 9.

The one-hour trial, number 6, tested not significant with $N = 31$ and a t-value of less than 1.00.

The two-hour trial, number 9, tested significant. Data for the trial 9 follows.

Model

The variance ratio formula was used to test for homogeneity of variance, to see if the pooled variance model could be used:

$$F = \frac{S_2^2}{S_1^2}$$

where $S_2^2$ was the greater variance and $S_1^2$ the lesser. Subsample 1 had the greater variance, therefore, it became the numerator in the ratio formula:

$$F = \frac{662.4460}{656.9772} = 1.008$$

Since $F_{22,16}(K_1 - 1$ and $K_2 - 1) = 2.26$, the obtained value was not significant. The data variances were considered to be equal, and the pooled variance model was used:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{K_1} + \frac{1}{K_2}}}$$

The calculations were:

$$t = \frac{23.0782 - 4.8823}{\sqrt{\frac{1}{1319.4232} + \frac{1}{23} + \frac{1}{17}}} = 2.21$$
Conclusion

\[ t_{23+17-2(K_1+K_2-2)} = 2.02 \text{ with } \alpha \text{ at .05.} \] The \( t \)-value was significant at the 5 percent level. The results of the AOV for the total sample and the \( t \)-test for trial 9 agree. Visual-audio control using the sound input was effective in increasing learning for those electrical students in the two-hour trial. Based on the ANOV and \( t \)-test results, Hypothesis III was rejected.

Hypothesis III, Replication 1
Analysis of Variance, Sample 10

Sample 10

Sample 10 contained 44 observations of subjects in science classes at Marshalltown and South Hamilton schools. The subject-material was modern science and chemistry. Two like-trials were combined for a total of 44. To test for the effects of IQ, three categories of mental ability were used. Interaction was written into the mathematical model to see if the categories would benefit differentially from the treatment. Length of the trials was two hours.

Model

The mathematical model used for testing, using ANOV, was again:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

Limits

Limits were: \( I = 2, J = 3, K = 11 \). Again, since the non-orthogonal mode was used, \( K \) was the number in the largest cell.
Frequencies

Frequencies in the cells of sample 10 are listed in Table 24.

Table 24. Frequencies for sample 10, audio-visual with sound

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, $B_1$</td>
<td>6</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>Medium, $B_2$</td>
<td>6</td>
<td>5</td>
<td>11</td>
</tr>
<tr>
<td>Low, $B_3$</td>
<td>11</td>
<td>8</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>23</td>
<td>21</td>
<td>44</td>
</tr>
</tbody>
</table>

Means

Means of the factors were:

$$A_1 = 10.9347, A_2 = 2.9142, B_1 = 8.9571,$$

$$B_2 = 5.8545, B_3 = 6.4684$$

Summary ANOV

Analyzing the effectiveness of visual-audio control using sound in sample 10, the summary analysis of variance is shown in Table 25.

Conclusion

The values of $F_c$ for the treatment, categories, and interaction are less than 1.00 and, therefore, not significant.

For the factor $A$, there was no significant difference between the means of the treatment group and the control group. In this sample of 44 students, learning was not increased by the treatment. There was insufficient evidence to reject Hypothesis III on the basis of this analysis.
Table 25. Summary analysis of variance for sample 10. Treatment was visual-audio with sound, subject-matter science

<table>
<thead>
<tr>
<th>Source^a</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>22.1250</td>
<td>22.1250</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>67.0898</td>
<td>33.5449</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>84.9179</td>
<td>42.4589</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>38</td>
<td>13289.9960</td>
<td>349.7365</td>
<td></td>
</tr>
</tbody>
</table>

^aN = 44.

^bF-values less than 1.00 are not shown.

**t-test, Sample 10**

**Sample 10**

Sample 10 had 44 observations. The classification was science. The null hypothesis of no difference between the means of the two groups was to be tested. To see if the variances could be pooled, the variance ratio formula was used:

\[
F = \frac{S_2^2}{S_1^2}
\]

For subgroup 1, the variance was 288.5388 and for subgroup 2, 321.6450. Subgroup 2 was, therefore, used in the numerator. The solution was:

\[
F = \frac{321.6450}{288.5388} = 1.1147
\]

\[F_{20,22}(K_2-1 \text{ and } K_1-1) = 2.07\] interpreted as the 10 percent level with at .05. The F-value calculated was, therefore, not significant. The
variances were considered to be equal. The pooled variance formula was used:

\[
t = \sqrt{\frac{\bar{X}_1 - \bar{X}_2}{\frac{1}{S^2} \left( \frac{1}{k_1} + \frac{1}{k_2} \right)}}
\]

The computation was:

\[
t = \sqrt{\frac{10.9348 - 2.9143}{610.1838 \left( \frac{1}{23} + \frac{1}{21} \right)}} = 1.5233
\]

Conclusion

The table value of \( t_{23+21-2(k_1+k_2-2)} = 2.019 \) with \( \alpha \) at .05. The obtained \( t \)-value of 1.52 was, therefore, not significant.

The results of the \( t \)-test agreed with those of the \( F \)-test. No significant difference was found between the performance of the experimental group and the control group. There was insufficient evidence to reject Hypothesis III on the basis of this replication.

Hypothesis III, Replication 2

Sample 11

Sample 11 had 47 observations of science students at Marshalltown. Analysis of variance was used. The sample was structured for analysis with three categories of mental ability and interaction.

Model

The mathematical model was again:

\[
Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk}
\]
Limits

Limits were: \( I = 2, J = 3, K = 13 \).

Frequencies

Frequencies in the cells are listed in Table 26.

Means

Means of the factors were:

\[
A_1 = 6.0238, A_2 = -3.1346, B_1 = 1.4523, \\
B_2 = 3.3687, B_3 = 3.9399
\]

Table 26. Frequencies for sample 11, audio-visual with sound

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment ( A_1 )</th>
<th>Control ( A_2 )</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, ( B_1 )</td>
<td>8</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>Medium, ( B_2 )</td>
<td>8</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Low, ( B_3 )</td>
<td>5</td>
<td>5</td>
<td>10</td>
</tr>
<tr>
<td>Total</td>
<td>21</td>
<td>26</td>
<td>47</td>
</tr>
</tbody>
</table>

Summary ANOV

The summary analysis of variance is shown in Table 27.

Conclusion

Since the calculated \( F \)-values were less than 1.00, none were significant. There was no significant difference between the A factors, therefore,
Table 27. Summary analysis of variance for sample 11. Treatment was visual-audio with sound, subject-matter science

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>94.3984</td>
<td>94.3984</td>
<td>b</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>474.9921</td>
<td>237.4960</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>499.9257</td>
<td>249.9628</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>41</td>
<td>20475.0859</td>
<td>499.3923</td>
<td></td>
</tr>
</tbody>
</table>

\[^a] N = 47.

\[^b] F\text{-}values less than 1.00 are not shown.

The treatment group did no better with respect to scores than did the control group.

The lack of significance between the B factors suggests IQ level had no appreciable effect in the sample.

There was insufficient evidence to reject Hypothesis III on the basis of the results of analysis of this sample.

t-test, Sample 11

For sample 11, N = 47. Classification was science, and the length of trial was two hours.

Model

To see if the pooled variance model could be used, the data were tested for equal variances within the subgroups. The variance ratio formula was used:
Subgroup number two had the greater variance. The ratio was:

\[ F = \frac{581.2951}{407.8906} = 1.4251 \]

The table value of \( F \) was 2.07 at 25, 20 degrees of freedom, therefore, the calculated value was not significant. The variances were considered to be equal. The pooled variance model was used:

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{k_1} + \frac{1}{k_2}}} \]

Calculations were:

\[ t = \frac{6.0238 - (-)3.1346}{\sqrt{989.1857 \frac{1}{21} + \frac{1}{26}}} = 1.4118 \]

**Conclusion**

The table value of \( t_{21+26-2(K_1+K_2-2)} \) was 2.017. Therefore, the calculated value was not significant. There was no significant difference detected between the experimental and control group. The results of the ANOV and t-tests agreed. For this replication, the null hypothesis was not rejected. Visual-audio control with sound did not increase learning.
Hypothesis III, Replication 3
*t-test* of Samples 10 and 11

Sample 12

It was decided to combine samples 10 and 11 and test for significance between the experimental and control groups. Samples 10 and 11 consisted of science students at Marshalltown except for one trial, 23 observations of chemistry students at South Hamilton. For a more homogenous sample and to see the effectivity upon modern science students alone, the samples were combined without the chemistry observations for $N = 69$.

Without regard to mental category, the treatment and control groups were tested for significant difference using the *t*-test.

The null hypothesis of no difference between the groups was tested.

Model

To test for unequal variances in the groups, the variance ratio formula was used:

$$F = \frac{S^2}{\frac{A_1}{A_2}} = \frac{458.7290}{375.3577} = 1.22211$$

Since $F_{31, 36}(K_1 - 1$ and $K_2 - 1) = 1.77$, the calculated value was not significant at the 10 percent level. Therefore, the variances were considered to be equal. The pooled variance model was used.

Frequencies

Frequencies of the two cells were:

$$A_1 = 32, A_2 = 37$$
Means

Means of sample 12 were:

\[ A_1 = 9.2437, A_2 = -2.3968 \]

Data

Data for sample 12 are listed in Table 28.

Calculations

Using the pooled variance formula, calculations for sample 12 were:

\[
\begin{align*}
t &= \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{K_1} + \frac{1}{K_2}}} \\
&= \frac{9.2437 - (-)2.3968}{\sqrt{834.0867 \frac{1}{32} + \frac{1}{37}}} = 2.35244
\end{align*}
\]

Conclusion

The table value of \( t_{32+37-2(K_1+K_2-2)} \) is 1.998. The calculated value for \( t \) is significant with \( \alpha \) at .05 level. There was a significant difference between the treatment group and the control. A comparison of the two means indicates the difference to be toward the control group. For the sample of science students at Marshalltown, the visual-audio control using sound was effective in increasing learning according to the results of the \( t \)-test. The null hypothesis of no difference between the groups was rejected on the basis of this sample.
Table 28. Gains of the experimental group and the control group for sample 12, science students

<table>
<thead>
<tr>
<th>Groups *</th>
<th>A&lt;sub&gt;1&lt;/sub&gt;</th>
<th>A&lt;sub&gt;2&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treatment VAS **</td>
<td>Control</td>
<td></td>
</tr>
<tr>
<td>33.26</td>
<td>19.80</td>
<td>-2.60</td>
</tr>
<tr>
<td>12.76</td>
<td>-3.90</td>
<td>-24.40</td>
</tr>
<tr>
<td>-32.00</td>
<td>52.46</td>
<td>48.62</td>
</tr>
<tr>
<td>-5.60</td>
<td>25.58</td>
<td>-3.90</td>
</tr>
<tr>
<td>15.68</td>
<td>-11.80</td>
<td>40.94</td>
</tr>
<tr>
<td>-4.40</td>
<td>6.00</td>
<td>-46.20</td>
</tr>
<tr>
<td>5.36</td>
<td>15.68</td>
<td>7.76</td>
</tr>
<tr>
<td>-0.88</td>
<td>-25.60</td>
<td>12.88</td>
</tr>
<tr>
<td>15.04</td>
<td>-1.82</td>
<td>12.24</td>
</tr>
<tr>
<td>7.62</td>
<td>32.04</td>
<td>-4.96</td>
</tr>
<tr>
<td>6.38</td>
<td>11.40</td>
<td>12.24</td>
</tr>
<tr>
<td>-19.30</td>
<td>7.96</td>
<td>-11.80</td>
</tr>
<tr>
<td>40.70</td>
<td>7.96</td>
<td>-18.70</td>
</tr>
<tr>
<td>31.80</td>
<td>24.62</td>
<td>8.16</td>
</tr>
<tr>
<td>14.84</td>
<td>7.96</td>
<td>-8.40</td>
</tr>
<tr>
<td>28.60</td>
<td>-22.40</td>
<td>25.36</td>
</tr>
<tr>
<td></td>
<td></td>
<td>15.04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-15.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>-8.40</td>
</tr>
</tbody>
</table>

* N = 69.

** Visual-audio with sound.

Hypothesis III, Replication 4
Analysis of Variance, Sample 13

Sample 13

This replication involved students in science classes at the Marshall-town High School. The subject-material studied was modern science. Again, the students were pre-tested before choice of the X or Y group was made, from which the experimental group was drawn. Two-way classification was used in analysis; A<sub>1</sub> and A<sub>2</sub> represented the experimental group and the con-
trol group, respectively, $B_1, B_2,$ and $B_3$ represented three levels of mental category.

**Model**

The mathematical model was again:

$$Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk}$$

**Limits**

Limits were: $I = 2, J = 3, K = 13$ where $K$ was the largest cell frequency.

**Frequencies**

In Table 29, frequencies of each of the four cells are listed.

**Table 29. Frequencies for sample 13, treatment audio-visual with sound**

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, $B_1$</td>
<td>10</td>
<td>13</td>
<td>23</td>
</tr>
<tr>
<td>Medium, $B_2$</td>
<td>10</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td>Low, $B_3$</td>
<td>8</td>
<td>7</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td>30</td>
<td>58</td>
</tr>
</tbody>
</table>

**Means**

Means for the factors of sample 13 were:

$$A_1 = 7.9642, A_2 = -2.9399, B_1 = 3.3391,$$

$$B_2 = 3.8300, B_3 = -1.2399$$
Summary ANOV

Analysis of the means of gains for sample 13 is shown in Table 30.

Table 30. Summary analysis of variance for sample 13. Treatment was visual-audio with sound, subject-matter science

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>57.5351</td>
<td>57.5351</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>363.6914</td>
<td>181.8457</td>
<td></td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>446.9726</td>
<td>223.4863</td>
<td></td>
</tr>
<tr>
<td>Error</td>
<td>52</td>
<td>24251.6523</td>
<td>466.3779</td>
<td></td>
</tr>
</tbody>
</table>

aN = 58.

F-values less than 1.00 are not shown.

Conclusion

Since the values of F were less than 1.00, no significant difference between groups or categories was indicated. There was insufficient evidence to reject Hypothesis III. Under these experimental conditions, the visual-audio shielding using the sound input was not effective in increasing learning for the students in these science classes.

t-test, Sample 13

Sample 13 contained 58 observations of modern science students at Marshalltown High School.

Means for the sample were:

\[ A_1 = 7.9643, A_2 = 2.9400 \]
Model

To see if pooled variance could be used, the variance ratio formula was used. The ratio was:

\[ F = \frac{S_2^2}{S_1^2} \]

where \( S_2^2 \) was the greater variance and \( S_1^2 \) the lesser. For this sample, \( S_1^2 = 337.8965 \) and \( S_2^2 = 489.9229 \). The ratio was, therefore:

\[ F = \frac{489.9229}{337.8965} = 1.44992 \]

Since \( F_{27,29} = 1.93 \), the calculated value was not significant. Therefore, the pooled variance could be used.

The computation was:

\[ t = \frac{\bar{x}_1 - \bar{x}_2}{\sqrt{\frac{1}{k_1} + \frac{1}{k_2}}} \]

The computation was:

\[ t = \frac{7.9643 - (-)2.9400}{\sqrt{827.8194 \frac{1}{28} + \frac{1}{30}}} = 2.03306 \]

Conclusion

The table value, \( t_{28+30-2(K_1+K_2-2)} = 2.002 \) with \( \alpha \) at .05. Since the calculated value of 2.03306 was greater, there was significance at .05. There was a significant difference between the treatment group and the control group. The greater mean, 7.9643 for the treatment group, compared to -2.9400 for the control group, suggested the difference was toward the treatment group.
Visual-audio control with sound input was effective in increasing learning for these science students.

The results of this t-test were in contrast with the result of the F-test using analysis of variance. The F-test resulted in no significance at the .05 level.

Hypothesis III, Replication 5
Analysis of Variance, Sample 14

Sample 14

Sample 14 contained observations of 57 academic students at South Hamilton High School. The subject-material was geography and English literature. Again, interaction was written into the model with three levels of mental category to see if the categories would perform differentially.

Model

The mathematical model used for testing with ANOVA was again:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

Limits

Limits were: \( I = 2, J = 3, K = 11 \) where \( K \) is the value of the largest cell.

Frequencies

Frequencies in the cells of sample 14 are listed in Table 31.

Means

Means of the factors of sample 14 were:

\[ A_1 = 21.3724, A_2 = 13.2499, B_1 = 22.7095, \]
\[ B_2 = 12.8888, B_3 = 15.6611 \]
Table 31. Frequencies for sample 14, treatment audio-visual with sound

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment $A_1$</th>
<th>Control $A_2$</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, $B_1$</td>
<td>11</td>
<td>10</td>
<td>21</td>
</tr>
<tr>
<td>Medium, $B_2$</td>
<td>10</td>
<td>8</td>
<td>18</td>
</tr>
<tr>
<td>Low, $B_3$</td>
<td>8</td>
<td>10</td>
<td>18</td>
</tr>
<tr>
<td>Total</td>
<td>29</td>
<td>28</td>
<td>57</td>
</tr>
</tbody>
</table>

Summary ANOV

Table 32 shows the results of analysis of sample 14.

Table 32. Summary analysis of variance for sample 14, academic students. Treatment was audio-visual with sound

<table>
<thead>
<tr>
<th>Source $^a$</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>801.0468</td>
<td>801.0468</td>
<td>1.73</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>2171.4296</td>
<td>1085.7148</td>
<td>2.35</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>213.2421</td>
<td>156.6216</td>
<td>$^b$</td>
</tr>
<tr>
<td>Error</td>
<td>51</td>
<td>23550.8085</td>
<td>461.7805</td>
<td></td>
</tr>
</tbody>
</table>

$^aN = 57.$

$^bF$-values less than 1.00 are not shown.

Conclusion

Since $F_{2,51} = 3.18$, no significant difference was found between the levels of treatment nor the levels of mental category. The academic stu-
Students in the treatment group of this sample did not perform above those in the control group. There was insufficient evidence to reject Hypothesis III on the basis of the results of analysis of this sample.

**t-test of Sample 14**

Sample 14 contained observations of academic students. Of the four trials involved, three utilized geography students and one, English literature. The question arose as to whether this constituted a heterogeneous grouping. And, if so, whether the results would differ, using the t-test.

**Sample 14**

To check the theory, observations from the small trial (11) were withdrawn from the sample leaving \( N = 54 \) observations of geography students. This sample, 14, was tested using the t-test. The hypothesis of no difference between the experimental group and the control group was tested.

**Model**

To test for equal variances, the variance ratio formula was used:

\[
F = \frac{S^2_2}{S^2_1} = \frac{485.6890}{419.8862} = 1.15672
\]

\( F_{27,26} = 1.92 \), therefore, the calculated value is not significant. The variances were considered to be equal. The pooled variance model was used.

**Frequencies**

Frequencies for sample 14 were:

\[ A_1 = 28, \ A_2 = 26 \]
Means

Means of the sample were:

\[ A_1 = 20.3228, A_2 = 11.6361 \]

Calculations

Using the pooled variance model, calculations were:

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{s^2}{K_1} + \frac{1}{K_2}}}\]

The solution was:

\[
t = \frac{20.3228 - 11.6361}{\sqrt{905.5752 \cdot \frac{1}{28} + \frac{1}{26}}} = 1.4962
\]

Conclusion

The table value of \( t_{28+26-2(K_1+K_2-2)} \) was 2.007, therefore, the calculated value was not significant. There was no significant difference detected between the experimental group and the control group. There was insufficient evidence to reject the null hypothesis on the basis of results of this sample. For the sample of academic students, visual-audio control with sound did not increase learning.

Hypothesis III, Replication 5
Analysis of Variance, Sample 15

Sample 15

Sample 15 contained 48 observations of technical-vocational students at the Des Moines Area Community College. The subject-material was data processing and college secretarive procedures. Records of mental ability ratings were not available in the post-high schools. Therefore, no grouping
into categories was used, and the t-test was used to test the null hypothesis of no difference between the levels of A. The levels of A, therefore, represented the experimental group and the control group.

To check for equal variance, the variance ratio formula was used:

\[ F = \frac{S_2^2}{S_1^2} \]

Subgroup one had a variance of 153.3426 and subgroup two, 227.5601. Therefore, subgroup two became the numerator:

\[ F = \frac{227.5601}{153.3426} = 1.4840 \]

\[ F_{24,22}(K_2-1 \text{ and } K_1-1) = 2.03, \text{ therefore, the obtained value was not significant.} \]

The pooled variance model was used:

\[ t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{S^2 \left( \frac{1}{K_1} + \frac{1}{K_2} \right)}} \]

The computation was:

\[ t = \frac{13.2674 - 10.3208}{\sqrt{\frac{1}{23} + \frac{1}{25}}} = 0.7358 \]

**Conclusion**

Since the calculated t-value was less than 1.00, it was obviously not significant at 23+25-2 degrees of freedom. The technical-vocational students in the experimental group did not perform above those in the control group according to the results of the t-test. There was insufficient evidence to reject Hypothesis III on the basis of this sample.
Hypothesis III, Replication 6
Analysis of Variance, Sample 16

Sample 16

The final replication toward Hypothesis III contained 138 observations. As in the last replication toward Hypothesis II, three samples which had been previously tested were combined to see if the larger N would affect significance. Samples 10, 11, and 15 were combined.

Model

The mathematical model used for testing with ANOV was again:

\[ Y_{ijk} = \mu + A_i + B_j + AB_{ij} + E_{ijk} \]

Limits

Limits were: \( I = 2, J = 3, K = 32 \) where \( K \) was the value of the largest cell frequency.

Frequencies

Frequencies in the cells of sample 16 are listed in Table 33.

Table 33. Frequencies for sample 16, treatment audio-visual with sound

<table>
<thead>
<tr>
<th>Mental ability</th>
<th>Treatment A₁</th>
<th>Control A₂</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>High, B₁</td>
<td>31</td>
<td>32</td>
<td>63</td>
</tr>
<tr>
<td>Medium, B₂</td>
<td>18</td>
<td>21</td>
<td>39</td>
</tr>
<tr>
<td>Low, B₃</td>
<td>20</td>
<td>16</td>
<td>36</td>
</tr>
<tr>
<td>Total</td>
<td>69</td>
<td>69</td>
<td>138</td>
</tr>
</tbody>
</table>
Means

Means of the factors of sample 16 were:

\[ A_1 = 14.2057, A_2 = 6.6275, B_1 = 13.6258, \]
\[ B_2 = 3.4549, B_3 = 8.7916 \]

Summary ANOV

Table 34 shows the results of analysis of sample 16.

Table 34a. Summary analysis of variance for sample 16. Treatment was audio-visual with sound, subject-matter data processing and college secretarial procedures

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>1048.5546</td>
<td>1048.5546</td>
<td>2.32</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>2701.6992</td>
<td>1350.4896</td>
<td>2.99</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>1600.8945</td>
<td>800.4472</td>
<td>1.77</td>
</tr>
<tr>
<td>Error</td>
<td>132</td>
<td>59574.8593</td>
<td>451.3244</td>
<td></td>
</tr>
</tbody>
</table>

\(^a_{N} = 138.\)

Conclusion

The value of \( F_{1,132} = 3.92 \) and the value of \( F_{2,132} = 3.07 \) with \( \alpha \) at .05. Testing for significance between the experimental groups and the control groups, the calculated value of 2.32 was less. Therefore, no significant difference was detected. For the large sample, audio-visual control with sound was not effective in increasing learning. There was insufficient evidence to reject Hypothesis III for this ANOV.
Testing for difference between the mental ability categories and the treatment, the calculated values of 2.99 and 1.77 were less. Therefore, no significant difference was detected between the levels of mental category. The higher categories did not learn more due to the treatment than the lower categories. There was insufficient evidence to reject Hypothesis IV.

**t-test of Sample 16**

The N for sample 16 was 138. The hypothesis of no difference between the experimental groups and the control groups was tested.

**Model**

To test for homogeneity, the variance ratio formula was used:

\[ F = \frac{S_g^2}{S_1^2} \]

where \( S_g^2 \) was the subgroup with the larger variance and \( S_1^2 \) the lesser. Subgroup one had a variance of 460.6377 and subgroup two had 453.2690. Therefore, subgroup one became the numerator:

\[ F = \frac{460.6377}{453.2690} = 1.0162 \]

\( F_{68,68}(K_1-1 \text{ and } K_2-1) \) is greater than 1.47, therefore, the obtained value was not significant. The variances were considered equal. The pooled variance model was used:

\[ t = \frac{x_1 - x_2}{\sqrt{\frac{S^2}{k_1} + \frac{1}{k_2}}} \]
The computation was:

\[ t = \frac{14.2057 - 4.6275}{\sqrt{\frac{913.9067}{69} + \frac{1}{69}}} = 2.6318 \]

**Conclusion**

The value of \( t_{69+69-2(K_1+K_2-2)} \) is less than 2.00. The calculated value of \( t \) was greater, therefore, the difference was significant. The greater mean for \( A_1 \) suggested the difference was toward the experimental group. The results of the ANOVA and the t-test did not agree.

Testing for effectivity of the treatment, the experimental group learned more. Audio-visual shielding using sound was effective in increasing learning according to the results of the t-test on the two samples.

Hypothesis III was rejected on the basis of the t-test.

**Hypothesis III, All Samples**

Analysis of Variance

It was decided to test the cumulative effectiveness of the samples used toward Hypothesis III. As in the test of all samples for Hypothesis II, the questions of experimental interests were whether the experimental groups would learn more than their respective control groups and whether individuals in a given mental category would perform differently from individuals in a different category but in the same treatment group. Two-way classification was again used.

**Model**

The model used was again:

\[ Y_{ijk} = \mu + A_i + B_j + A_iB_j + e_{ijk} \]
Limits

Limits were:  I = 2,  B = 3,  J = 72.

Means

Means were:

\[ A_1 = 17.0510, A_2 = 8.1692, B_1 = 17.7020, \]
\[ B_2 = 10.4580, B_3 = 8.0404 \]

Summary ANOV

Analysis of the cumulative samples toward Hypothesis III is shown in Table 34b.

Table 34b. Summary analysis of variance of the cumulative samples toward hypothesis III

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1</td>
<td>2193.3125</td>
<td>2193.3125</td>
<td>4.50</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>957.9375</td>
<td>478.9687</td>
<td>b</td>
</tr>
<tr>
<td>AB</td>
<td>2</td>
<td>774.7500</td>
<td>387.3750</td>
<td>b</td>
</tr>
<tr>
<td>Error</td>
<td>261</td>
<td>127186.0625</td>
<td>487.3027</td>
<td></td>
</tr>
</tbody>
</table>

\[ N = 267. \]
\[ \text{Values less than 1.00 not shown.} \]

Conclusion

Testing for difference between the levels of A, the critical value of \( F_{1,261} = 3.87 \) with \( \alpha \) at .05. The calculated value was 4.50, therefore, the difference was significant. Referring to the means, the value of \( A_1 \)
was approximately double that of $A_2$. The difference was in favor of the experimental group. Hypothesis III was rejected on the basis of the cumulative analysis.

**t-test, All Samples Toward Hypothesis III**

The samples testing Hypothesis III was tested for cumulative effectiveness using the t-test. The hypothesis of no difference between the experimental groups and their respective control groups was tested.

**Model**

To see if the pooled variance model could be used, the subgroups were tested for homogeneity of variance using the variance ratio formula:

$$F = \frac{S_2^2}{S_1^2}$$

where the variance of the larger group was used as the numerator. Subgroup 2 had a variance of 533.0278, and subgroup 1 had 437.5590. The ratio was:

$$F = \frac{533.0278}{437.5590} = 1.2181$$

Testing for equal variance, $F_{127,138}$ is greater than 1.29, therefore, the obtained value of 1.21 was not significant. The variances were not unequal. The pooled variance model was used:

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S^2}{k_1} + \frac{1}{k_2}}}$$

The calculations were:

$$t = \frac{16.7905 - 8.4523}{\sqrt{\frac{1}{134} + \frac{1}{128}}} = 3.09$$
Conclusion

Testing the levels of $A$, $t_{139+128-2(K_1+K_2-2)} < 2.70$ with $\alpha$ at .01. Therefore, the calculated value was highly significant. The $t$-test detected a significant difference between the means of the experimental group gains and the means of the control group gains. Hypothesis III was rejected on the basis of this $t$-test.

Cumulative Analysis Toward Hypothesis III

Cumulative summary AOV

A summary of results of analysis of the data testing Hypothesis III is shown in Table 35 and Table 36. Table 35 shows the combined results of analysis of variance; Table 36 shows combined comparison of means using the $t$-test.

A cumulative summary of $t$-tests and comparison of the means of the samples testing Hypothesis III are shown in Table 36.

Samples 10 and 11 were not significant using ANOV, but when the two were combined and the sample (12) "cleaned up" by removing the chemistry observations, it tested significant at the .05 level. The sample contained observations of modern science students.

Sample 13 contained observations of science students also. Using ANOV, there was no significant difference detected between the groups. But, using the $t$-test to test for significant differences, the experimental group did significantly better than the control group.
Table 35. Cumulative summary AOV for the samples toward hypothesis III

<table>
<thead>
<tr>
<th>Source</th>
<th>sample</th>
<th>DF</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>A</td>
<td>1</td>
<td>4167.6523</td>
<td>4167.6523</td>
<td>7.49**</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>1</td>
<td>478.0195</td>
<td>478.0195</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>1</td>
<td>19.7343</td>
<td>19.7343</td>
<td>a</td>
</tr>
<tr>
<td>10</td>
<td>A</td>
<td>1</td>
<td>22.1250</td>
<td>22.1250</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>67.0898</td>
<td>33.5449</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>84.9179</td>
<td>42.4589</td>
<td>a</td>
</tr>
<tr>
<td>11</td>
<td>A</td>
<td>1</td>
<td>94.3984</td>
<td>94.3984</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>474.9921</td>
<td>237.4960</td>
<td>~a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>499.9257</td>
<td>249.9628</td>
<td>~a</td>
</tr>
<tr>
<td>13</td>
<td>A</td>
<td>1</td>
<td>57.5351</td>
<td>57.5351</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>363.6914</td>
<td>181.8457</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>446.9726</td>
<td>223.4863</td>
<td>a</td>
</tr>
<tr>
<td>14</td>
<td>A</td>
<td>1</td>
<td>801.0468</td>
<td>801.0468</td>
<td>1.73</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>2171.4296</td>
<td>1085.7148</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>313.2421</td>
<td>156.6216</td>
<td>a</td>
</tr>
<tr>
<td>16</td>
<td>A</td>
<td>1</td>
<td>1048.5546</td>
<td>1048.5546</td>
<td>2.32</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>2701.6992</td>
<td>1350.8496</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>1600.8945</td>
<td>800.4472</td>
<td>1.77</td>
</tr>
<tr>
<td>17</td>
<td>A (All)</td>
<td>1</td>
<td>2193.3125</td>
<td>2193.3125</td>
<td>4.50</td>
</tr>
<tr>
<td></td>
<td>B</td>
<td>2</td>
<td>957.9375</td>
<td>478.9687</td>
<td>a</td>
</tr>
<tr>
<td></td>
<td>AB</td>
<td>2</td>
<td>774.7500</td>
<td>387.3727</td>
<td>a</td>
</tr>
</tbody>
</table>

** Significant beyond the .01 level.

^ F-values were less than 1.00.

Summary

Cumulative summary, hypothesis III

The cumulative summary of all tests for Hypothesis III is shown in Table 37.
Table 36. Cumulative summary of t-tests and means of the samples toward hypothesis III

<table>
<thead>
<tr>
<th>Sample</th>
<th>N</th>
<th>$A_1$</th>
<th>$A_2$</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>71</td>
<td>25.3476</td>
<td>17.6352</td>
<td>1.22</td>
</tr>
<tr>
<td>9b</td>
<td>40</td>
<td>23.0782</td>
<td>4.8823</td>
<td>2.21*</td>
</tr>
<tr>
<td>10</td>
<td>44</td>
<td>10.9348</td>
<td>2.9143</td>
<td>1.52</td>
</tr>
<tr>
<td>11</td>
<td>47</td>
<td>6.0238</td>
<td>-3.1346</td>
<td>1.41</td>
</tr>
<tr>
<td>12</td>
<td>69</td>
<td>9.2437</td>
<td>-2.3968</td>
<td>2.35*</td>
</tr>
<tr>
<td>13</td>
<td>58</td>
<td>7.9643</td>
<td>-2.9400</td>
<td>2.03*</td>
</tr>
<tr>
<td>14</td>
<td>57</td>
<td>20.3228</td>
<td>11.6361</td>
<td>1.49</td>
</tr>
<tr>
<td>15</td>
<td>48</td>
<td>13.2674</td>
<td>10.3208</td>
<td>0.73</td>
</tr>
<tr>
<td>16</td>
<td>138</td>
<td>14.2057</td>
<td>4.6275</td>
<td>2.63**</td>
</tr>
<tr>
<td>17</td>
<td>16,790</td>
<td>16.7905</td>
<td>8.4523</td>
<td>3.09**</td>
</tr>
</tbody>
</table>

*Significant beyond the .05 level.

**Significant beyond the .01 level.

Table 37. Cumulative summary of all tests toward hypothesis III

<table>
<thead>
<tr>
<th>Sample</th>
<th>AOV Source</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>$A_1$</td>
<td>7.40</td>
<td>$b$</td>
<td>$a$</td>
<td>1.22</td>
</tr>
<tr>
<td>9b</td>
<td>$A_2$</td>
<td>$b$</td>
<td>$b$</td>
<td>$b$</td>
<td>2.21</td>
</tr>
<tr>
<td>10</td>
<td>$A_1$</td>
<td>$a$</td>
<td>$a$</td>
<td>$a$</td>
<td>1.52</td>
</tr>
<tr>
<td>11</td>
<td>$A_2$</td>
<td>$a$</td>
<td>$a$</td>
<td>$a$</td>
<td>1.41</td>
</tr>
<tr>
<td>12</td>
<td>$A_1$</td>
<td>$b$</td>
<td>$b$</td>
<td>$b$</td>
<td>2.35</td>
</tr>
<tr>
<td>13</td>
<td>$A_2$</td>
<td>$a$</td>
<td>$a$</td>
<td>$a$</td>
<td>2.03</td>
</tr>
<tr>
<td>14</td>
<td>$A_1$</td>
<td>1.73</td>
<td>2.35</td>
<td>$a$</td>
<td>1.49</td>
</tr>
<tr>
<td>15</td>
<td>$A_2$</td>
<td>$b$</td>
<td>$b$</td>
<td>$a$</td>
<td>2.63</td>
</tr>
<tr>
<td>16</td>
<td>$A_1$</td>
<td>2.32</td>
<td>2.99</td>
<td>1.77</td>
<td>2.63</td>
</tr>
<tr>
<td>17 (All)</td>
<td>$A_2$</td>
<td>4.50</td>
<td>$a$</td>
<td>$a$</td>
<td>3.09</td>
</tr>
</tbody>
</table>

Values less than 1.00 not shown.

Not tested.
Summary conclusions

Hypothesis III stated the null effect, of audio-visual shielding with an audio-blanket sound input, upon the gain scores of the experimental group. The sound input to the subject's audio system was a 100-cycle tone of low amplitude.

ANOV

In the analysis of variance, significance of difference between the experimental groups and their respective control groups in each trial was tested as the levels of A. Significance of difference between the mental ability categories was tested as the levels of B. Significance of interaction between the levels of A and B was tested.

The difference between the levels of A of sample 9 was highly significant. And, in the ANOVA, the difference between the levels of A in the cumulative sample where all samples were tested together was significant. The experimental groups performed significantly better than the control groups for those two samples. There was no other significant difference found between the levels of A.

No significant difference was detected between the levels of B. No significant interaction between the levels of A and B, in the samples testing Hypothesis III, was detected.

t-tests

For four samples of the nine, significant differences were detected between the levels of A. They were samples 12, 13, 16, and 17. Sample 16 had combined three previous samples, and sample 17 was a cumulative analysis of all the samples toward Hypothesis III. In the other five samples,
no significant difference was found between the levels of A, using the t-test.

**Hypothesis IV**

Concerning interaction between mental ability and the treatments, no significance was found in the data of this section. The subjects did not gain differentially between mental ability categories within a given treatment. There was insufficient evidence to reject Hypothesis IV.
DISCUSSION

Environmental Control

General

If the principle of environmental control of distractive stimuli at the individual's level is effective in increasing learning, many persons might benefit from it. Regardless of mental ability level, the need to increase study efficiency for students seems to be universal. Surprisingly, only one sample reflected a significant difference between mental ability categories; the difference was found to be in favor of the higher category. One might expect the low ability individuals to gain over a wider range of scores in response to innovation. Their initial score may be only half that of the high individuals. Therefore, to double his gain, one individual may only need to improve his post-test score from 20 to 40. But, the high ability individual may need to improve a score of 80 to show a gain. In Table 14, the mean of the low ability group in the $A_1B_3$ cell, i.e., the treatment group, category 3, was only 11-plus compared to 23-plus and 27-plus for the medium and high ability categories in the treatment group. The gains in that sample favored the higher categories.

However, the above is not to say that benefit from the gain is categorically in favor of the higher achievers. While the percentage of gain for a low ability individual may be much less than for a high ability individual, the educational value to him of any gain whatsoever may be greater. But, throughout the study, significance of categories was found to be low.

The question arises how the principle of environmental control at the individual's level would affect mentally deficient or brain damaged indi-
viduals. Perhaps the resulting added concentration may help them achieve more and attain a more firm initial footing in some areas of study, based on the theory that such individuals are more easily distracted from study and have shorter concentration periods. This study, however, did not investigate the effects of shielding upon mentally deficient or mentally retarded individuals. Presumably, to gather data against hypotheses concerning this group, many of the techniques would need to be altered from those used in this study. Specialist help from developmental and clinical psychology would also be needed.

An interesting conclusion based upon observation without statistical analysis resulted from the data collection effort. The control group seemed to read consistently faster than the treatment group in virtually all the trials. During the trials, it was the practice of the experimenters to monitor the reading speed of the two groups. Periodically, a page-check was made of individuals in both groups. Notes were taken during trials and then typed without editing in the form of "post-experiment remarks" immediately after the trial. The following are some typical post-experiment remarks:

English testing began in their third period. Again, the subjects were pre-tested and allowed a couple of minutes to adjust the apparatus and get used to it. The reading began at 10:45. Observations were taken every 5 minutes to see the reading position of each individual by treatment group and control group. After 5 minutes of reading time (the reading began on page 163), in the treatment group, 7 were on page 164 and 3 on page 165. Within the control group, 2 were on page 164, 9 on page 165, 2 on page 166, and 1 on page 168. At 10 minutes of reading time, within the treatment group, 4 were on page 165, 4 on page 166, 1 on page 167, and 1 on page 168. Within the control group, 1 was on page 164, 2 on page 165, 1 on page 166, 4 on page 167, and 1 on page 168. At the next reading check, within the treatment group, 4 were on page 166, 4 on page 167, 1 on page 168, and 1 on page 170. Within the control group, 1 was on page 166, 4 on page 167, 6 on page 168, 2 on page 169, 1 on page 170, and 2 on page 172. From just a cursory examination, it looks like the control group is defi-
nately reading faster than the treatment group. At 10 minutes of reading time, there was some restlessness in the class. There were sighs, muffled whistles, and sniffs. There were 10 subjects in the treatment group and 24 subjects in the entire class. At 15 minutes reading time, 7 subjects in the control group appeared restless, and 1 in the treatment group appeared restless. I used a definite set of words in orienting this class of how they were to undertake the reading. "Read for comprehension". It seems to me that this class was reading a little more slowly and a little more carefully than usual. At 20 minutes, there were fewer signs of restlessness in the control group. There were 5 that appeared restless and 2 in the treatment group appeared restless. Apparently these subjects go through a restless period about anywhere from 10 to 15 minutes and recover from that and get back down to working intensely again. Here, for example, only 5 in the 20 minutes appeared restless and 7 of them appeared restless at 15 minutes. The reading was stopped at 21 minutes. Post-tests were completed at 11:10.

No explanation is attempted of the apparent faster reading of the control group over the treatment group, since no statistical analysis was made. It is to be noted, however, that the mean scores of the control group were consistently lower than those of the treatment group throughout the study. This suggests an effect of the isolation was to increase comprehension or to somehow enhance retention for the treatment groups.

Hypothesis I

An examination of the means in sample 1 suggests the balance was in favor of the treatment group, even though environmental control was not complete enough to result in significance on the tests. Results of the data supported the null hypothesis of no significant differences between the groups.

This study did not prove the effects of time, however, i.e., the effects of shorter-vs-longer trial periods. It is most difficult to obtain permission to experiment with an entire class in a given high school for say several hours or days. The trials toward Hypothesis I were only one
hour. This is probably the minimum time for an individual to become familiar with such an apparatus as was used here and begin to utilize it in studying. If there exists a learning factor, i.e., a tendency to improve with practice, one would expect the results to increase in favor of the treatment group with longer trials. Only one-hour trials were conducted in the visual mode.

On the basis of results of analysis of the data of sample 1, the null effect of visual control, as stated in Hypothesis I, is apparent. Hypothesis I was not rejected.

**Hypothesis II**

As stated previously, the only case where IQ category was significant in the entire study was found in sample 6. The reason is not readily apparent. The proportion of individuals in the medium and low categories was not greatly different from other samples, but there were fewer individuals in the high category. Cell $A_1B_1$, i.e., the high category of the treatment group, had the lowest frequency in the sample with only seven observations and the highest mean. Its mean was 27-plus compared to 9-plus for $A_1B_3$ which was the next lowest cell frequency with only 9. One might suspect disparity between categories in the sample as contributing to a chance occurrence to cause the condition. But, the disparity is great between the highest and lowest cell frequencies also, 3 to 1, and there was no interaction noted. So there is a contradiction to the theory that disparity between numbers in the categories caused the significance.

In arguing that an advantage exists in favor of the treatment ("experimental") group over the control group whenever a complicated apparatus is
to be utilized by the treatment group, the effects of such an advantage should certainly have appeared in some of the seven samples analyzed toward Hypothesis II. The apparatus was impressive; commercial ear pads, supported over the top of the head with a padded, adjustable spring steel support was first put on the subject. Then the visual shield was placed over the assembly. The effect was once described as one of being "harnessed in". There was no significant differences found between the treatment group and the control group in any of the seven samples. There was significant difference found between the groups in the "sound" configuration, i.e., the one with sound input, in which the configuration apparatus was not as bulky.

The effects of extended practice were not determined in the part of the study applying to Hypothesis II. Lengths of the trials were one and two hours only. Again, one can only speculate as to the effects of extended study with visual shielding and audio blocking, since neither the one- nor the two-hour trials were significantly effective. As to representation, all three classifications of students were represented in the seven samples toward Hypothesis II.

One of the major characteristics of these data is the difference in the results of analysis toward Hypothesis II and III. Toward the former, there was no significant difference found between the experimental groups and their counterparts, the respective control groups, using the analysis of variance to test for significance. A significant difference was detected in one sample, sample 5, and the cumulative analysis, i.e., all samples together, using the t-test.

The t-test does not account for characteristic variations of individuals within a group, such as IQ. Being less sensitive, it can thus be
expected to sense significance which is really due to these organic variables and not the effects of the treatment.

A check on the IQ characteristics of individuals in sample 5 reveals a wide variation in the IQ groupings of these academic students. Sample 5 had 70 sets of observations from academic students in the Des Moines North High School and the Gilbert and Story City Community Schools. While the majority of individuals in the Gilbert and Story City trials were about equally placed in each of the three IQ categories, the three trials from Des Moines North contained individuals with IQs all in the lower category. The IQs ranged only from 79 to 99.

This variation in performance due to mental ability level would not be detected by the t-test but would be sensed as a significant difference. The results of analysis of the data toward Hypothesis II suggests that such individual differences are present in the data and that those differences were effectively accounted for by blocking in the three IQ categories. This condition is evidenced by the failure to sense a single significant difference between the levels of A with the AOV, but the t-test had sensed significant differences in the two instances.

In the test for homogeneity of variance of sample 5, a significant F-value resulted. There was unequal variance in the data. Therefore, the pooled variance model could not be used for the test, but the statistical model used for testing between two means with separate group variance had to be used. This condition supports the above theory that the significant difference sensed by the t-test for sample 5 was due to internal variances of individuals and not due to the effects of the treatment.
To search the unequal variance theory further, the means of groups $A_1$ and $A_2$ of sample 5 reflect a difference of 15.1684 between them. This wide range supports the theory of unequal variance contributing to the different findings by the two tests.

Hypothesis II stated the null effect upon learning of using visual control and audio control with sound blocking. There were no significant differences found between the experimental groups and their respective control groups in samples 2-8, using analysis of variance. Using the t-test, sample 5 was found to have a significant difference and the cumulative test of all samples, i.e., 2-7. On the basis of these results, Hypothesis II was accepted.

Hypothesis III

Hypothesis III stated the null effect upon learning of visual control and audio control using a sound input to the subject's audio system. The analysis of variance test sensed significant differences between the experimental groups and their respective control groups in two cases, sample 9 and the cumulative analysis of all samples.

Sample 9 contained observations of electrical/electronic students. There was a small span of IQ ratings in the sample; most ratings were in the medium range, i.e., 103-113. The data were also homogeneous with respect to variance. The pooled variance model for the t-test resulted in a nonsignificant sensing.

It was decided at this point to partition sample 9 to try to find the reason for the contradictory results of the tests. All computer runs had been completed at this time, and the results had been written. A recheck
of the two component parts of sample 9, trials 6 and 9, revealed they were of different lengths. Trial 6 was a one-hour trial and trial 9 was a two-hour trial. By design of the analysis, it was not intended to combine trials of different lengths for analysis.

Testing of the component parts of sample 9 was then performed using the t-test. Trial 6 tested not significant, but trial 9, the two-hour trial, tested significant. On the basis of the significant AOV and t-test for trial 9, the null hypothesis was rejected for these electrical students.

The question was then, what conditions caused the disparity in results of the F-test and the t-test of sample 9? The cause seems apparent after consideration of the means in each of the cells. First, a summary of the results seems appropriate:

1. Trial 6 (of sample 9) tested not significant.
2. Trial 9 (of sample 9) tested significant.
3. There was not enough difference sensed between the $A_1$ and $A_2$ for significance when the trials were combined in sample 9.
4. There was not enough difference sensed between the levels of $B$ for significance.
5. No significant interaction was sensed.
6. Sample 9 (trials 6 and 9) tested significant with the F-test.

The answer seems to be apparent when one considers the cell means in the test matrix:
Table 38. Cell means of the test matrix for sample 9

<table>
<thead>
<tr>
<th></th>
<th>$A_1$ experimental</th>
<th>$B_1$ control</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>28.82</td>
<td>32.40</td>
</tr>
<tr>
<td>$B_1$</td>
<td>Trial 6</td>
<td></td>
</tr>
<tr>
<td></td>
<td>23.07</td>
<td>4.88</td>
</tr>
<tr>
<td>$B_2$</td>
<td>Trial 9</td>
<td></td>
</tr>
</tbody>
</table>

Since the t-test senses difference between the levels of $A$, there was not enough difference between the means $A_1B_1$ and $A_2B_1$ for significance in trial 6. There was great difference between the means of cells $A_1B_2$ and $A_2B_2$, i.e., 23.07 and 4.88. Therefore, there was a significant difference between the levels of $A$ for trial 9.

With the trials combined, however, the t-test "lumps" all means together within a given level of $A$, and the difference of the lumped means of $A_1$ and $A_2$ is tested. In this case, the mean of $A_1$ was 25.34 and $A_2$ was 18.22. Although there had been great disparity between the means of the two cells of $A_2$, i.e., $32.40$-$vs$-$4.88$, when the two means were combined, the average was not significantly different from the average of the cells of $A_1$.

Thus the t-test of sample 9, testing the difference between $A_1$ and $A_2$, i.e., 25.34 and 18.22, did not sense significance.

However, since blocking by trial was used in the AOV, the comparison was then between $A_1$ and $A_2$ in each of the levels of $B$. There was enough difference between $A_1B_2$ and $A_2B_2$ to sense high significance in the F-test.

It is noted that the unique contributor to the difference between trials 6 and 9 was length of the trial. This suggests a learning factor.
was present; perhaps if the learning unit which the subjects study were lengthened to two or more hours, a greater difference would result between the experimental group and the control group.

The results were significant using the t-test in four instances other than the sample 9 which was previously discussed. Of all the analyses toward Hypothesis III, five were significant (three at the .05 level and two at the .01 level), and five were not significant.

Samples 10 and 11, science students, were not significant. But, when the two samples were combined and the chemistry observations removed for a more homogeneous grouping of modern science observations, the sample (12) tested significant. For the modern science students, the audio-visual control using sound was effective. Hypothesis III was rejected.

Sample 13 tested significant with the t-test but not with the F-test. This sample also contained modern science students. A check of the cell means of the test matrix suggests a similar condition to the one found in sample 9; there was considerable difference between the means of A₁ and A₂ taken over all levels of B. The t-test sensed this difference as significance. But, when blocking into three levels of mental ability was used for the AOV, there was not enough difference between A₁ and A₂ within each category of mental ability to be significant. Thus the F-test was not significant, but the t-test was. For this group of science students, Hypothesis III was not rejected.

Sample 14 was not significant using either test. For these academic students, Hypothesis III was accepted. The audio-visual control was not effective in increasing learning. It was noted in the observation notes and the post-experimental remarks these students seemed preoccupied with
the apparatus. They adjusted the volume often, they discussed the apparatus, they looked over the mechanism, and called for experimenter help often.

It is the impression of the experimenter that these academic subjects need a longer training orientation period to become acquainted with and used to the apparatus. Then, the true effect of the audio-visual-sound principle, as it applies to these academic students, can be assessed.

Sample 15 was not significant using the t-test. Records of mental ability were not available for these voc-tech students at the area community college level. Therefore, there was no grouping by category, and only the t-test was applied to the data. For these students, Hypothesis III was accepted. The audio-visual-sound control was not effective.

The subject-material in the learning unit of sample 15 was accounting procedures. There was a majority of girls in the class. It is the opinion of the experimenter the two trials of this sample were biased in that the girls "didn't take to" the apparatus. There seemed to be excessive self-consciousness on the part of the girls when they were drawn in the experimental draws. And, they fussed over hairdos and complained that the wings of the apparatus messed up the hair. It was a policy of the experiment, during all trials of the study, not to accept escapes. Once drawn into the experimental group, no substitutes for individuals or transfers were accepted. This practice controlled biasing due to volunteering of the confident students and escapes of the shy ones, but it resulted in excessive complaining in these trials where most of the students were girls.

The solution for a better evaluation of the effectiveness of the audio-visual-sound concept, where there is a considerable number of female subjects present in the trial, calls for modification of the apparatus to bet-
ter accommodate the female coiffure and practice to encourage her to become more at ease with the apparatus.

In sample 16, the t-values did not reach significance, but the t-test was significant at the .01 level. This test involved a large N, 138. Since these was a combination of three samples and since the F-value did not quite reach significance, the high t-value could be due, at least in part, to internal variances of individuals. However, the data tested homogeneous using Hartley's test before the pooled variance model was used. So there was significance, at least to some degree, when the large N of 138 was tested. For this sample, the hypothesis was rejected. The principle of control using audio-visual-sound was effective for this group of science students.

Sample 17 was a combination of all samples, technical, vocational, and academic. The idea was to see if the experimental groups, of all samples using audio-visual-sound, would perform significantly better than their respective control groups in each of the trials of each sample.

The AOV test was significant with $\alpha$ at .05, and the t-test was significant with $\alpha$ at .01. For all samples toward Hypothesis III, considered together, the principle of environmental control for individuals using audio-visual with sound was effective in increasing learning. Considering all samples, Hypothesis III was rejected.

**Hypothesis IV**

Hypothesis IV stated the null effect of interaction between mental ability categories and the treatments. No interaction was found in the entire study. Hypothesis IV was accepted.
SUMMARY AND RECOMMENDATIONS

Procedure, Findings, and Application

Purpose

The purpose of the study was to see if learning could be improved by controlling the environment at the individual student's level. The idea was to control against random, unwanted, visual and audio stimuli.

An experiment was designed to take observations of student-subject's performance in certain Iowa schools. If control of a subject's environment at the individual's level was effective in increasing learning, attention could then be directed to help various groups and individuals learn faster.

The intent was to find out the effect of such control upon students in their school environment, i.e., the classrooms and study halls. Some 900 observations were made in technical-vocational schools, in area community colleges, and in high schools of Iowa.

Design

The study was designed to utilize an experiment in the schools. Data from the experiment would be analyzed and the results applied toward the hypotheses concerning the effectivity of such environmental control. Four hypotheses were formulated:

Hypothesis I - Video control of ambient visual stimuli is not effective in increasing learning for students.

Hypothesis II - Video and audio control of ambient stimuli is not effective in increasing learning.

Hypothesis III - Video control of ambient stimuli with an audio-blanket sound input is not effective in increasing learning for students.
Hypothesis IV - There will be no interaction between the treatments and the levels of mental ability.

Method

To obtain data to apply to the hypotheses, the pre-test, post-test, random-choice design was chosen. Each trial involved an experimental group and a control group. Each trial involved an entire class of students at a given time. Lengths of the trials, i.e., the study period, was one and two hours.

The subjects were first pre-tested, then they studied the learning unit, and then they were post-tested over the subject-matter of the learning unit. The gain, i.e., the difference between an individual's pre-test and his post-test was the "score" used in analysis. The mean gains of the experimental groups and the respective control groups were analyzed for effectivity of the treatments.

Analysis

In analyzing the data, analysis of variance and the t-test were used to analyze for significant differences between groups, between the levels of mental ability, and interactions.

Apparatus

An apparatus was developed and patented to control the experimental subject's environment. Three configurations were used: the visual shield, the visual shield and audio-blocking, and the visual shield audio control using sound.
Grouping

When mental ability records were available, subjects were grouped in three categories: the high category ranged from a rating of 114 upward, the medium from 103 through 113, and the low from 102 downward. In those trials involving the area community colleges and the technical institute, such records were not available, and analysis of variance single class and the t-test were used.

Results

A summary of the cumulative analysis of all data is shown in Table 39.

Hypothesis I - was accepted. In sample 1, there were 78 observations. Length was one hour. The subject-matter was technical. The AOV sensed no significant difference between the experimental group and the control group, nor between the levels of mental ability, nor interaction. The t-test agreed with respect to the null effect of visual control. The null hypothesis was accepted.

Hypothesis II - was accepted. Some significance was sensed between the experimental group and control group, however. In samples 2-8, no significant differences were found by the AOV between the experimental groups and their control groups. The t-test sensed significant differences in sample 5 and the cumulative sample. It appeared that interval variance of individuals within groups caused the significant sensing. Hypothesis II, which stated the null effect of audio-visual control using sound blocking, was accepted for these data.

Hypothesis III - was rejected for the technical students and the science students but not for the academic students.
Table 39. Cumulative summary of the analyses of all data

<table>
<thead>
<tr>
<th>Hypotheses</th>
<th>Sample</th>
<th>AOV Source$^a$</th>
<th>A</th>
<th>B</th>
<th>AB</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>1</td>
<td></td>
<td>_b</td>
<td>1.10</td>
<td>_b</td>
<td>1.66</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td></td>
<td>_b</td>
<td>1.77</td>
<td>2.21</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>1.34</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td></td>
<td>1.04</td>
<td>1.28</td>
<td>_b</td>
<td>_b</td>
</tr>
<tr>
<td>II</td>
<td>5</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>3.03</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td></td>
<td>_b</td>
<td>9.20</td>
<td>_b</td>
<td>_b</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>1.43</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
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<tr>
<td></td>
<td>2-7</td>
<td></td>
<td>2.52</td>
<td>3.35</td>
<td>_b</td>
<td>3.29</td>
</tr>
<tr>
<td>III</td>
<td>9</td>
<td></td>
<td>7.40</td>
<td>_b</td>
<td>_b</td>
<td>1.22</td>
</tr>
<tr>
<td></td>
<td>9b</td>
<td></td>
<td>_c</td>
<td>_c</td>
<td>_c</td>
<td>2.21</td>
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<tr>
<td></td>
<td>10</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>1.52</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>1.41</td>
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<tr>
<td></td>
<td>12</td>
<td></td>
<td>_c</td>
<td>_c</td>
<td>_c</td>
<td>2.35</td>
</tr>
<tr>
<td></td>
<td>13</td>
<td></td>
<td>_b</td>
<td>_b</td>
<td>_b</td>
<td>2.03</td>
</tr>
<tr>
<td></td>
<td>14</td>
<td></td>
<td>1.73</td>
<td>2.35</td>
<td>_b</td>
<td>1.49</td>
</tr>
<tr>
<td></td>
<td>15</td>
<td></td>
<td>_c</td>
<td>_c</td>
<td>_c</td>
<td>_b</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td></td>
<td>2.32</td>
<td>2.99</td>
<td>1.77</td>
<td>2.63</td>
</tr>
<tr>
<td></td>
<td>9-15</td>
<td></td>
<td>4.50</td>
<td>_b</td>
<td>_b</td>
<td>3.09</td>
</tr>
</tbody>
</table>

$^a$A = treatment.
B = category.
AB = interaction.

$^b$Values less than 1.00 not shown.

$^c$Not tested.

Samples 9-16 applied toward Hypothesis III. In sample 9, the AOV sensed high significance between the experimental group and the control group. These were technical students. Later partitioning of the sample into one- and two-hour trials resulted in significance in the two-hour trial data. A learning factor is apparent; longer trials may result in more significance, especially for the academic students.
Samples 10 and 11 tested not significant singly, but when combined and the sample "cleaned up" by removing some chemistry observations, the modern science-subject observations tested significant.

Sample 13 tested significant with the t-test. Samples 14 and 15 tested not significant. Sample 16 and the cumulative sample tested significant. The t-test was highly significant, but the F-test failed to quite reach significance. The cumulative test, samples 9-15, tested significant with both tests.

Hypothesis IV - was accepted. Hypothesis IV stated the null effect of interaction between mental ability and the types of treatment. No interaction was found in the entire study. The null hypothesis was accepted.

Summary

Hypothesis I was accepted. Visual control was not effective in increasing learning.

Hypothesis II was accepted. Audio-visual control using commercial ear pads to block sound was not effective in increasing learning.

Hypothesis III was rejected for the technical students and science students but not for academic students. Audio-visual control using sound input to the subject's audio system was effective in increasing learning for those two classifications of students.

Hypothesis IV was accepted. There was no interaction found between mental ability levels and the types of treatments.
Recommendations

The findings, in regard to the principle of increasing learning by controlling environmental distractions at the subject's level, suggest several possibilities for gainful use of the principle.

Without regard to individual's IQ rating, students can benefit by use of these controls. The apparatus would not be expensive to provide for entire classes; the cost would probably be on the order of ten dollars per unit.

The results suggest that longer study-units, with students using the apparatus, would result in more significance; i.e., higher rates of learning gain for individuals.

Uses

Some general uses are suggested: college students, who have trouble concentrating in atmospheres of high distractions such as dorms, libraries, or even at home and adults, who are out of practice studying and have difficulty concentrating on written subject-matter or who try to study in atmospheres of high distractions.

For school uses, the principle proved effective for entire classes. The regular classes, where all levels of ability are present, could benefit. Split classes in the cases where some students of the class are either ahead or behind in the subject-matter and need to study during the class period. In this way, the teacher can continue with a presentation while parts of the class are attending to other written matter. In special classes, perhaps low-ability or brain damaged students could be helped to concentrate more intensely on written material.
In many study halls, the atmosphere is not conducive to study. The apparatus would control distractions for individuals.

Programmed study, with little modification to the apparatus, could be utilized. The unit could be connected to a central program station-outlet. Some students in a class could receive programmed instruction through the earphone system of the apparatus while some attend to presentation by the teacher and still others could attend to written matter.

Effectivity of the principle appears greatest and most immediately for the technical and science students. There appears to be a learning factor involved; the longer the usage of the apparatus, the more effective it is. Perhaps the academic students need longer study-units with the apparatus, i.e., to become acquainted with the unit and get used to it and practice for more effectivity.

Summary

Principle

The principle of environmental control at the subject's level should prove beneficial for students in many categories. There seems to be always a need to increase learning efficiency for individuals.

IQ

Only one sample in this study reflected a significant difference between mental ability levels; that difference was found to be in favor of the higher ability category subjects. This seems surprising in that one might expect the lower category individuals to show a greater response to any innovation which could tend to help them gain toward higher achievement. They have lower pre-scores from which to gain and need to improve the
scores over a smaller range in order to show a given percentage of gain. It should be easier for a low category student to double his score by gaining from 20 to 40 than for a higher category student to gain from 50 to 100%. But, the higher category students gained more in the one sample where IQ was significant.

However, the lower category individuals probably benefit more from a given amount of gain. The individuals in higher categories seem to manage well, with or without innovations. But, any gain the lower category individuals can make can be of great benefit to them. The educational value to these individuals may be greater, whatever the amount of gain.

It was not demonstrated how this environmental control affects brain damaged or mentally deficient students. Perhaps the opportunity for added concentration would help them to a better footing in given subject-areas of study. If these students are characteristically more easily distracted from intense concentration, then this principle should prove useful. It was noted throughout the study that the control groups consistently read faster than the experimental groups. No statistical analysis was made of this observation, but it seems to suggest that the experimental groups were concentrating more intensely than the control groups.

**Hypothesis I**

Hypothesis I was accepted on the basis of the analysis. The hypothesis stated the null effect of environmental control by visual shielding of the subject only. The AOV and the t-tests of the data proved not significant. There was no significant difference between the A groups, therefore, Hypothesis I was accepted.
Hypothesis II

Hypothesis II, which stated the null effect on learning of audio-visual control using sound blocking, was accepted. It was in this group of samples that the single case of significance of IQ was found. Succeeding analyses of like subjects in similar classes revealed no other cases where the IQ category was significant.

In two samples, 5 and the cumulative sample, there was significant difference found between the experimental groups and the control groups using the t-test. The t-test does not account for characteristic variations of individuals within a group, such as IQ variations which might exist. In sample 5, there was wide variations in the grouping of those academic students. Using Hartley's test for homogeneity, the data were shown to have unequal variance within. This variance appears to be the source of the significance between the experimental groups and the control groups, rather than the true effects of the treatment. This theory is supported by the lack of significance sensed by the AOV.

In the cumulative samples, where N = 290, there was also wide variation within the samples. The within variation of this sample is also probably the source of the significance sensed by the t-test.

The effects of extended practice over longer study periods were not investigated. Perhaps if the trials were extended from two to several hours duration, different effectivity would result. But, under the conditions of this experiment, audio-visual control using the commercial ear pads to block sound to the subject's audio system was shown to be ineffective in increasing learning. Hypothesis II was thus accepted on the basis of these results.
Hypothesis III

Hypothesis III, which stated the null effect of audio-visual control with sound, was rejected. The control was effective in increasing learning.

In sample 9 and in the cumulative sample, the AOV sensed significance between the experimental groups and their respective control groups.

In five samples of the total of ten, the t-test sensed significance between the experimental groups and their respective control groups.

There was no significance sensed between the levels of IQ in any of the ten samples.

There arose the question, in analysis of sample 9, as to why the t-test was not significant when the ADV had been highly significant. Partitioning and reanalysis of the sample revealed that one- and two-hour trials had been mistakenly combined - initially. The partitioned trial containing the one-hour observations proved not significant; the trial containing the two-hour observations proved significant with both the AOV and the t-test. This outcome suggested that there was a learning factor and that the results would vary with the length of the trials, i.e., study periods.

Not only should an increase in study time prove more effective for the technical students, but it appears that the academic students may improve their performance with such as increase.

Samples 10 and 11, containing observations of science students, were significant singly. But when combined and the sample made more homogeneous by removing a certain trial of chemistry observations, the sample tested significant with the t-test. For those modern science students, the audio-visual control using sound input was effective.
Sample 13 also tested significant with the t-test. But this significance could not be claimed as being entirely due to the effects of the treatment. After the blocking by category in the AOV, no significance was detected by the AOV. For that group of students, Hypothesis III was not rejected.

Sample 14 was not significant using either test. It is the opinion of the experimenter that academic students need longer training/orientation periods, to become acquainted with and used to the apparatus.

Sample 15 was not significant. This class contained a majority of girls. It is felt that they attended more to the apparatus and to their hairdos than to the subject-matter. Modification of the apparatus and longer training periods may result in improved performance by the girls.

Sample 16 was highly significant using the t-test. It had a larger N, i.e., 138. For this sample, Hypothesis III was rejected. The control using audio-visual with sound was effective.

Sample 17 was the cumulative sample of samples 9-15. The AOV was significant, and the t-test was highly significant. Considered over the larger number of observations, i.e., N = 267, the principle of environmental control using audio-visual with sound was effective in increasing learning. Hypothesis III was rejected for these samples.

**Hypothesis IV**

Hypothesis IV, which stated the null effect of interaction, was rejected. As stated previously, no interaction was found in the entire study.
BIBLIOGRAPHY


APPENDIX A

Research Proposal
April 8, 1968

Mr. Paul E. Sumter
C/O Mr. Lowell L. Carver
Industrial Education Curriculum
202 New Industrial Education Building
Iowa State University
Ames, Iowa 50010

Re: Research Proposal #53 - "Learning Experiment: Investigation into learning for: Effectiveness of Visual/Audio Shielding upon student learning; Effectiveness of a conditioner upon student learning"

Dear Mr. Sumter:

Enclosed you will find the following:

Two copies of Voucher No. 1 for signature of proper person. Both copies should be signed on front and back where it is checked in red pencil. Please return both copies to the Research Coordinating Unit.

Two copies of Memorandum of Agreement to be signed by the proper persons. Please return the original to this Unit and you may keep the duplicate.

Very truly yours,

Kenneth M. Wold, Director
Research Coordinating Unit
VOCATIONAL EDUCATION BRANCH

KMW/jc

Encs.
APPENDIX B

Scales, Sample 1
1. To gather data in support of, or against the kinetic theory, which approach is used?
   a. Only true molecules are observed
   b. Single molecules are observed
   c. Atoms and ions are observed
   d. Large groups of molecules are observed

2. Scientists describe molecular behavior by describing:
   a. Individual behavior in a mass of molecules
   b. The average behavior in a mass of molecules
   c. Individual behavior by indirect observation
   d. Individual behavior by direct observation

One basic assumption of the kinetic theory is--matter is composed of molecules:

3. Their chemical properties depend upon
   a. ________________________________

4. Their physical properties depend upon
   a. ________________________________
   b. ________________________________

5. What is a theory? Define. ________________________________

Two other basic assumptions of the kinetic theory describe the nature of motion and momentum of molecules:

6. Which is/are correct regarding motion?
   a. Heating molecules starts them in motion
   b. Their motion causes kinetic energy
   c. They are constantly in motion
   d. b and c are correct
7. Which is/are correct regarding momentum?
   a. Momentum and energy are conserved
   b. Elastic collisions cause momentum and energy to be conserved
   c. a and b are correct
   d. None are correct

8. Regarding the forces between molecules:
   a. Liquid molecules have greater forces between them than do those in solids
   b. The mass in solids is increased because of greater forces between molecules
   c. The mass in liquids is decreased because of greater forces between molecules
   d. Liquids have lesser forces between them than do those in solids

9. Which is true regarding the value of the force between molecules?
   a. The force increases as the distances between them increases
   b. The force increases as the distance between them decreases
   c. The forces can be attractive or repulsive
   d. Both b and c are correct

10. Regarding "normal" spacing:
    a. It is the point of balance of forces between molecules
    b. In solids, normal spacing is less than in liquids
    c. Neither a nor b is correct
    d. Both a and b are correct

TRUE OR FALSE

11. T F Gravitational forces are stronger than inter-molecular forces.

12. T F Inter-molecular forces tend to hold the molecule together.

13. T F Gravitational forces tend to hold the mass together.

14. T F Molecules have no net electrical charge (are neutral).

15. T F Molecules attract, or repel, each other according to the distance separating them.

16. Collisions occur between two molecules when:
    a. The surface-charge density causes regions of net opposite charge, resulting in attraction between them
    b. The surface-charge density causes regions of net equal charge, resulting in attraction between them
    c. Neither a nor b is correct
    d. Both a and b are correct
17. Which is/are correct about the force and distance?
   a. The distance of closest approach in a collision is $2.5 \times 10^{-10}$ meter
   b. The force between molecules varies with distance
   c. At a distance of four diameters apart, the force is about zero
   d. a, b and c are correct

18. Which is true of solids?
   a. Their molecules are spaced more randomly throughout the mass
   b. Their shape is indefinite
   c. They are all crystalline
   d. Their molecular energy is less than gasses

19. Solids:
   a. Are crystalline or amorphous
   b. Have only a regular (orderly) arrangement of particles
   c. Have only a random (dis-orderly) arrangement of particles
   d. Have varying shapes according to their volume

20. Which is true of the particles of solids:
   a. They all have metallic crystals
   b. Crystalline solids may have atomic, molecular, ionic, or macromolecular crystals
   c. None have metallic crystals
   d. a, b and c are correct

TRUE OR FALSE

21. T F Some solids are not crystalline.

22. T F Metals have ionic crystals.

23. T F In metals, the bond is due to a chemical force.

24. T F Some non-metallic elements such as sulfur are crystalline.

25. T F Macromolecular crystals have many small molecular units.

26. T F In a diamond, the atoms share electrons in pairs.

27. T F Diffusion cannot take place in solids.

28. T F Cohesion is the force which binds a solid together.

29. T F Adhesion is the force which causes molecules of a solid to vibrate about a fixed position.
30. Below are three properties of solids which depend upon cohesion. What do they mean?

1. Tensile strength
2. Ductility
3. Elasticity
1. What is a machine?
   a. Anything that produces energy
   b. Any tool that may be used to pry with
   c. Anything that uses energy
   d. Any tool that helps a person do work

2. Energy may be described as:
   a. Anything that is able to move other things
   b. Anything that moves
   c. Anything that is able to move itself
   d. a and c are correct

3. The following are examples of energy:
   a. Food
   b. Electricity
   c. Smoke
   d. a and b are correct

4. Six other forms of energy are named in the text. Name four:
   1. _______________________
   2. _______________________
   3. _______________________
   4. _______________________

5. What is potential energy?
   a. Any energy of motion which is being used
   b. Energy which is being used at a given time
   c. Energy which may be used at a later time
   d. None of the above are correct

6. What do we call the type of energy like a falling boulder or a racing car?
   _______________________

7. How do you classify the following forms of energy?
   Gasoline? ______________________ energy
   Burning Coal? ______________________ energy
   Ultraviolet? ______________________ energy
8. The process of driving can be described as:
   a. An example of transformation of energy
   b. Energy change from mechanical-to chemical-to mechanical
   c. Neither a nor b are correct
   d. Both a and b are correct

9. How are force and energy related?
   a. Energy requires force
   b. Energy is a push or a pull
   c. Force requires energy
   d. Both b and c are correct

TRUE OR FALSE

10. T F When an object is in motion, work is being done.
11. T F When you use kinetic energy, you are performing work.
12. T F If you exert force on an object, you are performing work.

Using the formula \( W = F \times D \), how much work is done in these examples?

13. A 10 lb. weight raised 10 feet? ________________
14. A 10 lb. weight lowered 10 feet? ________________
15. A 2 lb. book is taken 50 feet upstairs? ____________
1. Cellular respiration involves:
   a. Buildup of molecular energy
   b. Intracellular synthesis
   c. Release of molecular energy
   c. Extracellular synthesis

2. Cellular respiration results in:
   a. Uncontrolled oxidation, occurring simultaneously
   b. Buildup of fuel molecules
   c. Controlled oxidation, occurring in steps
   d. Buildup of oxygen molecules

3. Compare cellular respiration with combustion. Which statement is true?
   a. They occur at considerably different temperatures
   b. Respiration results in solar energy, combustion does not
   c. They occur at similar temperatures
   d. Combustion is accomplished by enzyme action

4. Which is fuel for respiration?
   a. Any non-organic molecule present in a cell
   b. The mitochondria of a cell
   c. Any organic molecule present in a cell
   d. The photosynthesis of a cell

5. Typical molecules which serve as fuel for respiration are:
   a. Glucose
   b. Fatty acids
   c. Glycerol
   d. All of the above

6. By what process is energy released in a cell during respiration?
   a. Synthesis
   b. Transfer
   c. Photosynthesis
   d. Oxidation

7. List the three forms of respiration.
   1. ______________________
   2. ______________________
   3. ______________________
8. Using the Mohs scale of hardness, name the abrasive material to match the hardness value given:

<table>
<thead>
<tr>
<th>Hardness</th>
<th>Abrasive Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) 10.00</td>
<td></td>
</tr>
<tr>
<td>2) 9.87</td>
<td></td>
</tr>
<tr>
<td>3) 9.60</td>
<td></td>
</tr>
</tbody>
</table>

9. Which abrasive would you use for grinding the following materials?
   1) Very hard, such as ceramics, pottery, tungsten carbide
   2) Tool steel, high speed steel

10. How is the hardness of grinding wheels determined?
    a. By the hardness or softness of the grains
    b. By the size and hardness of the bonding used
    c. By the size and hardness of the grains
    d. By the amount and kind of bonding used

TRUE OR FALSE:

11. T F Of the 5 types of bonds mentioned, vitrified and silicate are used most.

12. T F Another type of bond mentioned was resinoid.

13. T F The silicate bond is used most often of all.

14. T F The vitrified bond has other materials in it, such as glass, flint, etc.

15. T F The rubber grinding wheel is safer than the vitrious grinding wheel.
APPENDIX C

Scales, Sample 2
1. What is the value of the strength of a magnetic field around a coil?
   a. The value of the strongest field around a single turn of the wire
   b. The value of the weakest field around a single turn of the wire
   c. The maximum strength of all the fields around the turns
   d. The next (or total) effect of all the individual fields around the turns

2. What effect does DC (direct current) flow have upon the magnetic field around a coil?
   a. Induce an e.m.f.
   b. Expand the field
   c. Contract the field
   d. No effect after the field is established

3. Induced e.m.f.:
   a. Produces current itself
   b. Opposes current buildup from the source
   c. Aids current buildup from the source
   d. Induces current itself

4. What determines the value of induced voltage in a coil?
   a. The level of the applied voltage
   b. The rate at which lines of force are cut by wires
   c. The rate at which flux lines are cut by wires
   d. b and c above

5. To induce an e.m.f., which will be most effective?
   a. A 500-turn coil in a 10 V.D.C. circuit
   b. A 300-turn coil in a 5V, 60-cycle circuit
   c. A 300-turn coil in a 50 V.D.C. circuit
   d. A 300-turn coil in a 5V, 400-cycle circuit

6. In a given 60-cycle circuit, what is the period of time for current to build up from zero?
   a. \( \frac{1}{240} \) second
   b. \( \frac{1}{120} \) second
   c. \( \frac{1}{60} \) second
   d. 1 second
7. Given a coil in a 60-cycle a.c. circuit:
   a. The value of current is \( I = \frac{E}{R} \)
   b. The current varies with the inductive reactance
   c. The current is opposed by inductive reactance
   d. Both a and c are correct

TRUE OR FALSE:

8. T F The higher the frequency in an inductive circuit, the lower the induced e.m.f.

9. T F The higher the frequency, the lower the amplitude of induced current in a circuit.

10. T F In an inductive circuit, the current and voltage are one-half cycle apart.

11. Consider power in an inductive circuit, without regard to any resistance. Fill the blanks.
   
   The unit of power is _____________________________
   
   The formula to find power is _____________________________
   
   When voltage is zero, power is _____________________________
   
   When current is zero, power is _____________________________
   
   With \( + V \) and \( - I \), power is _____________________________
   
   With \( - V \) and \( + I \), power is _____________________________
1. An "open" subroutine:
   a. has no "return" mechanism.
   b. has a "compiler" mechanism.
   c. need not be rewritten each time.
   d. d and c are correct.

2. Explain "Linkage".

3. If the address of a jump instruction is bracketed at a given instruction, this signifies:
   a. It is computed by the program.
   b. It is pre-set into the program.

4. In DATAC the SJ is an instruction to:
   a. set index jump.
   b. set up linkages with fewer instructions.
   c. neither a nor c is correct.
   d. both a and c are correct.

5. What is a UJ?
   a. An unconditional indexed jump at the start of a subroutine.
   b. An indexed unconditional jump at the end of a subroutine.

6. The purpose for calling sequences is:
   a. To provide a return address for a subroutine.
   b. To provide a subroutine with extra information.
1. What is a "closed" subroutine?
   a. Any small routine to perform a specific function.
   b. Any small portion of a master program.
   c. A self-contained section to which a main routine jumps then returns after completion.
   d. A separate section of a main routine, which is used to refer the main routine to its correct place.

2. An "open" subroutine:
   a. Has no "return" mechanism.
   b. Has a "compiler" mechanism.
   c. Need not be rewritten each time.
   d. d and c are correct.

3. A necessary feature of a subroutine is:
   a. It must remember the jumps from the main routine.
   b. It must be told where the main routine is jumped from.
   c. It must know where to go when the sub-routine is finished.
   d. b and c are correct.

4. Explain "Linkage".

5. One method of setting up a linkage for a subroutine is:
   a. Leave in the H register a record of where the routine is to jump.
   b. Execute a bring instruction with the same address as the instruction.

6. If the address of a jump instruction is bracketed at a given instruction, this signifies:
   a. It is computed by the program.
   b. It is pre-set into the program.

7. Which is true of a linkage?
   a. It requires a call.
   b. It does not always require a call.
   c. It works wherever it is called.
   d. A and c are correct.
INDEXED LINKAGES

8. In DATAC the SJ is an instruction to:
   a. Set index jump.
   b. Set up linkages with fewer instructions
   c. Neither a nor c is correct.
   d. Both a and c are correct.

9. Which is the function of the SJ?
   a. Jump to the next specified location (as addressed) then store the contents of the location counter.
   b. Place the contents of the location counter in the modifier part of the specified indexer, then jump to the next location as specified by the address, to obtain the next instruction.

10. What is a UJ?
    a. An unconditional indexed jump at the start of a subroutine.
    b. An indexed unconditional jump at the end of a subroutine.

11. Which is the effective address?
    Address shown 14 87
    UJ 0001
    a. Not enough information is shown to determine the effective address.
    b. 14 87

CALLING SEQUENCES

12. The purpose for calling sequences is:
    a. To provide a return address for a subroutine.
    b. To provide a subroutine with extra information.

13. What is the calling sequence technique?

14. Where may a calling sequence be written in the routine?

TRUE OR FALSE

15. T  F The calling sequence must contain the information which is to be found at the specified address.

16. T  F The return address from a linkage will be one location past the linkage.
17. For precise write-ups for routines, what information should the write-ups give?
APPENDIX D

Scales, Sample 3
1. What is the nature of the mechanisms for bonding metals?
   a. Mechanical Fasteners
   b. Metallurgical
   c. Mechanical holders
   d. Cements

2. Which of the following are mechanical applications of the technique of metallurgical bonding?
   a. Sintering
   b. Welding
   c. Soldering
   d. Brazing
   e. All the above

3. What is the fundamental requirement of bonding?
   a. The metals to be joined must be in intimate contact with each other.
   b. The metals be beveled
   c. The metals be clean
   d. The metals need not be in intimate contact

4. A practical limitation to inhibit bonding if the metals remain solid is:
   a. An oxidizing agent is needed
   b. Intimate contact is easy
   c. A carborizing agent is needed
   d. Intimate contact can only be made by squeezing two solids together

5. A practical limitation to bonding is:
   a. Complete cleanliness of metallic surfaces is difficult
   b. Skills are difficult to acquire
   c. Metallic surfaces need not be clean
   d. Surface contact is only at asperities

6. T  F Intimate contact between solids requires plastic flow
7. F  T When pressure is applied to two solids, the contact area is increased by Elastic and Plastic deformation at the contact points
8. T F When the pressure between two solids is sufficient to start plastic flow, complete contact is assured.

9. T F When the pressure between two solids is sufficient to cause plastic flow over the entire contact area, complete contact is assured.

10. T F Metals to be joined must be of the same composition.

11. T F Metals to be joined may be of dissimilar analysis

ANSWER YES OR NO

12. Metals can be joined in which state or states? Yes or No:

   a. Both in liquid state
   b. One in liquid, other in solid state
   c. Both in solid state.
1. The offset plate surface which is known as the "ink-receptive" area is also called:
   a. The non-image area
   b. The printing area
   c. The water-repellent area
   d. Only b and c are right

2. There are 4 different styles of plate ends. Which one of the following is not included:
   a. Slotted, or oval hole
   b. Pin-bar punched
   c. Square
   d. Serrated
   e. Straight

3. Following the developing of a plate, it is generally gummed in order to:
   a. Prevent deterioration of the clear area of the metal plate
   b. Protect the clear areas from smudges of ink
   c. Both a and b are right
   d. Neither a nor b are right

4. In the lithographic field, gum arabic solution:
   a. Is the base of deep-etch coatings
   b. Is mixed with plate etches and fountain solutions
   c. Is applied directly to many types of offset plates to prevent oxidation of the non-image areas
   d. All of the above is true
   e. Only a and c are right

TRUE OR FALSE

5. T F The style of plate end needed depends upon the kind of plate clamps with which the press is equipped.

6. T F Common offset plates were made of aluminum, but now zinc is most common.

7. T F A gummed plate may be used immediately, or its use may be delayed a number of days.

8. T F If an albumin or deep etch plate is to be stored for any length of time, a coating of asphaltum should be applied over the gum.
1. The offset plate surface which is called the "clear area" is also known as:
   a. The water receptive area
   b. The printing area
   c. The ink-repellent area
   d. The image-bearing area
   e. Only a and c are right

2. The offset plate surface which is known as the "ink-receptive" area is also called:
   a. The non-image area
   b. The printing area
   c. The water-repellent area
   d. Only b and c are right

3. The possible ways of graining the surface of an offset plate are:
   a. Mechanical brush graining
   b. Chemical graining
   c. Brush graining
   d. Mechanical graining
   e. All of the above are true except a

4. There are 4 different styles of plate ends. Which one of the following is not included:
   a. Slotted, or oval hole
   b. Pin-bar punched
   c. Square
   d. Serrated
   e. Straight

5. Common offset plates are made of the following materials except one. Which one is it?
   a. Plastic-coated paper
   b. Zinc
   c. Steel on plastic
   d. Aluminum
   e. Plastic on steel

6. Following the developing of a plate, it is generally gummed in order to:
   a. Prevent deterioration of the clear area of the metal plate
   b. Protect the clear areas from smudges of ink
   c. Both a and b are right
   d. Neither a nor b are right

7. If a developed albumin or deep-etch plate is to be stored for any length of time, it should be both gummed and "put under".
   a. Without this coating, the developing ink on the image area might dry and thus not accept ink
   b. This procedure is advised if the plate is to print any color other than black
   c. The gum and asphaltum coatings cannot be removed when the plate is on the press
   d. All of the above are right
   e. Only a and c are right
8. In the lithographic field, gum arabic solution:
   a. Is the base of deep-etch coatings
   b. Is mixed with plate etches and fountain solutions
   c. Is applied directly to many types of offset plates to prevent oxidation of
      the non-image areas
   d. All of the above is true
   e. Only a and c are right

   TRUE OR FALSE

9. T F The surface of an offset plate must be grained to make it ink receptive.

10. T F The style of plate end needed depends upon the kind of plate clamps with
     which the press is equipped.

11. T F All photographic plates are sensitized so that they are usable on both
     sides.

12. T F Common offset plates were made of aluminum, but now zinc is most common.

13. T F The unused plates should be kept in warm location.

14. T F A gummed plate may be used immediately, or its use may be delayed a num-
     ber of days.

15. T F Presensitized plates have a durable lacquer coating, and so, they do not
     usually require being put under.

16. T F If an albumin or deep etch plate is to be stored for any length of time,
     a coating of asphaltum should be applied over the gum.

17. T F There is no need to gum the plate if the press run is interrupted for
     only few minutes.
APPENDIX E

Scales, Sample 4
Reading Pg. 447 (Ch. 36) and Pg. 477 (Ch. 38)

1. We may use the stored energy of plants for food in the form of:
   a. Proteins, enzymes and fats
   b. Proteins, enzymes and carbohydrates
   c. Carbohydrates, fats and proteins
   d. Carbohydrates, enzymes and fats

2. Reasons why the tissues cannot use foods in the eaten form are:
   a. They are too complex chemically
   b. Some are insoluble in water
   c. Both a and b are reasons
   d. Neither a nor b is a reason

3. What is the function of mucus in the mouth?
   a. It lubricates, for chewing and swallowing
   b. It has no function in the digestive system

4. The tongue performs 5 functions. Can you remember 4 of them?

5. The stomach muscles:
   a. Secrete bile into the stomach
   b. Cause a mixing motion
   c. Secrete saliva into the stomach

6. What is the name of the valve which controls passage of food into the small intestine?

7. Digestion in the alimentary canal:
   a. Is intracellular
   b. Is extracellular
   c. Neither a nor b

TRUE OR FALSE

8. T  F Ptyalin is in saliva.

9. T  F Lipase splits fats into fatty acids and glycerin.
10. What is blood?
   a. A fluid
   b. A tissue
   c. Neither a nor b
   d. Both a and b

11. Plasma may be described:
   a. Yellowish, mostly water
   b. Colorless, mostly water
   c. Nine-tenths dissolved food and waste matter
   d. Neither is correct

12. What causes plasma to have its color?
   a. Serum globulin (red)
   b. Hemoglobin (yellow)
   c. Serum albumin (red)
   d. Wastes (straw colored)

13. Red cells:
   a. Pick up oxygen from the cells
   b. Carry waste to the lungs
   c. Pick up oxygen from the lungs
   d. Both b and c are correct

14. What does the blood do?
   a. Carry food to the cells
   b. Carry food away from the cells
   c. Carry oxygen to the cells
   d. A and c are correct

15. When is there danger concerning the Rh factor?
   a. When an Rh positive person receives Rh negative blood for the second transfusion
   b. When antigens (a protein) are present in the blood of a person
   c. When an Rh negative person receives Rh positive blood for the second time

16. In circulation, what prevents the blood from flowing back from the great arteries into the ventricles again?
   a. The PV valves
   b. Nothing, it is supposed to flow from the great arteries into the ventricles
   c. The AV valves

TRUE OR FALSE

17. T  F Your heart is in the left side of your chest cavity.

18. T  F Your heart has four chambers.
Reading Pg. 447 (Ch. 36)

1. We may use the stored energy of plants for food in the form of:
   a. Proteins, enzymes and fats
   b. Proteins, enzymes and carbohydrates
   c. Carbohydrates, fats and proteins
   d. Carbohydrates, enzymes and fats

2. Food is used, at the tissue level, in the forms of:
   a. Glucose, carbohydrates and fatty acids
   b. Fatty acids, carbohydrates and amino acids
   c. Fatty acids, glucose and amino acids
   d. None of the above are correct

3. A basic function of the alimentary canal is:
   a. To digest food for the system
   b. To prepare food for digestion
   c. Neither a nor b is correct
   d. Both a and b are correct

4. Reasons why the tissues cannot use foods in the eaten form are:
   a. They are too complex chemically
   b. Some are insoluble in water
   c. Both a and b are reasons
   d. Neither a nor b is a reason

5. What are the changes in digestion?
   a. Physical
   b. Mechanical
   c. Chemical

6. The function of enzymes in digestion is:
   a. To accomplish mechanical digestion
   b. To accomplish physical digestion
   c. Neither a nor b is correct

7. Do you recall the 3 organs for digestion in the mouth?
   ___________________  ___________________

8. What is the function of mucus in the mouth?
   a. It lubricates, for chewing and swallowing
   b. It has no function in the digestive system
9. Which are saliva glands?
   a. Parotid
   b. Pharynx
   c. Submaxillary
   d. A and c

10. The disease, mumps, is caused by an infection of:
    a. The submaxillary gland
    b. The mucus gland
    c. Neither a nor b is correct

11. The tongue
    a. Has papillae for tasteing
    b. Has sublinguals for tasteing
    c. Both a and b are correct

12. The tongue performs 5 functions. Can you remember 4 of them?

   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________
   _______________________________________________________________________

13. Match the kinds of teeth with their functions.

   Kinds of Teeth | Function
   ---------------|--------
   Incisors       | Grinding
   Premolars      | Tearing
   Canine         | Cutting

14. Match the parts of a tooth above, or below, the gum line:
    (Check "above", or "below", or both)

   Part             Above       Below
   Neck             
   Cementum        
   Enamel          
   Crown           
   Periodontal Membrane
   Dentine         
   Pulp Cavity     

15. The Esophagus:
    a. Is lined with contracting muscles
    b. Is a passageway for food
    c. Is a passageway for breathing
    d. A and b are correct
16. The stomach muscles:
   a. Secrete bile into the stomach
   b. Cause a mixing motion
   c. Secrete saliva into the stomach

17. What enables the different foods to become soluble in the stomach?
   a. Nothing, they are insoluble together
   b. A secretion from the mucus cells in the lining
   c. An enzyme and an acid from cells in the lining

WHAT DO YOU REMEMBER?

18. What are the two elements in the gastric fluid?

19. How long does food usually stay in the stomach?

20. What is the name of the valve which controls passage of food into the small intestine?

21. Which is the largest gland?

22. The Pancreas:
   a. Produced fluid for two different purposes only
   b. Produces pancreatic fluid only
   c. Produces pancreatic acid only
   d. Neither of the above is correct

23. The vermiform appendix is:
   a. Is located at the sigmoid
   b. Is on the small intestine
   c. Is on the cæcum
   d. Is on the chyme

24. Digestion in the alimentary canal:
   a. Is intracellular
   b. Is extracellular
   c. Neither a nor b

TRUE OR FALSE

25. T  F Digestion is essentially hydrolysis.

26. T  F The same enzyme is used in all the digestive processes.

27. T  F Ptyalin hydrolyzes starch.
28. T F Ptyalin is in saliva.
29. T F Pancreatic fluid has 5 enzymes.
30. T F Trypsin is an enzyme which breaks down proteins.
31. T F Amylose changes starch into maltose.
32. T F Lipase splits fats into fatty acids and glycerin.
APPENDIX F

Scales, Sample 5
1. The sectional strife just prior to the Civil War was over various issues:
   a. Tariffs
   b. Banking and currency
   c. Public lands
   d. A, b and c

2. Which is correct about this time in history?
   a. Congress had prohibited slavery before (in a territory)
   b. Before the emancipation, Congress had not prohibited slavery in a State or Territory
   c. Alabama had just come into the Union at this time
   d. Both a and c are correct

3. The Tariff issue:
   a. Caused talk of secession
   b. Caused Jackson to interfere with Federal troops
   c. None of the above

4. How did Texas figure in the strife?
   a. Congress accepted its application as a slave state in 1838
   b. Congress was again faced with the upset of the "balance"
   c. Congress accepted its application as a free state in 1838
   d. James C. Birney (candidate Liberty Party) favored bringing Texas into the Union as a slave state

5. Match the statesmen with the issue(s) they favored:

<table>
<thead>
<tr>
<th>Statesman</th>
<th>Issue(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglass</td>
<td>Compromise of 1850</td>
</tr>
<tr>
<td>Webster</td>
<td>Popular sovemity</td>
</tr>
<tr>
<td>Clay</td>
<td>Fugitive Slave Law</td>
</tr>
<tr>
<td>Calhoun</td>
<td></td>
</tr>
</tbody>
</table>

6. "Free soil, free speech, free men and Fremont":
   a. The Republican party in 1856
   b. The Whigs and "Know Nothing" Party, 1856
   c. The party slogan of James Buchanan, 1856
   d. The party slogan of Millard Fillmore, 1856
TRUE OR FALSE

7. T F The North disliked the Dred Scott Decision.

8. T F The Southerners claimed that the Southern forts, Pickens, Sumter, etc., belonged to the Confederate States of America.

9. When Lincoln first called for 75,000 volunteers:
   a. There were 11 states in the Confederacy
   b. The South had 22,000,000 men
   c. There were 7 states in the Confederacy
   d. The South had 11,000,000 men

10. Missouri:
   a. Was Confederate through the War
   b. Was first Union, then later Confederate
   c. Was Union throughout the War
   d. Was in sympathy with the South first, later the North

11. The first "Bull Run":
   a. The Confederates won it
   b. Was the first important battle
   c. The North won it
   d. A and b are correct

12. At Pittsburg Landing (Shiloh):
   a. General Grant defeated General Forest
   b. General Forest suffered a "serious reversal" by General Johnston
   c. General Grant suffered a "serious reversal" by General Johnston
   d. General Forest defeated General Grant

13. The Gatling gun:
   a. Was used extensively in the War
   b. Had six barrels
   c. Was never adopted by the United States Army

14. Who were eligible for Conscription in the Confederacy?

TRUE OR FALSE

15. T F The North financed the War by the Tariff, Bonds, Income Tax and paper money.

16. T F Of the 2,000,000 in the Union Armies, 180,000 were Negroes.
1. The sectional strife just prior to the Civil War was over various issues:
   a. Tariffs
   b. Banking and currency
   c. Public lands
   d. A, b and c

2. The first serious, political clash between the North and South was over admitting Missouri to the Union:
   a. When Monroe was in office
   b. When Jackson was in office
   c. In 1850

3. What was the real concern over Missouri coming into the Union?
   a. Missouri would even the "balance of power"
   b. Missouri would upset the "balance" in favor of the South
   c. Missouri would upset the "balance" in favor of the North
   d. The North would have 24 votes, the South 22

4. Which is correct about this time in history?
   a. Congress had prohibited slavery before (in a territory)
   b. Before the emancipation, Congress had not prohibited slavery in a State or Territory
   c. Alabama had just come into the Union at this time
   d. Both a and c are correct

5. The Missouri Amendment (Amendment to Missouri's application):
   a. Was proposed by Senator Clay
   b. Was to free the slaves in Missouri
   c. Was proposed by Senator Talmage
   d. Was to free all children in Missouri

6. The Missouri Amendment (1819):
   a. Carried (was adopted) by the Congress
   b. Was defeated, the South "won" the issue
   c. Showed the voting sentiment was not clearly divided between North and South
   d. B and c are correct

7. The Missouri Compromise (to the Amendment to Missouri's application):
   a. Was proposed by Clay to "balance" the power
   b. Was proposed by Talmage in favor of the South
   c. Neither a nor b are correct
8. The Tariff issue:
   a. Caused talk of secession
   b. Caused Jackson to interfere with Federal troops
   c. None of the above

9. The Tariff Act of 1833:
   a. Was proposed by Clay
   b. Was proposed by Talmage
   c. Reduced tariff rates
   d. A and c are correct

10. The "Abolitionists":
    a. Wanted to abolish the Tariff
    b. Wanted the Tariff reduced
    c. Neither a nor b is correct

11. The "Liberator":
    a. Was a paper "against" slavery
    b. Was a paper against the Tariff
    c. Neither a nor b is correct

12. How did Texas figure in the strife?
    a. Congress accepted its application as a slave state in 1836
    b. Congress was again faced with the upset of the "balance"
    c. Congress accepted its application as a free state in 1836
    d. James C. Birney (candidate Liberty party) favored bringing Texas into the Union as a slave state

13. The admission of Texas into the Union:
    a. Was the last of "balance" states
    b. Caused an issue with Great Britain
    c. Caused the United States to take over the boundary dispute with Mexico
    d. Neither of the above is correct

14. The war with Mexico:
    a. Ended with the Treaty of Guadalupe Hidalgo
    b. Resulted in more territory for the slavery issue
    c. Neither a nor b is correct
    d. Both a and b are correct

15. "I know no South, no North, no East, no West to which I owe allegiance":
    a. Jackson
    b. Taylor
    c. Clay
    d. Calhoun
16. Match the statesmen with the issue(s) they favored:

<table>
<thead>
<tr>
<th>Statesman</th>
<th>Issue(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Douglass</td>
<td>Compromise of 1850</td>
</tr>
<tr>
<td>Webster</td>
<td>Popular sovereignty</td>
</tr>
<tr>
<td>Clay</td>
<td>Fugitive Slave Law</td>
</tr>
<tr>
<td>Calhoun</td>
<td></td>
</tr>
</tbody>
</table>

17. The Kansas-Nebraska Act of 1854:
   a. Effectively repealed the Great Compromise
   b. Effectively repealed the Missouri Compromise
   c. Left slavery to the territories decision
   d. B and c are correct

18. The "steam engine in britches":
   a. Belonged to the Northern Democratic Party
   b. Dislike slavery
   c. Proposed the Kansas-Nebraska Act
   d. A, b and c are correct

19. The Republican party:
   a. Was formed during the 1850's
   b. Was formed as a pro-slavery party
   c. Was formed as a result of the Kansas-Nebraska Act
   d. Was formed for expansion of slavery in the territories

20. "Free soil, free speech, free men and Fremont":
   a. The Republican party in 1856
   b. The Whigs and "Know Nothing" Party, 1856
   c. The party slogan of James Buchanan, 1856
   d. The party slogan of Millard Fillmore, 1856

WHAT DO YOU RECALL

21. The Dred Scott Decision ruled on the status of a slave, and also ruled on the constitutionality of a certain Congressional Act. Do you recall the Act, and the Amendment (Constitutional) which the court cited, to making the decision?

   Act    
   Amendment cited by the Court

22. In the Lincoln-Douglass debates:

   What was the "Freeport Doctrine"?

   What was "Popular Sovereignty"?
What was Lincoln's stand on abolition of slavery? ____________________________

Which was Douglass' party? ____________________________
Which was Lincoln's Party? ____________________________

TRUE OR FALSE

23. T  F  John Brown was in favor of slavery.
24. T  F  The North disliked the Dred Scott decision.
25. T  F  Two of the four political parties in 1864 were the Douglass Democrats and the Constitutional Unionists.
26. T  F  The Confederate Constitution was vastly different from the Constitution of the United States.
27. T  F  President Buchanan worked hurriedly to save the situation while the southern states were seceeding, one by one.
28. T  F  The southerners claimed that the southern forts, Pickens, Sumter, etc., belonged to the Confederate States of America.
29. T  F  Lincoln refused to send reinforcements to Fort Sumter, because the Confederates would consider it an act of war.
30. T  F  Lincoln failed to send relief to Fort Sumter, this would appear as though he agreed with a state's right to secede.
TRUE OR FALSE

1. T F Any press can be operated by any person on the basis of trial and error since he has the manual.

2. T F In order to feel comfortable and to protect your fingers while working, you should wear gloves and a loose apron.

3. T F As a check to be certain there is no interference, you should turn the press by means of the handwheel for a revolution or two.

4. T F You should not adjust the speed setting unless the press is stopped.

5. T F The press must be lubricated daily while it is operating.

6. T F The delivery and feeder drive chains have to be lubricated with penetrating oil once a month.

7. T F If the motors have grease fittings, you should add grease twice yearly or every 1,000 hours.

8. T F The recommended oil level in the vacuum-blower pump jars should be checked daily.

9. T F It is better to start with too little ink on the rollers than too much.

10. T F In the feeder set-up process, the first step is to cut a piece of heavy cardboard 1/8" longer and wider than the stock to be run and place this on the paper supports.

11. T F The second step in the feeder set-up process is to fold a sheet of paper stock to be run in the center and place it on the feeder platform, so the crease is 1/8" to the left of the center mark on the scale.

12. T F No press run should be started until the test sheets are approved by the instructor or foreman.

13. T F You are supposed to start the run with a thick supply of image ink; then decrease the amount gradually to obtain the desired density.

14. T F On the test sheets, if the clear areas tend to scum, you should cut back some ink and increase the flow of water a bit.

15. T F If the press is stopped for one minute (while running a metal plate) you must gum the plate immediately.
APPENDIX G

Scales, Sample 6
1. Thermonic Emission describes which action:
   a. Electrons flow to the negative terminal
   b. The negative terminal collects free electrons
   c. Metals give up electrons when heated
   d. Metals collect electrons when heated

2. Given a filament and plate terminal in a powered circuit, current will flow when:
   a. The plate and filament are highly positive
   b. The plate is heated
   c. The filament is heated
   d. The plate and filament are highly negative

3. Thermonic emitters must have which special properties?
   a. Ability to carry high current loads
   b. Ability to withstand high temperatures
   c. Ability to withstand high voltages
   d. Ability to carry high voltage loads

4. A characteristic of thoriated-tungsten is:
   a. It operates at lower temperatures, thus decreasing the power required
   b. It operates at higher temperatures, thus decreasing the power required
   c. It is tungsten, coated with the lighter thorium
   d. It is thorium, coated with the lighter tungsten

5. Which is the most efficient type emitter?
   a. Thoriated-tungsten
   b. Oxide-coated
   c. Nickel-coated
   d. Carbon-tungsten

6. The "cathode" is the emitter in a vacuum tube. Which statement is true?
   a. Directly heated types usually use A.C. power for heating
   b. Cathodes are not usually heated
   c. Indirectly heated types usually use battery power
   d. Directly heated types usually use battery power
7. How much do you remember about materials of which the typical electron tube parts (as shown in text) are made?

<table>
<thead>
<tr>
<th>Part</th>
<th>Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Envelope</td>
<td></td>
</tr>
<tr>
<td>2. Plate</td>
<td></td>
</tr>
<tr>
<td>3. Cathode</td>
<td></td>
</tr>
<tr>
<td>4. Getter</td>
<td></td>
</tr>
</tbody>
</table>

8. Regarding the function of tube parts, the plate:
   a. Acts as emitter of electrons
   b. Acts as collector of electrons
   c. Acts as the heater of the circuit
   d. a and c are correct

9. A diode:
   a. Is a tube with a plate and a cathode
   b. Is a tube with two ("Di") main elements
   c. Neither a nor b is correct
   d. Both a and b are correct

10. In a tube number such as 6H6, the first number designates:
    a. The heaters require 6-volt power
    b. The heater-current characteristics
    c. The cathode convection numbers
    d. The plate connection numbers

11. If the plate of a Diode is positive, what will result?
    a. No electrons will flow
    b. The cathode will be heated
    c. The plate will be heated
    d. Electrons will flow

12. "Saturation" refers to which condition?
    a. No more positive voltage may be applied to the plate
    b. No more negative voltage may be applied to the plate
    c. An increase in plate voltage will not result in an increase in current
    d. An increase in plate voltage will result in an increase in current

13. Which are applications (uses) of Diodes?
    a. Power supplies and rectifiers
    b. Voltage-regulators and rectifiers
    c. Power supplies and voltage-regulators
    d. Power supplies and detectors

TRUE OR FALSE

14. T F The Diode utilizes a grid.
15. T F In Triode operation, an increase in plate voltage results in increasing current.

16. T F The Triode utilizes a grid.

17. T F In Triode operation, electrons cannot pass through a positive "control grid".

18. T F The Triode can amplify the signal.

19. T F When all electrons are repelled by a grid, the condition is called "cutoff".

20. T F When all electrons are repelled by a grid, the condition is "saturation".

21. T F The plate and grid require the same voltage.

22. T F "Bias" refers to the grid voltage.

23. T F Actual conditions in the operation of a tube are "static" conditions.

24. T F "Amplification" refers to a condition where a small change in grid voltage results in a large change in plate voltage.

**PROBLEM**

Given the formula \( MU = \frac{\text{change } E_P}{\text{change } E_g} \); where the change in plate voltage was 20 volts due to a change in grid voltage of 2 volts,

25. Find the amplification factor:
1. What is an abrasive?
   a. Any material sharper than another material
   b. Any material that can wear away a harder material
   c. Any material harder than another material
   d. Any material that can wear away a softer material

2. List the two natural abrasives:
   1. ______________________
   2. ______________________

3. Natural abrasives were limited because:
   a. They contained no aluminum oxide in their composition
   b. They had some impurities in their composition
   c. Aluminum oxide was not evenly distributed in their composition
   d. Choices b and c are both correct

4. An abrasive material was developed which is nearly as hard as diamonds. It is called:
   a. Emery oxide
   b. Silicon carbide
   c. Silicon oxide
   d. Emery carbide

5. Another abrasive material was developed by removing impurities from an existing material. This resulted in the following material and purity:
   a. 98% pure silicon oxide
   b. 98% pure aluminum oxide
   c. 95% pure silicon oxide
   d. 98% pure aluminum oxide

6. What are advantages of artificial abrasives over natural abrasives?
   a. Their purity can be controlled
   b. Their grain size can be controlled
   c. Neither a nor b is correct
   d. Both a and b are correct

7. In manufacture of abrasives, different methods of grading are used. They are:
   a. Grading screens
   b. Hydraulic methods
   c. Sedimentation methods
   d. All of the above
8. List the three products resulting from oxidation of glucose during respiration.
   1. ____________________________
   2. ____________________________
   3. ____________________________

TRUE OR FALSE

9. T  F  Some energy is given off in the form of heat during respiration of warm-blooded animals, but no cold-blooded animals or plants.

10. T  F  ADP (adenosine diphosphate) and ATP (adenosine triphosphate) are energy carriers in both photosynthesis and respiration.

11. T  F  As energy is needed for cell activity, the exchange equation for energy release is ADP + phosphate + energy – ATP.
APPENDIX H

Scales, Sample 7
1. What affect did the Marshall Plan and NATO have upon Western Europe during the Eisenhower administration?
   a. "Lost" those nations to communism
   b. "Shielded" those nations from communism
   c. Neither a nor b are correct

2. The armistice of July, 1953:
   a. Settled the "cold" war in Korea
   b. Settled the "hot" war in Indochina
   c. Settled the "hot" war in Korea
   d. Settled the "cold" war in Indochina

3. "Containment":
   a. The Democratic policy to cope with communism
   b. The Republican policy to cope with communism
   c. Neither a nor b is correct

4. In 1954, Secretary Dulles:
   a. Sent carriers and planes to help the French
   b. Was not willing to extend military aid to the French
   c. Settled the Indochina struggle
   d. Hoped the Geneva Conference would settle the struggle

5. What about the Middle East in 1957?
   a. Dulles advised Eisenhower to decline aid to countries there
   b. Dulles advised Eisenhower to extend aid to countries there
   c. The Bagdad pact was signed then

True or False

6. T F The cold war was settled during the Eisenhower administration.


8. T F Soviet space vehicles were better designed than those of the United States.
1. What affect did the Marshall Plan and NATO have upon Western Europe during the Eisenhower administration?
   a. "Lost" those nations to communism
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   a. Settled the "cold" war in Korea
   b. Settled the "hot" war in Indochina
   c. Settled the "hot" war in Korea
   d. Settled the "cold" war in Indochina

3. Under Eisenhower, John Foster Dulles:
   a. Was Secretary of Defense
   b. Advocated Brinkmanship
   c. Was Secretary of State
   d. b and c are correct

4. "Containment":
   a. The Democratic policy to cope with communism
   b. The Republican policy to cope with communism
   c. Neither a nor b is correct

5. "Massive retaliation":
   a. The Democratic policy for standing up to communism
   b. The Republican policy for standing up to communism
   c. Neither a nor b is correct

6. After the armistice in Korea:
   a. The cold war ended
   b. The cold war intensified
   c. American attention shifted to Europe
   d. American attention shifted to Indochina

7. Vietnam, Cambodia, and Laos:
   a. Were fully independent states
   b. Were Associated States of Indochina
   c. Were protectorates of France
   d. b and c are correct

8. In 1954, Secretary Dulles:
   a. Sent carriers and planes to help the French
   b. Was not willing to extend military aid to the French
   c. Settled the Indochina struggle
   d. Hoped the Geneva Conference would settle the struggle
9. In the SEATO treaty:
   a. The member nations of southeast Asia agreed an attack on one was a threat to all
   b. The member nations of southeast Asia agreed to provide armed forces to resist aggression
   c. The member nations agreed to protect Laos, Cambodia, and Vietnam
   d. None of the above are correct

10. SEATO:
    a. Was Dulles' policy to "roll back" the Iron Curtain
    b. Was the Republican's policy to "roll back" the Iron Curtain
    c. Was Dulles' policy to continue "containment"
    d. Was the Republicans' policy to continue "containment"

11. The 1956 revolts against communism in Hungary and Poland:
    a. Caused Dulles to "Go to the Brink" to liberate them
    b. Weakened the will of the communists to dominate
    c. Were crushed by the Soviets
    d. Neither is correct

12. What about the Middle East in 1957?
    a. Dulles advised Eisenhower to decline aid to countries there
    b. Dulles advised Eisenhower to extend aid to countries there
    c. The Bagdad pact was signed then

Do you recall

13. Who advocated conferences "at the Summit": ____________________________

14. What was Eisenhower's "open skies" plan: ______________________________
                ______________________________

15. What was "culture exchange": ______________________________

16. Who advocated "peaceful co-existence": ______________________________

17. When and how long was the Soviet leader in the United States __________

18. With respect to summit meetings, what was the "Failure at Paris": ______

        ______________________________

True or False:

19. T  F  The cold war was settled during the Eisenhower administration.


21. T  F  A planned visit by Eisenhower to the Soviet Union in 1960 was cancelled.

22. T  F  Eisenhower apologized for the U-2 incident.

23. T  F  Alaska was purchased in 1867.
24. T F Hawaii was purchased in 1894.


26. Which are the "problems" of the 1950's:
   T F Avoiding confrontation
   T F Avoiding nuclear war
   T F Halting the spread of communism
   T F Energizing the American economy
   T F Expanding the concept of equality

27. T F "Brown vs. Board of Education of Topeka" was a Supreme Court decision on desegregation.

28. T F In 1957, the Soviets had superior rocket power over the United States.

29. T F Soviet space vehicles were better designed than those of the United States.

30. T F The United States extended much foreign aid to Latin America during the 1950's.

31. T F The U.S. was well-liked by Latin America in 1959, 60.
APPENDIX I

Scales, Sample 9
1. From what you have read about frequency-shift radar, you now know that:
   a. If the target is leaving or approaching the antenna, the frequency of the
      returned signal varies in proportion to the target speed
   b. The receiver compares the fixed C-W frequency generated by the transmitter
      with the Doppler echo to determine target speed
   c. None of the above is right
   d. Both a and b are right

2. Complete the following diagram for a pulse radar system:
   Trigger → Modulator →

3. The frequency of modulation is about:
   a. 80 cps
   b. 8000 cps
   c. 180 cps
   d. 800 cps
   e. None of the above

TRUE OR FALSE

4. T F If the total time taken for one complete frequency sweep and the number
   of megacycles of deviations are known, the 25-MC beat note can be used
   to determine the distance to the target.

5. T F Doppler radar can be used to locate the moving object without detecting
   the mountains.

6. T F In the Pulse Radar system, the distance to the target in nautical miles
   can be determined by multiplying the echoing time of the pulse by 12.4
   usec.

7. T F The magnetron is the most common low-power radar r-f oscillator.
1. You have read now that the radar waves:
   a. Travel through air at a speed faster than the speed of light
   b. Like all radio waves, travel through air at the speed of sound
   c. Travel through air at the speed of light
   d. Travel at the speed of approximately 186,000 statute, or land, miles a second
   e. Only c and d are right.

2. From what you have read about frequency-shift radar, you now know that:
   a. If the target is leaving or approaching the antenna, the frequency of the returned signal varies in proportion to the target speed
   b. The receiver compares the fixed C-W frequency generated by the transmitter with the Doppler echo to determine target speed
   c. None of the above is right
   d. Both a and b are right

3. The frequency-shift radar system has some disadvantages:
   a. It can't detect an object moving crossways to the antenna
   b. It cannot detect a stationary object
   c. Both a and b are considered as disadvantages
   d. Neither a nor b are considered as disadvantages

4. Complete the following diagram for a pulse radar system:

   Trigger → Modulator → Transmitter

5. Which of the following is not a characteristic of the radar transmitting tubes?
   a. One of its advantages is the tube's high power-handling capacity
   b. It does provide good voltage gain at radar frequencies
   c. It can be employed for receiver r-f amplifiers as well as local oscillators in superheterodynes
   d. Velocity-modulated tubes, contain their own frequency-determining or tuned circuit

6. The frequency of modulation is about:
   a. 80 cps
   b. 8000 cps
   c. 180 cps
   d. 800 cps
   e. None of the above
TRUE OR FALSE

7. T F If a receiver located near the transmitter receives a signal from the transmitter by a direct path at the same time that it receives the reflected signal, a 25-MC beat note will be produced at the receiver.

8. T F If the total time taken for one complete frequency sweep and the number of megacycles of deviations are known, the 25-MC beat note can be used to determine the distance to the target.

9. T F The frequency of the beat decreases as the target moves away from the antenna and increases as the target approaches the antenna.

10. T F Doppler radar can be used to locate the moving object without detecting the mountains.

11. T F The most common system of radar uses pulsed r-f energy.

12. T F In the Pulse Radar system, the distance to the target in nautical miles can be determined by multiplying the echoing time of the pulse by 12.4 usec.

13. T F The basic r-f generator in a radar transmitter usually consists of an oscillator stage with no amplification.

14. T F The magnetron is the most common low-power radar r-f oscillator.

15. T F Magnetrons are capable of delivering very large quantities of r-f power for short periods when operated under pulsed conditions.
1. There are 3 ways of modulating. They are:

2. Which results from combining two voltages of different frequencies?
   a. A different frequency from the original two
   b. "Heterodyne action"
   c. a and b are correct

3. Which is a disadvantage of A-M?
   a. Static
   b. Beat frequencies
   c. Neither a nor b is correct

TRUE OR FALSE

4. T F In an a-m transmitter circuit, an r-f signal is generated, amplified, and then delivered to the antenna.

5. T F Grid modulation is the most widely used method of obtaining a-m.
1. A carrier-wave transmission has two basic elements. They are:
   a. An amplifier and a carrier
   b. A carrier and a transmitter
   c. A carrier and intelligence
   d. An amplifier and intelligence

2. Modulation is:
   a. A way of amplifying a carrier
   b. A way of amplifying an intelligence
   c. A way of putting intelligence on a carrier
   d. Neither a, b, nor c is correct

3. A signal has been modulated when: ________________________________

4. There are 3 ways of modulating. They are:

5. Match the terms.
   (1) The a-f wave ____________________________ Radio-frequency
   (2) The c-w ____________________________ Signal
   (3) Modulated-wave ____________________________ C-w has been varied
   (4) Side bands ____________________________ Produced by modulation

6. If an R-F signal height is varied ("clipped") according to a speech-wave, it is said to be modulated in what way? ________________________________

7. What is a "modulation envelope"? ________________________________

8. Which results from combining two voltages of different frequencies?
   a. A different frequency from the original two
   b. "Heterodyne action"
   c. a and b are correct

9. If the c-w frequency is 1500 kc and the signal frequency is 1000 kc, the lower sideband frequency will be:
   a. 500 kc
   b. 1500 kc
   c. 2500 kc
   d. Neither a, b, nor c is correct
10. If the c-w frequency is 1500 kc and the signal frequency is 1000 kc, the upper sideband frequency will be:
   a. 500 kc
   b. 1500 kc
   c. 2500 kc
   d. Neither a, b, nor c is correct

11. In an a-m wave, the side bands contain the intelligence. If music has frequencies up to 1500 kc, to modulate it upon a carrier, you would have side-band components:
   a. 750 kc above and below the carrier frequency
   b. 1500 kc above and below the carrier frequency
   c. a 750 kc "band"
   d. a 1500 kc "band"

12. Which is a disadvantage of A-M?
   a. Static
   b. Beat frequencies
   c. Neither a nor b is correct

13. In F-M systems:
   a. The noise amplitude varies with the signal amplitude
   b. The signal-to-noise ratio is increased
   c. Both a and b are correct

14. What is the "center" or "resting" frequency in an F-M transmitter? _________

15. Comparing a-m waves with f-m waves:
   a. The carrier is out of phase (with the side bands) in f-m
   b. The f-m transmitters are physically smaller
   c. Both a and b are correct

TRUE OR FALSE

16. T F In an a-m transmitter circuit, an r-f signal is generated, amplified, and then delivered to the antenna.

17. T F Low-power transmitters have 3 kw or less output.

18. T F Low-level modulation refers to the modulation in a stage after the final r-f amplifier.

19. T F In grid modulation, an r-f amplifier is usually "driven" by the output of an a-f tube.

20. T F Grid modulation is the most widely used method of obtaining a-m.
APPENDIX J

Scales, Sample 10
1. What is the result of breaking (splitting) a nucleus into two parts?
   a. More energy is needed in the nuclei
   b. Less energy is needed in the nuclei
   c. Energy is released
   d. Both b and c are correct

2. Radiation is:
   a. The splitting of many nuclei
   b. The emission of some particles
   c. Neither a nor b is correct

3. When particles come out of a nucleus:
   a. The atom is changed
   b. Energy is released
   c. A different element results
   d. a, b, and c are correct

4. What is the purpose of a cyclotron?
   a. Split atoms
   b. Make atoms
   c. Make radioisotopes
   d. a and c are correct

5. The cyclotron:
   a. Uses alternate charges to propell an atomic particle
   b. Uses electromagnetic fields to propell an atomic particle
   c. Neither a nor b
   d. Both a and b

6. What is the speed of a particle when it leaves the cyclotron? __________

7. What results from bombarding atoms with the "bullets"?
   a. The atoms are changed to other elements
   b. They are split in half, causing fusion
   c. Neither a nor b is correct

8. What is pitchblend? _______________________________

9. Uranium:
   a. Is 99% pitchblend
   b. Is made up of uranium-235 and uranium-238
   c. Has mostly uranium-238
   d. b and c are correct

10. Why is uranium so valuable to us?
    a. It is the only natural element that can fusion
    b. It is the only natural element that can fission
    c. Neither a nor b
11. What happens in "fission" and "fusion"?
   a. In fission, nuclei breaks up; in fusion, nuclei merge together
   b. In fusion, nuclei merge together; in fusion, nuclei break up
   c. Neither a nor b is correct

12. Nuclear energy:
   a. Is released because the two new nuclei (after bombardment) weigh less than
      the original nucleus
   b. Is released because the two new nuclei (after bombardment) weigh more than
      the original nucleus
   c. Is released (during bombardment) when uranium-235 is changed to uranium-238

13. Dr. Fermi discovered:
   a. Uranium-238 and uranium-235 will fission
   b. That slow-moving neutrons are more easily caught by a nucleus
   c. That fast-moving neutrons are more easily caught by a nucleus
   d. Radio-active radium

14. When neutrons hit other atoms and they break up giving off many more neutrons
    which break up even more atoms, the result is: ____________________________

15. What is the name for the two forms of uranium (U-235 and U-238)? __________

16. The name for the process of separating uranium 235 from uranium 238 is:
    ____________________________

17. An "atomic pike":
   a. Was used for the first fissioning
   b. Was used for the first chain reaction
   c. Both a and b are correct

TRUE OR FALSE

18. T F The purpose of carbon in a "pile" is to speed up the neutrons.

19. T F The "fragments" contain many new elements.

20. T F The "fragments" contain only barium.

21. T F Cadmium rods are used to slow up the neutrons.

22. Two new elements resulted from the atomic pile. They were ________________
1. What is the function of a clutch?
   a. To connect the engine to the rear wheels
   b. To disconnect the engine to the rear wheels
   c. Neither a nor b is correct
   d. Both a and b are correct

2. In early automobiles, how was the clutch connected to the rear wheels?
   a. By shaft
   b. By chain
   c. Neither, they were not connected

3. Why do you have a large gear attached to the pedals of your bicycle?
   a. You need more driving force, the wheel turns fewer turns.
   b. With a small force, you gain a large distance.
   c. With a larger force, you gain a smaller distance.

4. Why do we have different size gears in an automobile? _________________

5. Which is true of an "automatic shift"?
   a. No gears are used since it is automatic
   b. Gears are used but changed automatically
   c. Gears change according to the car speed
   d. b and c are correct

6. How many automobiles do we have now? _________________

7. How much does an average car weigh? _________________

8. What is the shape of the cross-section of a rail? _________________

9. Why is the top of the rail made in its particular shape?
   a. For strength alone
   b. For speed alone
   c. To fit and hold flats of the wheel
   d. To fit and hold flanges of the wheel

10. How many miles of track do we have today? _________________

11. What fuel is used for locomotives?
    a. Coal
    b. Kerosene

12. How much water is displaced by an object in the water?
    a. An amount equal to the object volume
    b. An amount equal to the object weight
    c. Both a and b are correct
13. "Any object placed in a liquid is pushed upward by a force equal to the weight of the":
   a. Object displaced
   b. Liquid displaced
   c. Neither

14. Which is true of water pressure in a container?
   a. Pressure is equal in all directions, at the same level
   b. Pressure increases in some directions
   c. Pressure changes at different levels
   d. a and c are correct

15. What is the function of a "Kingston valve"?
   a. Let water in and out of a tank
   b. Let air in and out of a tank
   c. Neither a nor b is correct

TRUE OR FALSE

16. T F If you remove air from a tin can, it will float.

17. T F A penny sinks because its weight is greater than the weight of its volume of water.

18. T F A snorkel was used to get air into submarine ballast tanks.

19. Match the words on the left with the right words or phrase on the right.

   Biplane
   Monoplane
   Ailerons
   Fuselage
   Elevator
   Rudder
   Flaps
   Wings
   Propeller

   One wing
   Two wings
   Banks the plane
   Cabin
   Turns right and left
   Steers up and down
   Lifts the plane
   Pulls (pushes) the plane
   Brakes the plane

20. What is "Bernoulli's principle"? _________________________________
Reading page 352

1. Which is characteristic of the Halogens?
   a. Their outermost energy levels have a stable number of electrons
   b. Their outermost energy levels lack one electron
   c. They have a stable valence level
   d. Neither a, b, nor c is correct

2. "Atomic size" is found by measuring:
   a. The diameter of atoms
   b. The distance between atoms
   c. Both a and b

3. How is fluorine made?
   a. By oxidation through electrolysis
   b. By electrolysis but without oxidation
   c. Neither a nor b is correct

TRUE OR FALSE

4. T F A substance that is easily reduced is a good oxidizing agent.

5. T F The Halogens require water to react.
1. Where in the periodic table are the Halogens with respect to the inert gasses?
   a. They are in the inert gasses
   b. Above (more electrons) the inert gasses
   c. Below (less electrons) the inert gasses

2. The molecules of Halogens:
   a. Are mostly colorless
   b. Are mostly colored
   c. Are all colorless
   d. Are all colored

3. What about the Hazard qualities of them?
   a. They are not harmful
   b. They are inert
   c. F₂ is not dangerous
   d. All are dangerous

4. Which is characteristic of the Halogens?
   a. Their outermost energy levels have a stable number of electrons
   b. Their outermost energy levels lack one electron
   c. They have a stable valence level
   d. Neither a, b, nor c is correct

5. The Halogens:
   a. Have ionic bonding
   b. Have covalent bonding
   c. Neither is correct

6. Do you recall the total number (charge) of electrons in these molecules?
   Florine _____
   Clorine _____
   Bromine _____
   Iodine _____

7. In "electron dot representation" of the florine and bromine molecules, each is represented with 8 dots for electrons. Why?
   a. They have the same number of valence electrons
   b. The 3d valence electrons are omitted for florine
   c. b and c are correct

8. "Atomic size" is found by measuring:
   a. The diameter of atoms
   b. The distance between atoms
   c. Both a and b

9. What is "covalent radius"?
   a. One-half the diameter of the atoms
   b. One-half the distance between the nuclei of two bonded atoms
   c. One-half the ionic radii
   d. a, b, and c are correct
10. Since electrical forces 

decrease with distance between the atoms, which Halogen

will have the greater bond energy?

a. Florine greater than chlorine
b. Chlorine greater than bromine
c. Florine greater than bromine
d. Bromine greater than chlorine

11. Halogens:

a. Occur uncombined in nature
b. Are too reactive to occur uncombined
c. Are of the oxidation-reaction type
d. b and c are correct

12. How is flourine made?

a. By oxidation through electrolysis
b. By electrolysis but without oxidation
c. Neither a nor b is correct

13. What are "Halide compounds"?

14. Chlorine is made by electrolysis of a molten substance. Do you remember the

substance and temperature?

15. Oxidizing ability varies with the energy E°. With the following E° values,

list their proper Halogen as an oxidizing agent (i.e. F₂, Cl₂, etc.).

-1.36 volts
-1.07 volts
-2.87 volts
-0.53 volts

TRUE OR FALSE

16. T F A substance that is easily reduced is a good oxidizing agent.

17. T F The use of F as a reducing agent and F₂ as an oxidizing agent is called

"Iodimetry".

18. T F Iodine has no specific reaction indicator.

19. T F Compounds of the type HClO₃ and HClO₄ are of the "Oxyacids" type.

20. T F The Halogens require water to react.
APPENDIX K

Scales, Sample 11
GEOLOGY PART II

Reading Pg. 215 (Ch. 9)

1. Capillary water:
   a. Collects below the water table
   b. Collects above the water table
   c. Neither a nor b is correct

2. Capillary water is removed from the soil:
   a. By evaporation from swamps, etc.
   b. By evapotranspiration only
   c. By transpiration from flat surfaces
   d. Neither a, b nor c is correct

3. Transpiration:
   a. Returns moisture to plants for photosynthesis
   b. Evaporates moisture from wet soils
   c. Neither a nor b is correct

4. Water changes from liquid to vapor:
   a. During evaporation only
   b. During transpiration and evaporation
   c. During transpiration only

5. Which are factors in evapotranspiration?
   a. Air temperatures and relative humidity
   b. Soil moisture and nature of the vegetation
   c. Neither a nor b
   d. Both a and b

6. Which condition represents a water "deficit"?
   a. The precipitation is less than "PE"
   b. The precipitation is more than "PE"
   c. The precipitation equals "PE"
   d. Neither of the above is correct

7. What happens if the "PE" is less than precipitation?
   a. Surface runoff
   b. A "surplus"
   c. Neither a nor b

8. What if "AE" is less than "PE"?
   a. Surface runoff occurs
   b. A "surplus" exists
   c. A deficit exists
   d. Neither a, b nor c is correct
DO YOU RECALL?

9. During which season does most precipitation occur?

10. How is water held in the soil?

11. How can bedrock store water?

12. During which season is evaporation highest?

THE WATER BUDGET

13. In the middle latitudes, water storage:
   a. Decreases during the summer
   b. Decreases during the winter
   c. Is steady from season to season
   d. Neither a, b, nor c is correct

14. Moisture "Income":
   a. Exceeds loss of moisture in summer
   b. Exceeds loss of moisture during autumn
   c. Is equal to loss of moisture all seasons
   d. Neither a, b nor c is correct

15. In spring moisture "Income":
   a. Is least
   b. Is greatest
   c. Is equal to precipitation

16. Moisture outgo:
   a. Exceeds moisture income in autumn
   b. Exceeds moisture income in winter
   c. Neither a nor c is correct

17. In summer, moisture outgo:
   a. Is least
   b. Is greatest
   c. Is equal to income

18. Using the "alphabet soup" of the text, where P - precipitation and PE - potential evaporation, etc., what would you expect to happen in arid regions during summer?
   a. P to exceed PE
   b. AE to exceed PE
   c. PE to exceed AE
   d. P to exceed AE
19. Using the same "alphabet soup", what happens in Iowa during summer?
   a. P to exceed PE
   b. AE to exceed PE
   c. P to exceed AE
   d. AE to exceed P

TRUE OR FALSE

20. T  F  Higher temperatures increase water loss.
21. T  F  The water cycle is repeated only annually.
22. T  F  "Recharge" occurs only in winter and spring.
23. T  F  In the Annual cycle, drought or floods may occur if the cycle is drastically altered.
24. T  F  In arid regions, some plants can control their rate of transpiration.
25. T  F  The fresh water problem of the world is too little precipitation.
26. T  F  The problem is to distribute water better.
27. T  F  Humans are gradually consuming the supply of fresh water.
APPENDIX L

Scales, Sample 13
1. Which is true concerning ecology?
   a. It involves organisms in their environment
   b. Organisms are shaped by their environment
   c. The word "ecology" literally means "house"
   d. All of the above

2. What is the "biosphere"?

3. The most important single factor affecting the biosphere is:
   a. Green plants
   b. Oxygen
   c. Both a & b
   d. None of the above

4. In ecosystems:
   a. Only living things interact
   b. Only non-living things interact
   c. Both living and non-living things interact

5. An ecosystem:
   a. Cannot be a forest without animals
   b. Can be man in his environment
   c. Can be an insect in a jar
   d. Cannot be a fish in an aquarium

6. What is the "Biotic Community"?

7. How is population density expressed?
   a. Determine the factors which affect the uneven distribution
   b. Are made to discover why populations vary from year to year
   c. Are made by counting all the individuals in a certain population
   d. All of the above
   e. Both a & b

8. The population of a given organism depends mostly upon:
   a. The Immigration
   b. The death rate
   c. The birth rate
   d. All of the above
10. Finish the diagram of the ecosystem:

\[ \text{Ecosystem} \]

\[ \text{Biotic Community} \]

11. Three kinds of relationships occur in an ecosystem:

1. ____________________________
2. ____________________________
3. ____________________________

12. The author says that in the same population:

a. Organisms are not dependent on one another
b. The competition within the population decreases because organisms of the same population have almost identical requirements
c. Both a and b are correct
d. None of the above is correct

13. List three physical factors of the environment which interact with the biotic community.

a. ____________________________
b. ____________________________
c. ____________________________

TRUE OR FALSE

14. T F Temperature may have some effect on the organisms living in deep lakes.

15. T F Temperatures have a great effect on the organisms living in shallow water.

16. T F Man cannot be considered as a factor influencing the distribution of plants and animals.

17. T F There is interaction between the biotic community and the physical environment but there is no interaction within the physical environment.

18. T F There is interaction in the physical environment but it is always temporary and cannot be permanent.
1. What is the function of a clutch?
   a. To connect the engine to the rear wheels
   b. To disconnect the engine to the rear wheels
   c. Neither a nor b is correct
   d. Both a and b are correct

2. In early automobiles, how was the clutch connected to the rear wheels?
   a. By shaft
   b. By chain
   c. Neither, they were not connected

3. Why do you have a large gear attached to the pedals of your bicycle?
   a. You need more driving force, the wheel turns fewer turns.
   b. With a small force, you gain a larger distance.
   c. With a larger force, you gain a smaller distance.

4. Why do we have different size gears in an automobile?

5. Which is true of an "automatic shift"?
   a. No gears are used since it is automatic
   b. Gears are used but changed automatically
   c. Gears change according to the car speed
   d. b and c are correct

6. How many automobiles do we have now?

7. How much does an average car weigh?

8. What is the shape of the cross-section of a rail?
   a. For strength alone
   b. For speed alone
   c. To fit and hold flats of the wheel
   d. To fit and hold flanges of the wheel

9. How many miles of track do we have today?

10. What fuel is used for locomotives?
    a. Coal
    b. Kerosene

11. How much water is displaced by an object in the water?
    a. An amount equal to the object volume
    b. An amount equal to the object weight
    c. Both a and b are correct
13. "Any object placed in a liquid is pushed upward by a force equal to the weight of the":
   a. Object displaced
   b. Liquid displaced
   c. Neither

14. Which is true of water pressure in a container?
   a. Pressure is equal in all directions, at the same level
   b. Pressure increases in some directions
   c. Pressure changes at different levels
   d. a and c are correct

15. What is the function of a "Kingston valve"?
   a. Let water in and out of a tank
   b. Let air in and out of a tank
   c. Neither a nor b is correct

16. T F If you remove air from a tin can, it will float.

17. T F A penny sinks because its weight is greater than the weight of its volume of water.

18. T F A snorkel was used to get air into submarine ballast tanks.

19. Match the words on the left with the right words or phrase on the right.

   diplane                                      One wing
   Monoplane                                    Two wings
   Ailerons                                      Banks the plane
   Fuselage                                      Cabin
   Elevator                                      Turns right and left
   Rudder                                        Steers up and down
   Flaps                                         Lifts the plane
   Wings                                         Pulls (pushes) the plane
   Propeller                                     Brakes the plane

20. What is "Bernoulli's principle"?
APPENDIX M

Scales, Sample 14
1. What was the position of national politics during the last third of the nineteenth century?
   a. Prominent in the attention of the American people
   b. Overshadowed by a few events
   c. There were no significant issues in national politics

2. During that time:
   a. The judicial overshadowed the legislative branch
   b. The executive overshadowed the legislative branch
   c. The legislative overshadowed both branches
   d. There was a balance of influence between branches

3. What about the nation's economy during that time?
   a. The government's proper role in the economy was a strong issue in politics
   b. The economy did not figure in politics
   c. Congress manipulated the economy

4. What about the "spoils system"?
   a. It was never used extensively by the party in power
   b. It was discontinued soon after the war
   c. The "merit system" was proposed to replace it
   d. It guaranteed qualified officeholders

5. Why did democrats in 1868 favor "greenbacks"?
   a. This represented more money in circulation
   b. Greenbacks were more valuable
   c. Greenbacks represented profit for the poor and democrats were wealthy money lenders to the government

6. What was Grant's policies in reconstruction?
   a. He proved lenient toward the South
   b. He was mild on the issue
   c. He adopted a harsh policy

7. Do you remember two examples of corruption during the Grant administration?

8. Who advocated grasping hands across the "bloody chasm"?

9. Which was characteristic of Grant's second term?
   a. Economic depression
   b. Corruption in government
   c. Hard-money
   d. a, b, and c are correct

10. Why was Garfield chosen over Grant as republican candidate in 1880?
    a. The Stalwarts and the Half-breeds voted together
    b. Grant did not want a third-term nomination
    c. The Republican delegation had deadlocked
    d. Neither is correct
TRUE OR FALSE

11. T F The Democrats practiced "job insurance" to finance their campaign in 1880.

12. T F The candidates were Garfield and Hancock in 1880.


14. T F Garfield supported the Pendleton Act.

15. T F Arthur succeeded Garfield as president.
1. Which is true of the play in American history?
   a. No theaters were established during Colonial times
   b. Plays were common, even in new settlements
   c. Americans have never been playgoers
   d. a and c are correct

2. Which is true of storytelling?
   a. Men have always written stories
   b. Stories were acted out before men could write
   c. Pantomime is a form of storytelling
   d. b and c are correct

3. Which is true of drama?
   a. The actors must experience a play, the spectators remain passive
   b. The spectators must experience a play, the actors are passive
   c. Since drama is written, actors must not use imagination
   d. The reader of a drama may use imagination to energize the play

4. Which is true of plays?
   a. Most are "wordy"
   b. The description of setting is usually "wordy"
   c. The dialogue is usually "wordy"
   d. Every word of the dialogue counts

5. What is the locale of the play?
   a. A warship
   b. The Glencairn
   c. A merchant steamer
   d. b and c are correct

6. In the opening scene, a character arouses the suspicion of his mates:
   a. Scotty hides a small tin box in a suitcase
   b. Smitty removes something from his mattress
   c. Scotty hides a tin box under his mattress
   d. Smitty removes something from a suitcase

7. How did the men disarm the suspicious object?
   a. Dunk it in water
   b. Throw it overboard
   c. Neither a nor b
1. Which is true of the play in American history?
   a. No theaters were established during Colonial times
   b. Plays were common, even in new settlements
   c. Americans have never been playgoers
   d. a and c are correct

2. What about the drama?
   a. It was the first form of literature to develop in America
   b. Our plays have always contributed significantly to world literature
   c. Neither a nor b are correct
   d. Both a and b are correct

3. Recent drama in America:
   a. Has been varied in the past 100 years
   b. Has been flexible in the past 40 years
   c. Has always been stereotyped
   d. Neither are correct

4. Which is true of storytelling?
   a. Men have always written stories
   b. Stories were acted out before men could write
   c. Pantomime is a form of storytelling
   d. b and c are correct

5. Which is probably the older form of art?
   a. Acting
   b. Painting
   c. Writing

6. Which is true of drama?
   a. The actors must experience a play, the spectators remain passive
   b. The spectators must experience a play, the actors are passive
   c. Since drama is written, actors must not use imagination
   d. The reader of a drama may use imagination to energize the play

7. According to the text, what "is the truest spirit of the theater of all ages"?

8. What is "the distinctive character" of drama?

9. Which is true of plays?
   a. Most are "wordy"
   b. The description of setting is usually "wordy"
   c. The dialogue is usually "wordy"
   d. Every word of the dialogue counts
The dialogue performs four functions in a play. Can you recall them?

The following items pertain to Eugene O'Neill's In the Zone.

11. What is the locale of the play?
   a. A warship
   b. The Glencairn
   c. A merchant steamer
   d. b and c are correct

12. In the opening scene, a character arouses the *suspicion* of his mates:
   a. Scotty hides a small tin box in a suitcase
   b. Smitty removes something from his mattress
   c. Scotty hides a tin box under his mattress
   d. Smitty removes something from a suitcase

13. What are the characters afraid of?
   a. Scotty
   b. Submarines
   c. Neither

14. What did the crew have for breakfast?

15. Who is Jack?
   a. An American
   b. An Englishman
   c. The fourth mate

16. Why were the crew so sure to be "blown to smithereens" if an enemy shell hit them?
   a. They were a man-o-war
   b. The ship carried mines
   c. They were in a war zone
   d. The ship carried ammunition

17. What mannerism of the suspect heightens the suspicion of his mates?
   a. His surliness
   b. His bruskness
   c. His aloofness
   d. His friendliness

18. How did the men disarm the suspicious object?
   a. Dunk it in water
   b. Throw it overboard
   c. Neither a nor b
True or False

19. T F The crew did not want to turn their suspect over to the ship's officers because they would have to share credit for catching a spy.

20. T F The suspect was called a "dirty ound" and a "Dutch og".

21. T F Davis unlocked the box and discovered the letters.

22. T F The letters were all postmarked Berlin.

23. T F The suspect raged throughout the letter-reading.

24. T F The letters were postmarked Liverpool.

25. T F The scene ends with the crew going about its duties.
APPENDIX N

Scales, Sample 15
1. According to what you have just read now, almost all large business enterprises in the United States are organized as:
   a. Public corporations
   b. Private corporations
   c. Profit corporations
   d. Merely corporations
   e. Open corporations

2. The corporate form of organization is advantageous to individuals because:
   a. They can invest savings in business
   b. They can enjoy incurring responsibilities for management
   c. They don't risk their entire capital
   d. All of the above is right
   e. a and c are right

3. From the definition of a corporation, you now know that a corporation is:
   a. An invisible and artificial being
   b. An artificial person created by law
   c. A separate legal unity
   d. All of the above is true
   e. Only a and c are true

4. In contrast to a partnership, the life term of the corporation is not affected by the withdrawal of one of its owners. This fact gives a corporation the characteristic of:
   a. Limited liability of stockholders
   b. Transferable units of ownership
   c. Separate legal existence
   d. None of the above

5. According to the law, a corporation is required to pay:
   a. A fee to the federal government at the time of its organization
   b. A fee to the state at the time of its organization
   c. Only annual tax without any additional fee
   d. All of the above is wrong

6. In some states, corporations are restricted as to:
   a. The amount of real estate that they may own
   b. The amount of their own shares of stock that they may reacquire
   c. The amount of earnings that they may distribute
   d. All of the above is right
   e. Only a and b are right

7. According to the Ohio Statutes:
   a. Six or more natural persons, a majority of whom are citizens of the U.S.A., may form a corporation
   b. The amount of capital with which the corporation will begin business should not be less than 5,000 dollars.
   c. An American and two Mexicans can form a corporation
   d. None of the above is right
8. Complete the following corporate form of organization:

Stockholders

Board of Directors

9. The authority to distribute earnings to the stockholders rests with:
   a. The President
   b. Executive committee
   c. Board of directors
   d. None of the above

TRUE OR FALSE

10. T F Because the earnings of a corporation are subject to the federal income tax, it follows that when the remaining earnings are distributed to stockholders as dividends, they are not taxed.

11. T F Under certain conditions, corporations with no more than 10 stockholders may elect to be treated as partnership for income tax purposes.

12. T F The income of corporations electing the previous optional treatment must be included in the taxable income of the stockholders on condition that the income is distributed to the stockholders, and the corporation pays no tax.

13. T F Corporations may exceed the scope of activities described in their charters.

14. T F It is not unusual for the president to be a member of the board of directors.

15. T F Stockholders not expecting to attend the annual meeting cannot transfer their voting rights to someone else.

16. T F In the partnership form of organization, the net income in Expense and Revenue Summary is transferred to the respective capital accounts of the partner, while in the corporate form, the net income is transferred to Retained Earnings.
1. In preparing a seating chart, the chairman should be:
   a. At the center of the head table and the main speaker to his right
   b. To the right of the main speaker
   c. To the left of the main speaker who should be at the center of the head table
   d. All of the previous arrangements can be done

2. When correcting the minutes:
   a. Errors should be erased and written again correctly
   b. The corrections are made so that they can be identified
   c. Errors are not erased and the corrections should be made in red ink
   d. If the correction is extensive, the erroneous material may be crossed out in red ink with a marginal note about where the corrections can be found
   e. All of the above are true, except a.

3. When setting up resolutions:
   a. The paragraphs giving the reasons for the resolution are introduced by the word "Since"
   b. The final paragraphs (stating the action to be taken) are introduced by the word "Resolution"
   c. The resolution can be expressed in any one of many ways, ranging from a simple letter to a very formal document
   d. All of the above are right
   e. None of the above is true

TRUE OR FALSE

4. T F One of the basic parliamentary procedures is that the needs and wishes of the majority must prevail without giving minority opinions any consideration.

5. T F It has been estimated that as much as one-third of an executive's time is spent in company meetings that are held to reach decisions, to report progress, etc.

6. T F Most business meetings are conducted in an informal fashion.

7. T F In general, corporate meetings follow procedures common to all other formal meetings.
1. The Secretary to the executive with committee responsibilities or official duties is expected to:
   a. Prepare reports containing recommendations
   b. Assist in planning of a regular or a special program
   c. To type
   d. All of the above is true
   e. Only a and b are right

2. In preparing a seating chart, the chairman should be:
   a. At the center of the head table and the main speaker to his right
   b. To the right of the main speaker
   c. To the left of the main speaker who should be at the center of the head table
   d. All of the previous arrangements can be done

3. Minutes of formal meetings:
   a. Should not be written in great detail
   b. Are often from 10-20 pages long
   c. Include complete copies of all committee reports, usually attached as appendixes
   d. Are put into form which is usually established by custom
   e. Only c and d are right

4. When correcting the minutes:
   a. Errors should be erased and written again correctly
   b. The corrections are made so that they can be identified
   c. Errors are not erased and the corrections should be made in red ink
   d. If the correction is extensive, the erroneous material may be crossed out in red ink with a marginal note about where the corrections can be found
   e. All of the above are true, except a.

5. At formal meetings, a secretary is often responsible for taking notes on everything of importance. Which of the following is not true concerning reporting?
   a. Verbatim notes are not usually needed.
   b. Taking too few notes is more practical than taking too many notes
   c. If the secretary does not hear a particular motion, she should ask that it be repeated
   d. The secretary may request that a particularly involved motion or a report be submitted to her in writing

6. When setting up resolutions:
   a. The paragraphs giving the reasons for the resolution are introduced by the word "Since"
   b. The final paragraphs (stating the action to be taken) are introduced by the word "Resolution"
   c. The resolution can be expressed in any one of many ways, ranging from a simple letter to a very formal document
   d. All of the above are right
   e. None of the above is true
7. Which one of the following is not a characteristic of the minutes:
   a. They should highlight the essential points
   b. They should properly identify participants
   c. They should be written in detail
   d. They should be easy to read

   TRUE OR FALSE

8. T F One of the basic parliamentary procedures is that the needs and wishes of the majority must prevail without giving minority opinions any consideration.

9. T F Each member in a group or an organization has to accept and be loyal only to the elected officers who are the member's choice.

10. T F It has been estimated that as much as one-third of an executive's time is spent in company meetings that are held to reach decisions, to report progress, etc.

11. T F In preparing a seating chart, the chairman should be at the center of the head table and the main speaker to his right.

12. T F Most business meetings are conducted in an informal fashion.

13. T F When arranging for an informal meeting, you have to be sure that notations of the meeting have been made on your calendar (but not necessarily on your employer's).

14. T F In general, corporate meetings follow procedures common to all other formal meetings.
1. Which one of the following is not considered as an advantage of the corporate form of organization?
   a. It has large capital and limited legal liability
   b. Corporations are subject to many legal restrictions and taxes
   c. The continued life of the corporation is not endangered by the death or disability of individual stockholders
   d. The large corporation can assemble specialists and experts it needs.

2. Your job future as a secretary may lie in the directions of:
   a. Promotion through supervision
   b. Promotion in secretarial rank
   c. Promotion to administrative assistant
   d. All of the above are right

3. Complete the following diagram of the functional organization:
   President
   |    |
   v    v
   Shipping Manager

TRUE OR FALSE

4. T F Most large businesses in the United States are corporations.

5. T F The secretary working for the head of the sales department under a functional plan has a boss who has more freedom of action and decision than in the line plan.

6. T F Secretaries to staff executives are not expected to qualify as administrative assistants.
1. Which of the following is not true concerning partnership?
   a. The plan brings more capital and talents into the business
   b. The partners share profits and losses
   c. Each partner is responsible only for his own decision
   d. The death of one partner terminates the formal partnership
   e. A secretary may serve all partners

2. Which one of the following is not considered as an advantage of the corporate
   form of organization?
   a. It has large capital and limited legal liability
   b. Corporations are subject to many legal restrictions and taxes
   c. The continued life of the corporation is not endangered by the death or
doctor disability of individual stockholders
   d. The large corporation can assemble specialists and experts it needs.

3. The head of the sales department under a functional plan is responsible to his
   superiors:
   a. Only for results
   b. For the observance of broad company policies
   c. For results and for every phase of how he achieves these results
   d. Only a and b are right

4. Your job future as a secretary may lie in the directions of:
   a. Promotion through supervision
   b. Promotion in secretarial rank
   c. Promotion to administrative assistant
   d. All of the above are right

5. The philosophers' and educators' studies indicate that successful businessmen
   and businesswomen are oriented toward:
   a. Results
   b. Responsibilities
   c. Profits and growth
   d. All of the above

6. Complete the following diagram of the functional organization:
   President
   |
   Shipping Manager
   |
7. Complete the following diagram of line-and-staff organization:

President

Secretary

General Manager

Executive Assistant

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TRUE OR FALSE

8. T F Most large businesses in the United States are corporations.

9. T F The secretary cannot have any authority over others in any case.

10. T F The secretary working for the head of the sales department under a functional plan has a boss who has more freedom of action and decision than in the line plan.

11. T F As secretaries show their readiness to assume more responsibilities, they often receive assignments involving the occasional supervision of others.

12. T F Secretaries to staff executives are not expected to qualify as administrative assistants.

13. T F Available evidence indicates that successful businessmen are not an explicit type.