Student achievement in a general education course using selected experimental time allocations

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Student achievement
in a general education course
using selected experimental time allocations

by

William James Lacroix

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## TABLE OF CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. INTRODUCTION</strong></td>
<td></td>
</tr>
<tr>
<td>A. Background and Setting</td>
<td>1</td>
</tr>
<tr>
<td>B. Statement of the Problem</td>
<td>3</td>
</tr>
<tr>
<td>C. Purpose of the Experiment</td>
<td>4</td>
</tr>
<tr>
<td>D. Delimitations of the Experiment</td>
<td>5</td>
</tr>
<tr>
<td>E. Organization of the Study</td>
<td>5</td>
</tr>
<tr>
<td><strong>II. REVIEW OF LITERATURE</strong></td>
<td></td>
</tr>
<tr>
<td>A. A Base of Theory</td>
<td>7</td>
</tr>
<tr>
<td>B. General Education</td>
<td>14</td>
</tr>
<tr>
<td>C. Independent Study</td>
<td>16</td>
</tr>
<tr>
<td>D. Summary</td>
<td>26</td>
</tr>
<tr>
<td><strong>III. METHOD OF PROCEDURE</strong></td>
<td></td>
</tr>
<tr>
<td>A. Sample Selection and Description</td>
<td>28</td>
</tr>
<tr>
<td>B. Experimental Design</td>
<td>34</td>
</tr>
<tr>
<td>C. Application of Experimental Design</td>
<td>38</td>
</tr>
<tr>
<td>D. Experimental Treatments</td>
<td></td>
</tr>
<tr>
<td>1. Control group</td>
<td>40</td>
</tr>
<tr>
<td>2. Experimental-I</td>
<td>41</td>
</tr>
<tr>
<td>3. Experimental-II</td>
<td>41</td>
</tr>
<tr>
<td>E. Personal Factors of Students</td>
<td></td>
</tr>
<tr>
<td>1. Factors of a continuous nature</td>
<td>43</td>
</tr>
<tr>
<td>2. Factors of a discrete nature</td>
<td>46</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td>Page</td>
</tr>
<tr>
<td>------------------------------------------------</td>
<td>------</td>
</tr>
<tr>
<td>TABLE OF CONTENTS</td>
<td></td>
</tr>
<tr>
<td>(Continued)</td>
<td></td>
</tr>
<tr>
<td>F. Criterion Measures</td>
<td>48</td>
</tr>
<tr>
<td>1. Mid-quarter examination</td>
<td>49</td>
</tr>
<tr>
<td>2. Final examination</td>
<td>50</td>
</tr>
<tr>
<td>3. Composite score</td>
<td>51</td>
</tr>
<tr>
<td>4. Pretest</td>
<td>53</td>
</tr>
<tr>
<td>G. Data Collection</td>
<td>54</td>
</tr>
<tr>
<td>H. Statistical Analyses</td>
<td>55</td>
</tr>
<tr>
<td>IV. FINDINGS</td>
<td>59</td>
</tr>
<tr>
<td>A. Sample Validation</td>
<td>60</td>
</tr>
<tr>
<td>B. Experimental Effects</td>
<td>62</td>
</tr>
<tr>
<td>C. Static Effects</td>
<td>69</td>
</tr>
<tr>
<td>D. A Prediction Equation</td>
<td>81</td>
</tr>
<tr>
<td>V. DISCUSSION</td>
<td>88</td>
</tr>
<tr>
<td>A. Implications of the Findings</td>
<td>88</td>
</tr>
<tr>
<td>B. Limitations of the Study</td>
<td>96</td>
</tr>
<tr>
<td>C. Recommendations for Further Study</td>
<td>97</td>
</tr>
<tr>
<td>VI. SUMMARY</td>
<td>99</td>
</tr>
<tr>
<td>VII. BIBLIOGRAPHY</td>
<td>105</td>
</tr>
<tr>
<td>VIII. ACKNOWLEDGMENTS</td>
<td>108</td>
</tr>
<tr>
<td>IX. APPENDIX A: COURSE SYLLABUS</td>
<td>110</td>
</tr>
<tr>
<td>X. APPENDIX B: PERSONAL FACTORS QUESTIONNAIRE</td>
<td>120</td>
</tr>
<tr>
<td>XI. APPENDIX C: CLASS RECORD FORM</td>
<td>122</td>
</tr>
<tr>
<td>XII. APPENDIX D: PRETEST</td>
<td>124</td>
</tr>
<tr>
<td>XIII. APPENDIX E: MID-QUARTER EXAMINATION</td>
<td>129</td>
</tr>
<tr>
<td>XIV. APPENDIX F: FINAL EXAMINATION</td>
<td>138</td>
</tr>
<tr>
<td>-----------------------------------</td>
<td>-----</td>
</tr>
<tr>
<td>XV. APPENDIX G: COMMON LESSON PLAN FOR DAY #1</td>
<td>154</td>
</tr>
<tr>
<td>XVI. APPENDIX H: COMMON LESSON PLAN FOR DAY #2</td>
<td>158</td>
</tr>
<tr>
<td>XVII. APPENDIX I: AUDIO SCRIPT FOR DAY #2</td>
<td>162</td>
</tr>
<tr>
<td>XVIII. APPENDIX J: AUDIO TAPE SUPPLEMENT</td>
<td>175</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>31</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>3</td>
<td>32</td>
</tr>
<tr>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>6</td>
<td>51</td>
</tr>
<tr>
<td>7</td>
<td>53</td>
</tr>
<tr>
<td>8</td>
<td>54</td>
</tr>
<tr>
<td>9</td>
<td>60</td>
</tr>
<tr>
<td>10</td>
<td>61</td>
</tr>
<tr>
<td>11</td>
<td>62</td>
</tr>
<tr>
<td>12</td>
<td>63</td>
</tr>
<tr>
<td>13</td>
<td>63</td>
</tr>
</tbody>
</table>

1. Number of students in each treatment group according to times of day
2. Number of students in each treatment group who were administered the pretest
3. Number of students in each treatment group according to sex of student
4. Means and standard deviations for four of the five student factors deemed to be of a continuous data nature
5. Mid-quarter examination mean scores for the three treatment conditions
6. Final examination mean scores for the three treatment conditions
7. Criterion mean scores and standard deviations for the three treatment conditions
8. Twenty-three item pretest mean scores for the three treatment conditions
9. Analysis of variance of differences in HS%R between the three experimental treatment conditions
10. Analysis of variance of differences in ACT between the three experimental treatment conditions
11. Analysis of variance of differences in pretest scores between the three experimental treatment conditions
12. Unadjusted and adjusted criterion mean scores of pretested and non-pretested students when ACT composite and high school class rank were used as covariates
13. Analysis of covariance of differences in criterion means between pretested and non-pretested students when ACT and high school class rank were used as covariates
<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td>Unadjusted and adjusted criterion mean scores for students during the four times of day when ACT composite and high school rank were used as covariates</td>
</tr>
<tr>
<td>15</td>
<td>Analysis of covariance of differences in criterion means between the four times of day when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>16</td>
<td>Unadjusted and adjusted criterion mean scores for students in each experimental treatment condition when ACT composite and high school rank were used as covariates</td>
</tr>
<tr>
<td>17</td>
<td>Analysis of covariance of differences in criterion means between the three experimental treatments when ACT composite high school class rank were used as covariates</td>
</tr>
<tr>
<td>18</td>
<td>Analysis of variance for pretest participation, time of day, treatment, and the associated first-order interactions</td>
</tr>
<tr>
<td>19</td>
<td>Unadjusted and adjusted criterion mean scores for students who were taught by one of the six instructors when ACT composite and high school rank were used as covariates</td>
</tr>
<tr>
<td>20</td>
<td>Analysis of covariance of differences in student criterion means between the six instructors when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>21</td>
<td>Unadjusted and adjusted criterion mean scores for student sex when ACT composite and high school rank were used as covariates</td>
</tr>
<tr>
<td>22</td>
<td>Analysis of covariance of differences in criterion means between sexes when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>23</td>
<td>Analysis of regression, regressing criterion score on the student age (age in months)</td>
</tr>
</tbody>
</table>
LIST OF TABLES
(Continued)

<table>
<thead>
<tr>
<th>Table</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>24</td>
<td>Unadjusted and adjusted criterion mean scores for student marital status when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>25</td>
<td>Analysis of covariance of differences in criterion means between married and single students when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>26</td>
<td>Unadjusted and adjusted criterion mean scores for student automobile availability when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>27</td>
<td>Analysis of covariance of differences in criterion means between students who did and did not have access to an automobile when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>28</td>
<td>Analysis of regression, regressing criterion score on quarters of college experience</td>
</tr>
<tr>
<td>29</td>
<td>Unadjusted and adjusted criterion mean scores for students living in each of the residence categories when ACT composite and high school rank were used as covariates</td>
</tr>
<tr>
<td>30</td>
<td>Analysis of covariance of differences in criterion means between five categories of student college residence when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>31</td>
<td>Unadjusted and adjusted criterion mean scores for transfer status of students when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>32</td>
<td>Analysis of covariance of differences in criterion means between students who had and had not transferred to St. Cloud State College from other institutions of higher education when ACT composite and high school class rank were used as covariates</td>
</tr>
<tr>
<td>33</td>
<td>Product-moment correlation matrix for selected variables</td>
</tr>
<tr>
<td>34</td>
<td>Summary of regression equation model-building process</td>
</tr>
</tbody>
</table>


LIST OF FIGURES

<table>
<thead>
<tr>
<th>Figure</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Physical arrangement and time configuration for the Industry 192 experiment at St. Cloud State College</td>
<td>33</td>
</tr>
<tr>
<td>2</td>
<td>Student achievement measurements during the experiment</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>Sequence of events during the first day of the experiment</td>
<td>39</td>
</tr>
<tr>
<td>4</td>
<td>Decision framework for the Industry 192 experiment at St. Cloud State College</td>
<td>57</td>
</tr>
</tbody>
</table>
I. INTRODUCTION

There have been few experimental studies designed to examine the desirability of differing in-class time requirements for college students. Four-credit college courses typically require student attendance in lectures, laboratories, or recitations at least four hours per week for the duration of an academic quarter. Parallel time stipulations are also placed on courses of other credit-hour ratings.

Perhaps the only consistent deviation from this well established pattern lay in the foundations of what is commonly referred to as independent study. However, independent study is most often reserved for those students who have exhibited an academic superiority and are enrolled in "Honors" curricula. Seldom does one encounter research specifically designed to ascertain the "typical" student's ability to perform competitively under independent study conditions.

A. Background and Setting

College and University courses generically titled General Education are numerous. These courses are specifically designed to broaden and enhance an education received from liberal arts institutions. Typically, such courses are required subject-matter of the college student. The student must either enroll in a particular course or select from a block of possibilities a certain number of credit-hours that
will satisfy college requirements and, eventually, allow for graduation. Since General Education requirements are usually lower-division courses, the greatest number of students enrolled are of Freshman and Sophomore level. This fact suggests that much of the natural attrition within the college population has not yet taken place and that General Education courses are courses involving large numbers of students. Large numbers of students require considerable physical space for the everyday college routine -- lecture halls, laboratories, and recitation rooms.

Demand on facilities necessitates considerable expenditures of public funds for classroom and laboratory buildings. Public funds are spent for physical facilities that could perhaps be better spent.

This experimental study was undertaken within the School of Industry at St. Cloud (Minnesota) State College. St. Cloud State College is:

... a multi-purpose institution offering undergraduate and graduate programs of study in the School of Liberal Arts and Sciences, School of Business, School of Education, School of Fine Arts, School of Industry and the Graduate School. (31, p. 3)

There are two departmental divisions within the School of Industry -- the Department of Technology and the Department of Industrial Education.

One of several college-wide General Education courses offered is offered through the Department of Industrial
Education (Ind.). This course is titled, "Modern Technology and Civilization" (Ind. 192). Industry 192 is currently described as an:

Analysis of contemporary technology and its effects on man and society. Special emphasis is placed on change created by technology, as well as such topics as modern industrial structure, the labor force, leisure, automation and the resulting social consequences. 4 credits. (31, p. 85)

As a part of the General Education requirement, every student graduated from St. Cloud State College with either a Bachelor of Arts or Bachelor of Science degree must have selected and successfully completed course requirements in three of a four-course block. In addition to Ind. 192, the courses in that block are: (1) Geography 171 -- Regional Human Geography, (2) History 101 -- Historical Studies, and (3) Psychology 121 -- General Psychology. (31)

The proposed experimental study in Modern Technology and Civilization was graciously received by the administration and faculty of the School of Industry, and permission was granted to perform the experiment during Winter Quarter, 1971 (January 6 - March 18, inclusive).

B. Statement of the Problem

Much has been written and discussed pertaining to the subject of independent study as it relates to a student's ability to assume responsibility for his own learning.

The problem associated with this study was to ascertain the relative merits of three methods of teaching the course,
Modern Technology and Civilization. Though the three methods did differ, a primary pair of stipulations were placed on the study. Those stipulations required that all students were to work and study from a common set of course objectives and that those objectives would be measured by common paper and pencil instruments.

Of the three techniques employed, the control group experienced instruction that was presented four hours each week through the traditional approach. One of the experimental groups was taught the same course content but experienced classroom exposure only three hours per week. The third group of students was essentially responsible for their own learning in the course, while meeting formally only once each week.

C. Purpose of the Experiment

The experiment was designed to determine the relative merits of teaching Modern Technology and Civilization to three groups of college students utilizing three methods of instruction. Those "relative merits" were determined on the basis of differential student achievement.

Specifically, the experiment's purpose was: (1) to determine the relative effectiveness of the three methods of teaching the course, (2) to determine the extent to which a college student is willing and able to accept the responsibility for his own learning through an exposure to independent study, and (3) to identify those factors which appeared to be
pertinent to student success in each of the three methods of instruction.

D. Delimitations of the Experiment

This experimental study was limited to those persons enrolled in eight selected sections of Industry 192 (Modern Technology and Civilization) at St. Cloud State College during the academic quarter of the experiment's administration (Winter, 1971).

The experiment permitted an examination of the relative merits (as measured by common paper and pencil tests) of teaching this course under three methods: (1) traditional approach, (2) three-class-meetings-per-week, and (3) independent study. Selected, student-specific variables and their relationship to student success under a particular technique of instruction were also studied and identified.

E. Organization of the Study

The report of this experimental study was structured as follows: Chapter I was drafted to briefly acquaint the reader with some background, problem, and purpose information. A review of the literature pertaining to this topic was presented in Chapter II. The literature was examined for a basis of logic, definitions of general education and independent study, and for previous studies of an analogous nature.

Chapter III was written to elaborate on the design and implementation phases of the experiment. This section
reported detailed descriptions of the various stipulations placed on many of the studied variables. The Findings chapter (Chapter IV) was devoted to a presentation of the tested hypotheses; displaying the several test statistics. Chapter V was devoted to discussions of implications, limitations, and recommendations resulting from the findings of the study.

Concluding the textual matter of this report was Chapter VI. Chapter VI summarized the experiment and its findings. Following these six chapters, ten appendices were included for the reader's reference. Materials contained in the appendices were excluded from the textual portions to allow continuity within the text while allowing the reader an opportunity for easy reference to those same, sometimes-essential, materials.
II. REVIEW OF LITERATURE

From the beginnings of recorded time man has sought better and more efficient ways in which to improve his living conditions. One important attempt of man's civilization has centered around the ways in which he has attempted to educate himself and his society. Assuming many forms through history, learning, teaching, and education have been with man for millennia.

Today, man finds himself confronted with many of the same problems that confronted his predecessors. Man finds himself somewhat baffled by the complexities and seeming inconsistencies of educational theory and practice. What seems to work toward advantageous learning in one group of students does not always seem to have the same success in other groups of students. As an individual, man seems to assimilate knowledge and formulate understandings through means that are seemingly unique. Yet man is a member of a species. Man is a member of a society. There are obvious similarities between human beings. There are probable similarities between the ways in which man learns.

A. A Base of Theory

Psychologists have generated models of learning based on a particular theory of learning or set of learning theories. Many of these theories have been abandoned by some but are tenaciously retained by others. At this point in time, there
is no one learning theory that is generally accepted by psychologists, educators, or others whose primary interest and profession centers around the individual.

Few would argue that for learning to take place in the individual, there must be some capacity for learning. That capacity is usually referred to as "intellect." And, like learning, intellect has also piqued psychological interest. As Dr. Frederick G. Brown (8, p. 316) notes, there are "several historically interesting and currently fashionable models" available for examination. The oldest and most simple explanation is that of the general intelligence theorists. Intelligence quotients of a single numeric expression are described by Dr. Brown as being indicative of a "uni-factor theory." Such a theory necessitates a reasoning that intellect can be singularly expressed. One expansion of this basic theory was that of Spearman. Spearman postulated a two-factor theory where a factor of general intelligence (g) was observed and defined to be one's reasoning ability. Spearman's second factor was conceptualized as specific intelligences. Therefore, an intelligence quotient in Spearman theory would indicate a considerable representation of general intelligence but would also begin to explain the presence of specific varieties of intelligence.

The theory of intellect most commonly accepted by American theorists -- as observed by Brown -- is that of group factors. Thorndike, Kelley, and Thurstone have been the prime
movers behind this theory and have done considerable empirical verification of the factors studied. The factors most commonly found to emerge from their investigations are space, perceptual speed, number, verbal comprehension, word fluency, rote memory and induction. Proponents of this theory envision the feasibility of describing any intellectual task in terms of "primary mental abilities." Such primary mental abilities being capable of measurement on a series of individual tests.

The third group of theories cited by Brown is that espoused by the hierarchical theorists. In this framework, it is assumed that intellect proceeds in a logical fashion from level to level. These levels typically emanate from an apex of what can be legitimately described as a base of general intelligence. Then, further levels of intellect within the hierarchical theory "explain" more specific areas of intelligence. A primary advocate of this theory has been P. E. Vernon.

Dr. J. P. Guilford is credited with the most recently formulated theory of intellectual structure. His model consists of a conceptualized cube having the axes of operations, contents, and products. The operations axis is defined as containing the processes of intellectual behavior -- cognition, memory, divergent thinking, convergent thinking, and evaluation. The contents axis is subdivided into figural, symbolic, semantic, and behavioral operations. The third, products, axis is comprised of units, classes, relations, systems,
transformations, and implications. In this hypothetical structure there are 120 cells that, theoretically, allow for unique explanation and study.

Granting that differing theories of intelligence structure do exist, the basic logic underlying the experiment at hand rests in the broader question of: What are the conditions under which man best learns a body of subject matter? The question is one of pragmatics. The question, however, cannot be approached until there is a base on which to build a practical solution.

Intellect is related to learning. Intellect is basic to learning. Intellect, however, is not a sufficient explanation for the extent to which one learns.

Like theorists of intelligence structure, learning theorists are numerous and diverse in their basic explanations. Hill (17) differentiates between two major groups of learning theorists by categorizing them in either the connectionist or cognitive group. Hill views the connectionists as those who maintain stimulus-response connections explain learning. Cognitive interpretations of learning suggest a concern for:

... the cognitions (perceptions or attitudes or beliefs) that the individual has about his environment, and with the ways these cognitions determine his behavior. ... learning is the study of the ways in which cognitions are modified by experience. (17, p. 28)

Of course, one would be hard pressed to find any two connectionists or any two cognitive theorists who agree com-
pletely on what is truly meant by the respective theory with which they are identified. A theory can remain only that — a theory. No theory of learning has yet been shown to have a general applicability.

Where intellect is basic to learning, learning is basic to education. To become educated, it is assumed that the learner has accumulated some knowledge or has furthered some understanding. In speaking about high school students and the purpose of education, Dr. B. Frank Brown (7, pp. 34-35) says:

If we should strip away the trimmings from the purposes of education and get down to the bare essentials, there would be universal agreement that the basic intent of education is to teach the individual how to make wise decisions. If this objective is to be realized, then students must have many more opportunities for making choices. . . . It is past time for the schools to recognize that students must be, not just permitted to make choices, but actually launched into various phases of decision making. For example, some students should attend classes only two or three days a week instead of five. Furthermore, they should exercise options as to how, when and perhaps where they will study on the other days. A few of the more highly self-directed students may need to attend classes only one or two days a week.

Though Brown addresses his remarks toward the high school, the extension of those remarks to students and systems of college campuses is not an unreal extension. The value of an education -- be it high school or college -- is manifold. The student is confronted by and learns a body of knowledge. But, perhaps even more important, the student learns to make intelligent and logical decisions for everyday living. Decision-making skills are unlikely learned most efficiently through
the systematized, clock-bound, approach that so characteristically describes typical educational techniques. It is more likely the case for decision-making skill development to take place when the student is allowed the opportunity of study and work on an individual and independent base.

Alluding to scheduling considerations, B. Frank Brown hints at the need for an increased flexibility in present-day school routine. While such flexibility seems to have an ever increasing acceptance, Alexander and Hines (1, p. 62) encourage progress with the remark:

Regardless of what schedule arrangement is made within a particular school to accommodate independent study plans, two features are believed essential:

1. **The schedule must be based on the principle that not all students need the same amount of time in a class or any other activity.**

2. **Scheduling arrangements must permit students to see teachers for conferences about their independent study problems.**

Reinforcing Dr. Brown's contentions of needed student involvement, Robert M. Gagne (14, p. 30) observes:

Many phrases in educational writing reflect the notion of learning as an event of social interaction, an "interpersonal encounter." Teaching is often referred to as something that is integrally involved in the learning process. The "teaching-learning process" is a phrase which often seems to imply that somehow these two entities are inseparable portions of a single type of event. Even "classroom learning" is sometimes used as though it defined a special variety of learning intimately bound up with the presence of other human beings in a social group. . . . Learning may take place in a social environment, but fundamentally it is a process that takes place within the individual.
Such consideration and concern for the student as an individual were seen as basic logical elements in the experimental investigation of this report. Each student was theoretically viewed as the product of a number of unique experiences, each of which can be seen as working independently and in combination with other experiences to affect and effect a total personality.

How that personality will react under certain specified conditions is of prime concern to sociologists, psychologists, and educators; for it is to their professions that one turns for explanations of human behavior. Unless the person offering explanations has some knowledge of the student's abilities and aptitudes, such explanations (or theories) cannot be expected to have substantial validity. When writing about aptitudes possessed by human beings, Dr. Frederick G. Brown (8, pp. 314-315) observed that:

An individual's performance on a given task is not determined solely by situational forces but is also a function of the characteristics of the individual -- his aptitudes. This is not to say that characteristics of the individual are the only important determiners of performance (as studies that utilize only psychological variables as predictors often seem to assume) but rather that the contribution of personal characteristics is not negligible. In all situations, performance will be determined by the individual's aptitudes, environmental factors, and the interaction of the two.

Seemingly, the neatness of this explanation would lend itself nicely to a mathematical expression. Aptitudes and environmental factors are characteristics that are conceivably
quantifiable and, thus, expressable in mathematical relations. It is this approach that many theorists and researchers have taken and one that is not at all ignored in the report of this experiment. The application of mathematical principles to the social sciences is a logical manner in which to confront the problems of the social sciences. However, as Hilgard (16, p. 401) notes, we must not regard mathematics as the answer to all problems in psychology or education.

With the advance of psychology as a science there will inevitably be an increased use of mathematics. Mathematics is the language of measurement, of precision, of prediction. Yet there is no royal road to scientific achievement and mathematics must remain subservient to observation and reflection. Instruments of precision in the laboratory are also the means of scientific progress, but we all know that in the wrong hands they may lead to narrowness and triviality instead of to advance. Therefore we need to examine mathematics critically as a powerful tool, but not a magical one.

B. General Education

While theorists may not completely agree on the ways in which one learns, practitioners seem overwhelmingly in favor of including certain basic elements in school curricula. In addition to the fundamentals associated with the "three R's," one notes a conspicuous presence of courses geared toward a general interest.

Four-year, degree-granting colleges typically refer to these general interest courses as "General Education" and require that a student be exposed to certain or selected
courses within the structure of General Education. Without known exception, colleges and universities whose philosophy is not specifically vocational, General Education courses are major portions of a student's curriculum.

One of six regional agencies, the North Central Association, defines General Education as:

... signifying "acquaintance with the major areas of knowledge." ... It "implies possession of the facts in such areas and some proficiency in the modes of thought involved in understanding such facts. ... It excludes definite vocational preparation." (4, p. 529)

Applying that definition to the realities of today's colleges and universities, Edward B. Blackman (4, p. 530) says:

In short, general education has become, at almost all American colleges and universities, an intellectual experience, looking to a certain fundamental understanding and awareness in the major divisions of learning, especially for the non-major.

General Education is designed to broaden student knowledge. It is meant to provide a base of knowledge that is not specifically geared to or for the student's sought-after profession. General Education is geared to those areas of man's achievement and experience that might go unstudied by the student were he not given the opportunity to study. General Education courses are designed to provide for a "better educated" individual and a more effective citizen. As Blackman (4, p. 526) states: "In a very real sense, however, all general education has at least some concern with individual self-development."
C. Independent Study

Increased enrollment in virtually all educational institutions has necessitated a rethinking on the part of educators, students, and even the taxpayers who ultimately support public education. Many attempts have been made to increase the efficiency of educational facilities and educational techniques. These attempts center on the objectives of cost-effectiveness, learning-effectiveness, and the optimum blending of the two.

All levels of the educational spectrum have experienced considerable change during the past decade. Elementary, secondary, and higher education have undergone progressive changes described by some as radical and irresponsible. Still, others contend that present-day education is living very much in the past. Then, there are those between the extremes.

Critics of the educational structure not only question the inefficient use of facilities, they criticize many of the techniques educators use in the teaching-learning process. Among these criticisms, one can hear critics questioning the rationale supporting the time-honored tradition of requiring a college student's attendance at one formal class meeting per week for each quarter-hour of college credit received.

In "Education by Appointment," Dr. B. Frank Brown (7, pp. 71-72) succinctly poses that same criticism when he says:

... the conventional classroom arrangement provides for teachers to conduct miniature lecture halls. Here the teacher, surrounded by his helpless captives, is the central figure of authority.
This alarming state of affairs is taking place in an age in which learning should be centered around a new collaboration between students and teachers. It is past time for teachers to recognize that they cannot do things to students which will result in their education. Students must do things to and for themselves.

The new relationship between students and teachers should be a flexible consortium. In this arrangement, the teacher meets students sometimes as individuals, often as members of a small group and frequently as a class. This structure brings teachers to a much closer understanding of the notion that schools are made for learning, not teaching.

The "consortium" of which Brown speaks rings of a need for flexible scheduling. It rings of a need for placing educational emphases on learning and student involvement in learning. It rings of a philosophy and technique of education that many refer to as independent study.

Alexander and Hines (1, pp. 4-11) noted that:

The underlying intent of encouraging study on the student's own has been clear enough and to achieve this aim varying forms and practices of independent study have been developed. . . .

Independent study as a substitute for organized instruction . . . ,
Independent study as honors work . . . ,
Independent study as a culminating activity . . . ,
Correspondence courses as independent study . . . ,
Programmed instruction as independent study . . . ,
Independent study as a supplement to group instruction . . . , and
Independent study as individualized instruction . . . .

Indeed, independent study could be viewed as enveloping any or all of these forms. However, for purposes of this study, the investigator chose to think of independent study
as encompassing the practices of its serving two functions: (1) an alternative (substitute) for teacher-organized and directed classroom instruction and (2) as individualized instruction. The aspect of independent study as Honors work was also of primary concern to the investigator, for St. Cloud State College does employ an "Honors" program. It was one intent of the experiment to consider the notion that only "academically superior" students are capable of independent study.

To say that independent study concepts are tied to any one philosophy of education would be an erroneous statement. If a philosophy of independent study were advanced, it would surely include aspects of maximizing student growth in the area of personal decision-making. It would also include a concern for the student as a member of society and not just a classroom. It would be concerned with the total growth of the student and not just a body of factual or philosophical information.

One definition of independent study to which the investigator subscribes is that cited by Linck (22, p. 36) in a recent issue of "Audiovisual Instruction."

Independent study is a broad form of self-instruction characterized by instructional programs whereby individual students become responsible for a significant portion of their learning without direct supervision, and for which school time and facilities are provided. . . . Some American colleges and universities have had established independent study programs for many years, often under the title "honors program" . . .
It was reasoned that independent study approaches to the study of this course (Modern Technology and Civilization) would allow for a more efficient use of the physical facilities. It was also reasoned that independent study would allow for growth within the individual student that is less apt to be realized in the more traditional methods of instruction. Of the many growths felt to be of real value to the student in the independent study sections of this experiment were such concepts as increased feelings of responsibility to and for one's own learning and increased individual motivation on the part of students.

Concurring with Linck's definition, B. Frank Brown (7, p. 57) says, "... independent study is a term used to describe programs which place greater responsibility on students for their own education."

Tracing the apparent sequence of independent study incorporation into a curriculum, William M. Rogge (30, pp. 11-12) sees an emerging pattern.

In beginning the use of independent study on the college level, high achieving students start the program and then typically it is opened to other ability levels. Later made into a required program, some students have a choice about enrolling. Students are generally considered able or unable to do the work, and thus little attention is given to nurturing students into a readiness for independent work. In voluntary programs the general view is that a student is ready at a particular grade level; and when a program is extended, it typically is done a grade level at a time. This latter practice is paradoxically contrary to the elaborate selection practices some schools will use upon their students at a particular grade level.
In reporting "Explorations in student-controlled instruction," Mager and Clark (24) examined several studies concerning "adult" (college level) students. Their observations and conclusions substantiate Rogge's contentions of initial differences between individuals.

The general conclusion we draw from these studies is that adult students are likely to enter a learning situation with a significant amount of relevant knowledge; in other words, they are likely to already know something about that which is to be taught. . . .

. . . We submit that it is timely to begin thinking about curriculum-generating machines! These devices would be designed to detect what the student already knows, compare this body of knowledge with that required by the objectives of the program, and then generate a curriculum for the student. (24, p. 237)

Of course, such "curriculum-generating machines" are impossible today and perhaps only facetiously suggested by the authors. The hardware implications of that suggestion may have been made in jest but the idealism of the notion cannot be ignored.

In the absence of a curriculum-generating machine, the adult learner himself might be a better judge of what he needs to add to his current knowledge in order to reach some given set of objectives than is a textbook writer, instructor, or programmer. Given half a chance and a set of reasonable objectives, he will probably generate for himself a curriculum that will lead him to achieve these objectives. Interestingly, this implication is not without support. There are several studies performed by professors (Duke, 1959; Milton, 1959; Weitman and Gruber, 1960) who have allowed one college class to attend all the lectures while prohibiting another group from any lecture attendance. Even in the absence of carefully specified objectives, students of the group who were not
allowed to come to class performed just as well as those in attendance. While this is not conclusive evidence that teachers aren't necessary, the data suggests that we might improve the efficiency of instruction by making better use of the intelligence and background which the adult student brings to the formal instructional experience. (24, pp. 237-238)

Such a theory is apparently buttressed by reality, for Rogge (30, p. 11) further states:

Colleges discovered that independent study, first limited to superior seniors, was even more appropriate, in the judgment of most reviewers, for lower classmen of varying academic abilities.

These and like observations piqued the investigator's desire to include a "typical" college class in an aspect of independent study.

However, as was seen in the Alexander and Hines statement, the concept of independent study can assume many profiles. An operational definition of independent study requires an examination of the particular circumstances under which that mode of instruction is being administered. Independent study cannot be defined in a universal sense where all situations employing it would fit a common conceptual framework. There are, however, ingredients of independent study that should be present in all approaches using "independent study" as the means through which the student explores and learns. Rogge (30, p. 18) seems to concur when he says:

What independent study should consist of is difficult to answer.... The criteria for acceptable models should include internal consistency, adjustment for individual differences, expectations of
the teacher's role and student activity, comprehensiveness, and outcomes.

The framework around which the experimental study of this paper was structured attempted to involve all of the criteria seen by Rogge as essential to an acceptable model.

Furthering the concept of independent study, Dr. B. Frank Brown (7, pp. 84-85) has cited thirteen "principles of independent study;" four of which seemed especially appropriate for the purposes of this experiment.

[1] The most meaningful learning takes place when an individual makes a personal commitment to learning and becomes deeply involved in his own education.

[2] Independent study places the student in a more active role in the learning process.

[3] The purpose of independent study is to help each student to learn how to take charge of the development of his own learning and to understand that he alone is largely responsible for his education.

[4] Independent study is designed to help each student to develop confidence in his own ability to learn, to be able to think imaginatively, and to explore ideas which appeal to him.

These "principles" provided the experimenter with a basic logic on which to build fundamental interests in the study of independent study.

Several studies incorporating the concept of independent study have been completed on all levels of the educational spectrum. Approaches used in these studies have considerable variation and the results have had diverse application inferred from their experience. One of the studies most closely
allied with the concerns of this report involved a 1965 experiment at Brigham Young University. That experiment compared two groups of students (traditional versus independent study) responsible for the same subject matter. Bigelow and Egbert (3, p. 37) reported the:

Results implied that students successful in traditional study succeeded as well in independent study, that intellectual efficiency and responsibility were personality traits pertinent to independent study success, and that within the group of successful independent study students, those with higher social needs indices tended to be less satisfied with completely autonomous study.

Such results and conclusions do not seem to be particularly astounding or unexpected. Rather, with some reflection, one can readily envision students of those traits performing in the manner they were observed.

A later study, but performed at the high school level, was reported by Diana Tracy (34, p. 3785-A) when she wrote:

... students of above average ability perform about as well studying independently as studying in the classroom, that self-sufficiency is related to achievement in an independent situation on tasks requiring knowledge of specific facts, and that students have a generally favorable attitude toward learner-directed study.

Still another study, reported by George Beltz (2, p. 2600-A), involved independent study techniques in selected high schools of Missouri. Beltz' report cites aspects of independent study that are frequently used by the doubting Thomases of educational change.

Problems thought to be correlaries of independent study -- time waste, lack of direction, addi-
tional discipline — had not plagued Missouri's early [independent study] innovators.

For purposes of his study, this investigator reasoned that if high school students are capable of avoiding such pitfalls, college students must certainly be every bit as mature in handling their personal independence in the course of studying a given subject.

Several reports of studies dealing with "independent study" seem to violate a true usage of the phrase. Glatthorn and Ferderbar (15) readily admit to equating the phrase "independent study" with "unscheduled time." A 1969 study by Jack D. McLeod (25) seems to use "independent study" in a way this writer would define "an assignment to be completed outside the classroom walls -- homework."

Most reports relating to what appears to approach "true" independent study seem to stress an observation that something other than native ability and an academic bent are present in those persons succeeding in independent study sections. That elusive construct of "maturity" is perhaps the force underpinning the probable success of a student who entertains independent study as a means of learning. Rogge (30, p. 12) notes that:

...academic aptitude is a low predictor for success in independent study. And to assume that all students are ready for independent study at a particular grade level reveals a conspicuous nonchalance to differences among students.

However, when weighed against a natural compensation for
individual differences between students, the concept of independent study is a most defensible learning technique. It was through this reasoning that the experimenter established a keen interest in pursuing such a concept in a college-level class. It was anticipated that, were independent study on the college level found beneficial, the incorporation of such would serve a three-fold purpose: (1) curtailing needless use of classrooms (with an expected increased usage of the Learning Resources facility), (2) forced improvement of student study skills, and (3) increased student-felt responsibility for his own learning.

D. Summary

Experimental research in any discipline necessitates a foundation in theory, a consistency in terminology and a defensible logic in experimental method. This chapter has attempted to formulate a base for the first two of those objectives. The third has been presented in the next chapter (Chapter III).

Primarily, the theory on which this experiment was based was: There are more efficient ways in which college students can learn. There are ways in which a student can gain knowledge while encountering experiences that will better prepare him for life. While the "better preparation for life" is a logically defensible hypothesis, it is one that necessarily went untested in this experiment.
With the major exception of "independent study," the terminology of this report is such that little, if any, ambiguity is present. However, it has been necessary to define what was meant by independent study.

In this experiment, students in independent study sections were confronted with choices about what (within limits) to study, when to study, and to what depth a particular objective of the course should be studied. Other, much more general descriptions of independent study were cited in this chapter.

Several completed studies have dealt with independent study students. Some of these studies have been done with considerable skill while others appear to violate the basic tenets of good research. Though reported results of past studies do vary, B. Frank Brown (7, p. 57) nicely summarizes many of the observations that seem to be somewhat common throughout the literature.

In the process of independent study a great deal more than just intellectual performance is required. Students who do best in independent study are those who have exhibited maturity of thinking, independence of thought and action, intuitive perception, and ability in expression.

The next chapter presents the logic employed and the actual techniques used in the experimental study of this report.
III. METHOD OF PROCEDURE

This experiment was performed within the School of Industry at St. Cloud State College during Winter Quarter, 1971. The four-hundred-seventy (470) subjects on whom the experiment was performed consisted of undergraduate male and female students enrolled in diverse curricula.

The course in which the experiment was performed, Modern Technology and Civilization, was one of four courses in a General Education block of courses required by the College. Each student graduated from St. Cloud State College must have selected, participated in, and successfully completed the requirements for three of the four courses. In addition to Modern Technology and Civilization -- Industry 192, the following three courses comprised that block of courses from which the student must have selected: Regional Human Geography -- Geography 171, Historical Studies -- History 101, and General Psychology -- Psychology 121. Each of these four courses was rated at four quarter-hours of credit, expected to meet for four lecture-presentation periods per week. Although all four courses were of the 1xx-level where the offering was considered a "freshman course," upperclassmen frequently enrolled each quarter.

The problem associated with this experiment was to ascertain the relative merits of three methods of teaching Industry 192 to a relatively large group of college students. The
three techniques of instruction employed in the experiment were: (1) the traditional approach of four class periods per week, (2) the traditional approach utilizing three periods of instruction per week, and (3) the approach of independent study where the class met but for one period each week. In addition to determining the relative effectiveness of the three methods of teaching the course, the investigator felt it of value to examine selected personal factors of students and to determine if and to what extent the factors tended to affect student performance.

A. Sample Selection and Description

During Winter Quarter 1971, the School of Industry had fourteen scheduled sections of Industry 192. Each section had a potential enrollment capacity of either fifty or seventy students; dependent upon the lecture-recitation room to which the section had been administratively assigned. Eight of the fourteen sections were scheduled in such a fashion as to have four time periods during the day when two sections were holding class at the same time. The investigator was granted permission by the Dean and the instructional staff of the School to administer the experiment within each of those eight sections.

So as to lessen the tendency of a student's selecting a particular section on the basis of the assigned instructor, the investigator requested that the instructor names be
replaced with ellipses on the schedule of classes -- the schedule from which students selected classes. That request was granted and the assumption was made that students did not elect a particular class section in preference for another because of a particular instructor's class assignment.

Students within a given time of day were randomly assigned to one of the three treatment conditions. Six columns of twenty random numbers were produced through the use of Winer's (35, p. 659) Table B.12. Together, the six columns contained all mutually exclusive numbers within the range of 1-120. This six-column table was referred to as the random selection table.

The experimenter's desire to pretest only half of each treatment group necessitated the six column framework for random assignment of students to specific treatment and sub-treatment (pretest - no pretest) groups.

In part, the first day of the experiment was used to inform students of their assigned instructor and the conditions under which they would receive instruction in the course. This was accomplished by requiring each student to letter his name on a 3-inch by 5-inch card (see Figure 3.). The cards were collected, placed in a common deck from the two commonly-scheduled sections, placed in alphabetic order, numbered serially from 1 to n (n ≤ 120) and selectively placed in a particular treatment group according to the random selection table. Lists of student names were generated on the basis of
the various decks and the students were notified before the end of the class period as to when and where their next Industry 192 class would meet.

Students who were not in attendance on the first day or who later "added" the course were given a number -- irrespective of alphabetic order -- one greater than the previous "last" person to enter the course during that particular time of the day. That number was then his "random" number and he was assigned to a treatment group according to the random selection table.

The randomization process resulted in an amenable distribution of students across the experiment. However, natural attrition and impossible access to some data on some students resulted in a total experimental mortality of twenty-three students. The experiment began with 493 students, of which 470 were used in the data analyses (an overall sample usage of 95.33 percent).

Those students who were ultimately studied through data analyses (470 students) also comprised amenable distributions. Table 1 illustrates the distribution of students within each experimental condition across times of day.

In addition to allowing random assignment of students to particular treatment conditions, the random selection table also had the facility to assign student pretest participation. Table 2 presents the distribution of students relative to
Table 1. Number of students in each treatment group according to times of day

<table>
<thead>
<tr>
<th>Times of Day</th>
<th>Treatment Group&lt;sup&gt;a&lt;/sup&gt;</th>
<th>C&lt;sup&gt;b&lt;/sup&gt;</th>
<th>E1&lt;sup&gt;c&lt;/sup&gt;</th>
<th>E2&lt;sup&gt;d&lt;/sup&gt;</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td></td>
<td>40</td>
<td>37</td>
<td>41</td>
<td>118</td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td>39</td>
<td>39</td>
<td>39</td>
<td>117</td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td>34</td>
<td>39</td>
<td>40</td>
<td>113</td>
</tr>
<tr>
<td>2:00</td>
<td></td>
<td>44</td>
<td>38</td>
<td>40</td>
<td>122</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>157</td>
<td>153</td>
<td>160</td>
<td>N=470</td>
</tr>
</tbody>
</table>

<sup>a</sup>The codes C, E1, and E2 are understood to identify the same treatment groups throughout this study.

<sup>b</sup>Traditional method; four class meetings per week.

<sup>c</sup>Traditional method; three class meetings per week.

<sup>d</sup>Independent study method; one class meeting per week.

Table 2. Number of students in each treatment group who were administered the pretest<sup>a</sup>

<table>
<thead>
<tr>
<th>Times of Day</th>
<th>Treatment Group</th>
<th>C</th>
<th>E1</th>
<th>E2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td></td>
<td>22</td>
<td>17</td>
<td>22</td>
<td>61 (57)</td>
</tr>
<tr>
<td></td>
<td>(18)</td>
<td></td>
<td>(20)</td>
<td>(19)</td>
<td>(57)</td>
</tr>
<tr>
<td>11:00</td>
<td></td>
<td>18</td>
<td>18</td>
<td>21</td>
<td>57 (60)</td>
</tr>
<tr>
<td></td>
<td>(21)</td>
<td></td>
<td>(21)</td>
<td>(18)</td>
<td>(60)</td>
</tr>
<tr>
<td>1:00</td>
<td></td>
<td>17</td>
<td>19</td>
<td>20</td>
<td>56 (57)</td>
</tr>
<tr>
<td></td>
<td>(17)</td>
<td></td>
<td>(20)</td>
<td>(20)</td>
<td>(57)</td>
</tr>
<tr>
<td>2:00</td>
<td></td>
<td>22</td>
<td>19</td>
<td>19</td>
<td>60 (62)</td>
</tr>
<tr>
<td></td>
<td>(22)</td>
<td></td>
<td>(19)</td>
<td>(21)</td>
<td>(62)</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>79</td>
<td>73</td>
<td>82</td>
<td>234 (236)</td>
</tr>
</tbody>
</table>

<sup>a</sup>Parenthetical entries denote the number of non-pretested students of that section.
pretest participation.

Prior to the second class day of the experiment, each instructor was provided a list of the randomly assigned students. The list provided for a concise record of the section population and allowed the instructor's immediate knowledge of which students were to be pretested. This listing was presented on a form (Appendix C) that was a facsimile of that used by the College, providing for usual record keeping.

For the sake of description, the experimenter examined the resulting samples according to student sex. See Table 3.

Table 3: Number of students in each treatment group according to sex of student

<table>
<thead>
<tr>
<th>Sex of Student</th>
<th>Treatment Group</th>
<th>C</th>
<th>E1</th>
<th>E2</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td>79</td>
<td>66</td>
<td>70</td>
<td>215</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>78</td>
<td>87</td>
<td>90</td>
<td>255</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>157</td>
<td>153</td>
<td>160</td>
<td>N=470</td>
</tr>
</tbody>
</table>

To better view the overall sampling procedure and how it related to the entire experiment, Figure 1 was drafted to facilitate communication between the investigator and the instructional staff at St. Cloud. That same paradigm was used here to portray the entire experiment in its basic elements and to better illustrate the sampling procedure used in the experiment.
<table>
<thead>
<tr>
<th>class time</th>
<th>sec. #</th>
<th>room #</th>
<th>instr.</th>
<th>N</th>
<th>students of the two sections are combined and then randomly assigned</th>
</tr>
</thead>
<tbody>
<tr>
<td>9:00</td>
<td>2</td>
<td>116</td>
<td>C</td>
<td>50</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>230</td>
<td>F</td>
<td>70</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td>11:00</td>
<td>5</td>
<td>116</td>
<td>C</td>
<td>50</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>230</td>
<td>E</td>
<td>70</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td>1:00</td>
<td>8</td>
<td>116</td>
<td>B</td>
<td>50</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>230</td>
<td>D</td>
<td>70</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td>2:00</td>
<td>10</td>
<td>116</td>
<td>A</td>
<td>50</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
<tr>
<td></td>
<td>11</td>
<td>230</td>
<td>C</td>
<td>70</td>
<td>40 → 120 - R 40 → 120 - R 40 → 120 - R 40 → 120 - R</td>
</tr>
</tbody>
</table>

Figure 1. Physical arrangement and time configuration for the Industry 192 experiment at St. Cloud State College
B. Experimental Design

The design employed in the experiment was a modified version of the Solomon four-group (Design 5) format as described by Campbell and Stanley (10, p. 24). The pre-experiment scheduling arrangement of classes at St. Cloud allowed for four simultaneous replications of the experiment within the framework of the Solomon design.

The experiment proceeded thusly:

<table>
<thead>
<tr>
<th>universe</th>
<th>time of class</th>
<th>design</th>
<th>original section number</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R O_p T_1 O_m T_1 O_f</td>
<td>2 and 3</td>
</tr>
<tr>
<td></td>
<td>9:00</td>
<td>R T_1 O_m T_1 O_f</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R O_p T_2 O_m T_2 O_f</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R T_2 O_m T_2 O_f</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R O_p T_3 O_m T_3 O_f</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>R T_3 O_m T_3 O_f</td>
<td></td>
</tr>
<tr>
<td>11:00</td>
<td>same as for 9:00</td>
<td>5 and 6</td>
<td></td>
</tr>
<tr>
<td>1:00</td>
<td>same as for 9:00</td>
<td>8 and 9</td>
<td></td>
</tr>
<tr>
<td>2:00</td>
<td>same as for 9:00</td>
<td>10 and 11</td>
<td></td>
</tr>
</tbody>
</table>

where

R = random assignment of students to one of the six experimental conditions,

T_1 = traditional lecture approach,

T_2 = traditional approach, less one class meeting per week,
\[ T_3 = \text{independent study approach}, \]
\[ O_p = \text{pretest}, \]
\[ O_m = \text{mid-quarter examination}, \]
\[ O_f = \text{final examination}. \]

The three experimental conditions were administered and monitored during each of the four time periods for the entire academic quarter. For purposes of the experiment, each student was evaluated at least twice -- once at mid-quarter and again during the final examination. Half of each treatment group also received a pretest. The paradigm of Figure 2 was employed to better visualize the measurement processes for each treatment group.

<table>
<thead>
<tr>
<th>Pretest</th>
<th>(treatment)</th>
<th>mid-quarter exam</th>
<th>(treatment) final exam</th>
</tr>
</thead>
<tbody>
<tr>
<td>No Pretest</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 2. Student achievement measurements during the experiment

Demonstrated performance on the criterion measure of the normalized standard mid-quarter and final examinations was viewed as having the most influential effect on the success a student would realize in this course. It was also thought that many factors possessed by the student would contribute to test performance. In other words, there were factors of probable uniqueness unto an individual that contributed substantially to his performance. It was reasoned that these factors
may have acted singly in that contribution or they may have acted in combination with one another to affect the measured performance.

It was also theorized that it might become desirable to ascertain the probable performance of a student in Industry 192 prior to his exposure to the course content. Predictive formulae based on noncourse-content information were seen as necessary tools of such prediction. Therefore, it was decided to utilize the technique of least squares analysis, known also as multiple regression analysis. This analysis allowed for a lessened concern for a lacking disproportionality in cell frequencies (non-orthogonality) while still providing for the essential decision-making attributes of the more frequently used analyses of variance and covariance techniques. Like analysis of variance, multiple regression techniques are readily adaptable to computer programming and such facilities and programs were used. The Computation Center of Iowa State University and its Series 360 - Model 65 International Business Machines (IBM) computer and peripheral equipment provided the hardware and software for the analysis of the data (29, p. 62).

The actual technique employed in analyzing the data for prediction purposes was that of the backward elimination regression procedure which is competently discussed in Chapter 6 (Section 6.2) of Draper and Smith (11).

Had all main effects and all possible interactions of the
selected variables been examined with the theoretical model, the model would have consisted of several thousand terms. Such an undertaking was deemed unwieldy and unnecessary. Rather, the following main-effects-only model was employed to examine the tenability of the several tested hypotheses.

\[ Y_{ijk} = \beta_0 x_0 + \beta_1 x_1 + \beta_2 x_2 + \cdots + \beta_4 x_4 + \epsilon_{ijk} \] (III.1)

where

- \( Y_{ijk} \) = composite of the mid-quarter and final exam scores,
- \( x_0 \) = dummy variable always equal to unity,
- \( x_1 \) = pretest scores,
- \( x_2 \) = ACT composite scores,
- \( x_3 \) = minutes studied per week,
- \( x_4 \) = high school percentile rank,
- \( x_5 \) = college experience (in quarters),
- \( x_6 \) = student age (in months),
- \( x_7, x_8 \) = dummy variables used to identify the treatment condition,
- \( x_9, x_{10}, x_{11} \) = dummy variables used to identify the time of day during which the treatment was given,
- \( x_{12}, x_{13}, \ldots, x_{16} \) = dummy variables used to identify the instructor under whom the treatment was given,
C. Application of Experimental Design

The first day of the quarter (Appendix G) was spent in orienting students to the course. That first day was also used to establish the various experimental treatment groups that were to determine the methods of operation for the remainder of the quarter. The flowchart scheme of Figure 3 was developed to clarify the instructional staff's understanding as to what simultaneous activities were taking place that first day.

The crux of the entire experiment centered on ascertaining variable student achievement in each of the three experimental conditions. Those treatments were viewed as imparting their effect on each student's score attained on the criterion
Figure 3. Sequence of events during the first day of the experiment

measure. The entire rigor of the physical, sampling, and administrative design arrangements was deemed necessary to maximize heterogeneity of student characteristics within each of the three conditions of a particular time of day and to
provide for homogeneity of those characteristics between the three condition groups.

The second day of the experiment (Appendix H) was set aside from the business of course content to further acquaint the students with the experiment. For information on the events of the first two class days of this experiment, the reader is referred to Appendices G, H, I, and J of this paper.

D. Experimental Treatments

There was no intent or desire on the part of the investigator to grade or evaluate student performance for the student's record. The primary intent of this experiment was to determine if any of the three experimental conditions was consistently more effective in a large group of students as measured by a composite of the two examinations. If this were found to be true, the intent became that of attempting to identify those student characteristics that were of an apparent contributory nature to that overall effectiveness of experimental learning condition. The conditions under which the students were to be exposed to the course content were explained during the second class day. This was accomplished by the assigned instructor employing the investigator-produced audio-tape (see Appendices G, H, I, J).

1. Control group

The Control Group comprised about one-third (33.40%) of the entire sample, or 157 students. There were actually four
control sub-groups where one met during each of the four times during the day (9:00, 11:00, 1:00, and 2:00). The conditions under which this group was taught were limited to the interpretation and approach of the assigned instructor. However, the instructor was to gear instruction to his satisfaction that the stated course objectives (Appendix A) had been taught by the time of their respective dates for testing. These classes met four times each week.

2. **Experimental-I**

   Like the Control Group, the Experimental-I (E1) group was also sub-grouped during the four times of day. One-hundred-fifty-three students (32.55% of the total sample) were assigned to E1 sections. The only, yet crucial, difference between this group and the Control Group was that the Experimental-I's experienced formal class meetings only three times each week. The logic involved in including this version of an experimental condition was that such an arrangement would require an instructor to reallocate established patterns in teaching the course. It was thought that the reduction of in-class exposure by twenty-five percent might result in the paring of nonessential material. This, of course, could only be concluded had there been no appreciable achievement score differences between this, Experimental-I, and the Control Group.

3. **Experimental-II**

   About one-third (34.04%) of the experimental sample was
administered the Experimental-II (E2) treatment. This condition was also present during each of the four time periods. There were 160 students in the four E2 sections. Experimental-II involved concepts of independent study where students were expected to meet formally with an assigned instructor for one class period each week. The instructor was to refrain from delivering any formal presentation during that period. He was to serve as a monitor, coordinator, and resource person for dialogue between students, and teacher and students. The inclusion of this aspect in the experiment was seen as allowing an examination of how willing or able college students were to interpret stated course objectives and -- independent of strict instructor direction -- to ferret out a competitive realization of the course objectives. Students involved in Experimental-II were encouraged to initiate individual conferences with their assigned instructors or any other instructor. Such conferences were to be used for clarifications on what had been read, to remedy difficulties the student may have had in locating certain information, and; in general, to individualize learning.

All students in all experimental conditions received a multilithed syllabus (Appendix A) that oriented them to the course. Contained in that syllabus was a detailed account of the number of test items that would be presented to measure each of the stated course objectives. That account of test content served as the logical base on which to conclude that
all students had identical before-the-fact information on examination content.

All students, then, were tested according to the same instruments. The mid-quarter examination was administered over a three day period (February 9-11, 1971), and the final examination was given Wednesday, March 17, 1971.

E. Personal Factors of Students

All individuals possess varying degrees of some characteristics that are defined (and believed) to be present in all human beings. It was decided to examine some of these characteristics (factors) and to determine if and to what extent they effected a student's composite score of mid-quarter and final examinations. Theoretically; were it possible to identify, isolate, calibrate, and measure all such factors; that contribution to the variance in a particular composite score could be accurately predicted 100 percent of the time. Such understandings of the human physiology and psyche are not now known. However, selected factors of experimental interest to the investigator were determined as having "possible" effect on one's success in this class. Those factors are elaborated upon on the following pages.

1. Factors of a continuous nature

Five "factors" deemed to have data characteristics of a continuous nature were gathered on each student. Descriptive statistics pertaining to these data have been entered in the
following table.

Table 4. Means and standard deviations for four of the five student factors deemed to be of a continuous data nature

<table>
<thead>
<tr>
<th>Factor</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>High School Rank (percentile)</td>
<td>66.4766</td>
</tr>
<tr>
<td>ACT (composite)</td>
<td>21.5532</td>
</tr>
<tr>
<td>College Experience (quarters)</td>
<td>2.7660</td>
</tr>
<tr>
<td>Student Age (months)</td>
<td>234.4681</td>
</tr>
</tbody>
</table>

a. High school rank  To align this experiment and its possible ramifications with existing educational thought and practice, high school rank data were secured on each student. High school rank was viewed as evidence of a person's past academic performance.

High school rank and the American College Testing Program (ACT) composite score were partial criteria used by St. Cloud State College in determining student eligibility for participation in the Honors Program. These data were secured on each student from the files of the Admissions and Records Office of St. Cloud State College.

b. ACT composite score  The logic utilized in including this score in the theoretical model was directly analogous to that logic of including high school rank. The ACT composite score (9) was viewed as evidence of a person's academic
ability. This information was also taken from confidential student files.

c. Minutes studied per week On seven specified dates throughout the quarter, each student was requested to report (Appendix J) the number of hours he had spent outside of class studying Industry 192 materials. These data were collected, converted to an average number of minutes studied each week, and coded for each student. Examination of the statistics describing that variable prompted the investigator to question its validity and worth. Data pertaining to the variable (average minutes studied per week) were abandoned as having little or no value in this experiment.

Viewed as having potential value in the study, data describing the following factors were secured through the student-completed Personal Factors Questionnaire (Appendix B). That questionnaire was completed during the first day of the experiment's administration.

d. College experience It was reasoned that the time a student had spent in a college environment could possibly effect his performance and achievement. These data were considered to be continuous and were coded in terms of total academic quarters completed at the time of the experiment's beginning.

e. Student age As with college experience, it was reasoned that a student's chronological age could conceivably have had some bearing on how he performed in or under each of
the three experimental conditions. The age of a student was determined from the quoted date of birth and was expressed in terms of months of age at the beginning of the experiment.

2. Factors of a discrete nature

In addition to the data of college experience and chronological age, the questionnaire provided data for five additional factors. These were factors producing data of a discrete nature where the calibration thereof consisted of indicating the presence or absence of the factor for that individual. As such, the actual data manipulation and examination involved each of the following factors being statistically handled in the "dummy" variable framework. The approach to dummy variables taken was that of Draper and Smith (11, p. 134).

a. Automobile availability The student was asked if he had ready access to an automobile while he was in college during Winter Quarter, 1971. The automobile had to have been registered in his or his immediate guardian's name in order that the answer be affirmative. Coding involved a simple yes or no response.

b. Marital status of student The marital status of a student was viewed as having a potential for influencing performance in the course and was, therefore, included in the model. Each student was considered to be married (at the beginning of the experiment) or not married. Divorced,
widowed, or engaged-to-be-married students were instructed to indicate that they were single.

c. **Residence while in college** The categories of housing in which students reside are perhaps difficult to establish. But one realizes that there are degrees of desirability in many types of residences and the investigator theorized that the environment in which a student spends much of his time and does much of his studying -- his college residence -- could have considerable bearing on how well he performed in class. The categories of housing decided upon for the purposes of this study were: (1) home -- the student lived with his parents or, if married, lived with his or her spouse, (2) dormitory -- the student lived in a college-operated, on-campus living facility, (3) rooming house -- single students who rented rooms or apartments from private individuals or private or public (non-college) corporations, and (4) fraternity or sorority -- the student lived in a facility operated for the benefit of member individuals in a fraternal organization. Although these were the categories represented on the Personal Factors Questionnaire, examination of the data necessitated a modification of categories. The categories of college residence ultimately used in this study were: (1) home, (2) dormitory, (3) rooming house, (4) apartment, and (5) other.

d. **Sex of student** In view of the basic content of Modern Technology and Civilization, it was thought advisable
to examine if, in fact, a sex bias existed in the course.

e. **College transfer status**  At the suggestion of the St. Cloud staff, the fact that a person had or had not transferred to St. Cloud State College was examined as it related to his achievement in the course. No attempt was made to determine from where a student had transferred or why he left his previous school to attend St. Cloud State College.

f. **Instructor for the course**  The effect a particular instructor might have had on or in a particular experimental condition was felt to be of sufficient importance as to warrant its inclusion in the model. Coding of this information was done in such a fashion as to render the code immediately unintelligible to anyone but the investigator. It was decided prior to the experiment that, regardless of the outcome of this influence on student achievement, the only reporting of such findings would be limited to very general statements and that no instructor would be identified as exceptional, typical, mediocre, or as a member of any other such category.

**F. Criterion Measures**

Though not a wholly defensible contention, a student's success in a course is most frequently judged on the basis of the grade he has received. Admittedly, the grade a student receives is not always the grade he has earned. For that reason, the experimenter did not choose the final course grade
as the criterion (dependent) measure. Rather, the normalized and standardized composite score of the mid-quarter and final examinations was used as the measure of course "success."

Both tests were experimenter-constructed and, in the main, consisted of items that had been used during previous years in various sections of Industry 192. Newly drafted items were used to augment existing items. The content and ability level of each item was catalogued according to simple test plans for each examination. Those test plans were available for student use (Appendix A) in studying for the tests. Items used in these tests were selected or drafted by the investigator on the basis of an item's logically measuring a particular course objective or portion of an objective.

1. **Mid-quarter examination**

   The mid-quarter examination (Appendix E) was administered over a three day period to all students in the experiment. The examination consisted of forty (40) multiple-choice and twenty (20) true-false items that purported to measure objectives A and B as stated in the syllabus (Appendix A).

   Non-availability of some student answer sheets necessitated abandoning intentions to eliminate "poor" items from the test. Therefore, an estimated Kuder-Richardson (formula 20) (KR-20) estimate of mid-quarter reliability was performed on the reduced sample (89.57% of the tested students). The estimated KR-20 reliability coefficient for the mid-quarter
examination of this experiment was 0.55. That index was not as high as the investigator would have liked (26). However, it was felt that had the opportunity been available to eliminate the poorer items, the coefficient of reliability could have been raised.

Table 5 was prepared to present mid-quarter examination mean scores for the three treatment groups.

Table 5. Mid-quarter examination mean scores for the three treatment conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>37.92</td>
</tr>
<tr>
<td>E1</td>
<td>36.44</td>
</tr>
<tr>
<td>E2</td>
<td>37.13</td>
</tr>
<tr>
<td>Overall(^a)</td>
<td>37.17</td>
</tr>
</tbody>
</table>

\(^a\)The standard deviation over all students was 4.57.

2. **Final examination**

The final examination (Appendix F) was administered en masse to all students in the experiment. Comprising the examination were eighty-four (84) multiple choice and thirty-six (36) true-false items that were designed to measure all stated objectives of the syllabus (Appendix A).

The initial item analysis revealed the KR-20 equal to 0.77 while indicating thirteen "poor" items. Upon removal of the thirteen items, another item analysis was run, producing an identical coefficient of reliability -- 0.77. For want of
a better method, the investigator arbitrarily chose the 107-item test score as the score of experimental-record for each student.

Table 6 was prepared to present final exam (107 items) mean scores for the three treatment groups.

Table 6. Final examination mean scores for the three treatment conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>65.51</td>
</tr>
<tr>
<td>E1</td>
<td>64.22</td>
</tr>
<tr>
<td>E2</td>
<td>63.64</td>
</tr>
<tr>
<td>Overall</td>
<td>64.45</td>
</tr>
</tbody>
</table>

^a The standard deviation over all students was 9.07.

3. Composite score

A normalized standard score was computed on the mid-quarter and final exam for each student in the experiment. The procedure followed was that of Brown (8, pp. 170-173). Each normalized standard score had a designed arithmetic mean of 100.0 and a designed variance of 100.0.

The composite score of these two measures consisted of a simple arithmetic sum and was referred to as the criterion measure of the experiment. It was that composite score against which many test statistics and techniques were applied.

Theoretically, the overall mean of the composite (criterion) scores should have had a mean of 200.0 and a standard
deviation of $10\sqrt{2}$. However, because of an unavoidable subject mortality after establishment of the criterion scores, the mean was actually 199.5319 and the standard deviation was 17.5224.

Nunnally's (27, p. 230) formula 7-15 was used to estimate the reliability of composite scores. Application of that formula resulted in:

$$r_{cc} = 1 - \frac{2 - r_{mm} - r_{ff}}{\sqrt{c}}$$

where

$\sqrt{c} = 2 + 2(r_{mf}) = 3.0834$ = variance of the composite scores, and

$$r_{cc} = 0.78$$

$\sqrt{c}$ = variance of the composite scores, and

$r_{cc}$ = estimated reliability of the composite scores,

$r_{mm} = 0.55$ = estimated reliability of the mid-quarter examination,

$r_{ff} = 0.77$ = estimated reliability of the final examination,

$r_{mf} = 0.5417$ = correlation coefficient between the mid-quarter and final examinations.

Though not as high as the investigator would have liked it, the fact remained; the estimated reliability index of the composite scores was 0.78.

Table 7 was prepared to present criterion measure mean scores and standard deviations for the three treatment groups.

Although the experimenter utilized the mid-quarter and
Table 7. Criterion mean scores and standard deviations for the three treatment conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Statistics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
</tr>
<tr>
<td>C</td>
<td>202.32</td>
</tr>
<tr>
<td>E1</td>
<td>197.84</td>
</tr>
<tr>
<td>E2</td>
<td>198.42</td>
</tr>
<tr>
<td>Overall</td>
<td>199.53</td>
</tr>
</tbody>
</table>

The final examination composite scores as the criterion of the experiment, several other measures were sometimes used as criterion (dependent) variables. Pretest scores were one of the more important "other" measures so used.

4. Pretest

The experimental design required pretesting only one-half of all students. The 234 students who were randomly assigned to take the pretest were administered a 25-item multiple-choice instrument.

The twenty-five items of the pretest (Appendix D) were the 25 "best" items of a 50-item test administered to a group (N=38) of college Sophomore and Junior students at Iowa State University during Fall Quarter 1970.

The item analysis (26) of the experimental pretest showed two items to be of questionable value. Prior to their removal, the KR-20 showed a reliability coefficient of 0.24. When the
pretest was reduced to 23 items, the index of reliability was raised to 0.31. Though neither of these values was sufficiently high to warrant terming the pretest "a good test," it was reasoned (26, p. 1) that the small number of items was surely contributory to the magnitude of the index.

Table 8 was prepared to present pretest (23 items) mean scores for the three treatment groups.

Table 8. Twenty-three item pretest mean scores for the three treatment conditions

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>12.96</td>
</tr>
<tr>
<td>E1</td>
<td>12.93</td>
</tr>
<tr>
<td>E2</td>
<td>12.82</td>
</tr>
<tr>
<td>Overall(^a)</td>
<td>12.90</td>
</tr>
</tbody>
</table>

\(^a\)The standard deviation over all pretested students was 2.64.

G. Data Collection

Data for the experiment were collected from four sources: (1) pretest data -- pretests were administered to approximately one-half (see Table 2) of each treatment group during each of the four time periods, (2) mid-quarter examination -- all students were administered the mid-quarter examination, (3) final examination -- all students were administered the final examination, and (4) college records -- college records provided data on high school graduation class rank and ACT
composite scores for each individual in the experiment.

As has been noted, the coding of much of the data required "dummy" variables. Some of the data were coded as raw scores. All data were collected and transcribed in the format of Klingensmith (21, p. 4).

Data pertaining to the main effects were keypunched into 80-column Hollerith cards and the punching was verified. This punching consumed about one and one-half cards per student.

After writing and debugging a Fortran program to generate selected first-order interaction terms, the data were computer-punched into another deck of cards. This "final" deck contained three 80-column cards for each student in the study.

H. Statistical Analyses

The crucial analyses employed in this study were analysis of variance and analysis of covariance considerations through multiple regression techniques. These analyses are extensively covered in Chapter IV and examine the significant contributions to the observed variances by the several variables under study.

All statistical analyses were experimenter-run under the Helarctos (19) computer program of the Statistical Laboratory, Iowa State University of Science and Technology. These analyses were carried out with respect to the model (19, p. 2):

$$Y_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \cdots + \beta_p x_{pi} + \epsilon_i$$  (III.3)
where
\[ Y_i = \text{observed scores (dependent variables)}, \]
\[ \beta_0 = \text{Y-intercept}, \]
\[ X_{ij} = \text{fixed known constants (independent variables)}, \]
\[ \beta_i = \text{slope of the } i^{th} \text{ regression line}, \]
\[ \epsilon_i = \text{random error}. \]

This model was used to analyze data via four procedures:
1. analysis of variance,
2. analysis of covariance,
3. regression analysis, and
4. backward elimination procedure of model-building.

The computer facilities of Iowa State University consisted of an IBM 360/65, complete with considerable peripheral hardware. Software, assistance in programming, and data interpretation was received from the Statistical Laboratory.

A procedural, decision-making framework (Figure 4) was established to better view the progression of the various analyses.
Figure 4. Decision framework for the Industry 192 experiment at St. Cloud State College
The basic six-group design as employed in this experiment, and simultaneously replicated four times, was a design modification of the more familiar Solomon four-group design. All of the desirable features and facilities for statistical analyses inherent in the Solomon design were judged as being present in this design as well. For a concise discussion of these features, the reader is referred to Kerlinger (20, p. 312) and Campbell and Stanley (10, p. 24).
IV. FINDINGS

Data analysis was performed to center on four main considerations. The first consideration concerned an examination of ACT composite scores, high school percentile ranks, and pretest scores. The first two of these variables were ultimately used as covariates in subsequent analyses. Pretest scores were examined to add credence to the procedure used in random assignment of students to experimental condition.

The second consideration in the data analysis involved examining those variables of prime concern to the investigator. Those variables were: (1) pretest participation, (2) times of day for treatment, (3) treatment condition, and (4) first-order interactions among any of the three.

The third consideration centered on examining student characteristics and their relationship to student achievement within the three experimental conditions.

Finally, the analysis procedure concerned itself with the generation of a prediction model for possible use in counseling students.

Hypotheses were tested for rejection at the five percent level of significance. When found to be rejected, hypotheses were further tested at the one percent level of significance. However, the five percent level was determined to be the level of rejection.
A. Sample Validation

Many procedures could have been employed to validate the sampling technique used in this experiment. Of those procedures, three were selected for display.

Null hypothesis number 1: There were no significant differences in student high school percentile graduation class ranks (HS%R) among students subjected to the three experimental conditions.

A non-significant F-ratio of 1.18 was obtained through an analysis of variance reported in Table 9. Null hypothesis number 1 was not rejected.

Table 9. Analysis of variance of differences in HS%R between the three experimental treatment conditions

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental treatments</td>
<td>2</td>
<td>978.45</td>
<td>489.23</td>
<td>1.18</td>
</tr>
<tr>
<td>Error</td>
<td>467</td>
<td>194398.79</td>
<td>416.27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>195377.24</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Having tested the distribution of student "past performance," it was logical to test the distribution of student "academic" ability.

Null hypothesis number 2: There were no significant differences in student American College Testing Program (ACT) composite scores among students subjected to the three experimental conditions.

Again, an analysis of variance yielded a non-significant
F-ratio ($F=0.44$). There was insufficient evidence to reject the null hypothesis. That analysis of variance was presented in Table 10.

**Table 10. Analysis of variance of differences in ACT between the three experimental treatment conditions**

<table>
<thead>
<tr>
<th>Source of Variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental treatments</td>
<td>2</td>
<td>11.18</td>
<td>5.59</td>
<td>0.44</td>
</tr>
<tr>
<td>Error</td>
<td>467</td>
<td>5920.99</td>
<td>12.68</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>5932.17</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

It was then decided to test whether or not there were differences in course-entry knowledge among students across the three treatments. Null hypothesis number 3 was drafted.

**Null hypothesis number 3:** There were no significant differences in student knowledge (as measured on the 23-item pretest) of the course subject matter among students subjected to the three experimental conditions.

Although 234 of the 470 sample were pretested (49.79%), it was reasoned that the random assignment to pretest participation provided a valid cross-section of all students. Here, like the analyses performed on HS%R and ACT, the analysis of variance (Table 11) revealed a non-significant F-ratio. The analysis showed the F-ratio equal to 0.07. There was insufficient evidence to reject the hypothesis.
Table 11. Analysis of variance of differences in pretest scores between the three experimental treatment conditions

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Experimental treatments</td>
<td>2</td>
<td>0.93</td>
<td>0.46</td>
<td>0.07</td>
</tr>
<tr>
<td>Error</td>
<td>231</td>
<td>1619.81</td>
<td>7.01</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td>1620.74</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

B. Experimental Effects

The conditions under which the experiment was conducted involved three main effects over which the experimenter had essential control. That "control" was exerted in the form of randomization. Student participation in the pretest was randomly assigned. The time of day a student enrolled in Industry 192 was deemed "random" for he had no information about a particular section other than the time of its meeting. Likewise, experimental conditions were randomly assigned to students after they had enrolled in the course.

Null hypothesis number 4: There was no significant difference in student achievement (as measured on the criterion score) between those students who participated in the pretest and those who did not participate in the pretest, when initial differences in ACT composite scores and high school ranks had been controlled.

Table 12 contained the unadjusted and adjusted criterion
means for the two pretest participation conditions. When the
effect due to the covariates (HS%R and ACT) were removed, the
difference in mean criterion scores was reduced from 2.55 to
1.12. The analysis of covariance of Table 13 tested the latter
difference for significance. That test resulted in a non-

Table 12. Unadjusted and adjusted criterion mean scores of
pretested and non-pretested students when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Pretest participation</th>
<th>Criterion means</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td></td>
</tr>
<tr>
<td>Pretest</td>
<td>198.25</td>
<td>198.97</td>
<td></td>
</tr>
<tr>
<td>No Pretest</td>
<td>200.80</td>
<td>200.09</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>2.55</td>
<td>1.12</td>
<td></td>
</tr>
</tbody>
</table>

Table 13. Analysis of covariance of differences in criterion means between pretested and non-pretested students when ACT and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pretest participation</td>
<td>1</td>
<td>147.57</td>
<td>147.57</td>
<td>0.63</td>
</tr>
<tr>
<td>Error</td>
<td>466</td>
<td>109857.60</td>
<td>235.75</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>110620.85^a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^aThe total residual sum of squares discrepancy of 615.68 was attributed to a lack of orthogonality in the X-matrix.
significant F-ratio of 0.63. Null hypothesis number 4 was not rejected.

Following the format as set forth in Figure 4, the next statistical test involved an examination of the times of day during which the treatments were administered.

Null hypothesis number 5: There were no significant differences in student achievement (as measured on the criterion score) among those students who enrolled in the course during the four daily time periods, when initial differences in ACT composite scores and high school ranks had been controlled.

Table 14. Unadjusted and adjusted criterion mean scores for students during the four times of day when ACT composite and high school rank were used as covariates

<table>
<thead>
<tr>
<th>Time of day</th>
<th>Criterion means</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>9:00</td>
<td>199.46</td>
<td>200.32</td>
</tr>
<tr>
<td>11:00</td>
<td>202.09</td>
<td>201.76</td>
</tr>
<tr>
<td>1:00</td>
<td>198.80</td>
<td>198.61</td>
</tr>
<tr>
<td>2:00</td>
<td>197.83</td>
<td>197.49</td>
</tr>
</tbody>
</table>

Differences:

- (9-11) 2.63 1.44
- (9-1) 0.66 1.71
- (9-2) 1.63 2.83
- (11-1) 3.29 3.15
- (11-2) 4.26 4.27
- (1-2) 0.97 1.12
The unadjusted and adjusted means were presented in Table 14. Criterion means were adjusted to a lower value in all instances except during the 9:00 sections. However, the critical value being tested in Table 15 (11:00 versus 2:00) experienced little mean difference change as a result of using the analysis of covariance. That change went from a difference of 4.26 to 4.27 where a test on the 4.27 difference revealed a non-significant F-ratio of 1.79. Such an F-ratio was too small to warrant a hypothesis rejection. Null hypothesis number 5 was not rejected.

Table 15. Analysis of covariance of differences in criterion means between the four times of day when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Times of day</td>
<td>3</td>
<td>1257.40</td>
<td>419.13</td>
<td>1.79</td>
</tr>
<tr>
<td>Error</td>
<td>464</td>
<td>108747.77</td>
<td>234.37</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>109931.83(^a)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)The total residual sum of squares discrepancy of 73.34 was attributed to a lack of orthogonality in the X-matrix.

The third consideration of "prime" experimental concern was that of treatment effects. Again, an analysis of covariance (Table 17) was performed on the adjusted means of Table 16.

Relative positions were not altered as a result of a
Table 16. Unadjusted and adjusted criterion mean scores for students in each experimental treatment condition when ACT composite and high school rank were used as covariates

<table>
<thead>
<tr>
<th>Experimental treatment</th>
<th>Criterion means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Control (C)</td>
<td>202.32</td>
</tr>
<tr>
<td>Experimental I (E1)</td>
<td>197.84</td>
</tr>
<tr>
<td>Experimental II (E2)</td>
<td>198.42</td>
</tr>
<tr>
<td>Differences:</td>
<td></td>
</tr>
<tr>
<td>(C-E1)</td>
<td>4.48</td>
</tr>
<tr>
<td>(C-E2)</td>
<td>3.90</td>
</tr>
<tr>
<td>(E1-E2)</td>
<td>0.58</td>
</tr>
</tbody>
</table>

covariate use but the extreme difference values (C versus E1) were further spread as a result of the covariate use. Mean differences went from an unadjusted 4.48 to an adjusted 5.28.

Table 17. Analysis of covariance of differences in criterion means between the three experimental treatments when ACT composite high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Residuals</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Source of variation</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Experimental treatments</td>
<td>2</td>
<td>2662.86</td>
<td>1331.43</td>
<td>5.77**</td>
</tr>
<tr>
<td>Error</td>
<td>465</td>
<td>107341.31</td>
<td>230.84</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>109199.39a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total residual sum of squares discrepancy of 805.78 was attributed to a lack of orthogonality in the X-matrix.

**Significant beyond the one per cent level.
Null hypothesis number 6a: There were no significant differences in student achievement (as measured on the criterion score) among those students who were subjected to the three experimental conditions, when initial differences in ACT composite scores and high school ranks had been controlled.

The highly significant F-ratio of 5.77 was sufficient evidence to warrant rejection of the null hypothesis. That rejection necessitated additional analyses to ascertain which, if any, of the other mean differences might have been explained by something other than chance.

The F-ratio of Table 17 was a test of C versus E1. The following two hypotheses were tested with a t-statistic.¹

Null hypothesis number 6b: There was no significant difference in student achievement (as measured on the criterion score) between C and E2 treatment conditions.

Null hypothesis number 6c: There was no significant difference in student achievement (as measured on the criterion score) between E1 and E2 treatment conditions.

The statistic used to test these hypotheses was:

\[ t = \frac{a\beta_i + b\beta_j}{\sqrt{\sigma^2 \left[ a^2C_{ii} + b^2C_{jj} + 2(a)(b)C_{ij} \right]}} \]  

where

\[ t = \text{a test of the hypothesis: } a\beta_i + b\beta_j = 0 \]

\[ C = \text{vector of beta coefficients} \]

\[ C' = \begin{bmatrix} a & b \end{bmatrix}; \text{(unique to a two-mean test)} \]

Test of \( H_{0b} \): \( t_{\alpha,452} = 2.053^* \)

The calculated t-value (using formula IV.1) to test hypothesis 6b was sufficient to reject the hypothesis. The criterion mean difference between the Control Group and the Experimental-II Group could be explained by chance less than five percent of the time.

Test of \( H_{0c} \): \( t_{\alpha,452} = -0.303 \)

The calculated t-value to test hypothesis 6c was non-significant and the hypothesis was not rejected.

Since hypotheses 4, 5, and 6 were the crux of the experiment, it was thought desirable to examine the three variables with a factorial design. Null hypothesis number 7 was formulated.

Null hypothesis number 7: There were no significant interactions among the experimental variables of pretest participation, time of day, and treatment.

The factorial design incorporated only the main effects and first-order interactions, producing the statistics of

*Significant beyond the five percent level.
the following table.

Table 18. Analysis of variance for pretest participation, time of day, treatment, and the associated first-order interactions

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A (pretest participation)</td>
<td>1</td>
<td>736.31</td>
<td>736.31</td>
<td>2.40</td>
</tr>
<tr>
<td>B (time of day)</td>
<td>3</td>
<td>1140.33</td>
<td>380.11</td>
<td>1.24</td>
</tr>
<tr>
<td>C (treatment)</td>
<td>2</td>
<td>1987.44</td>
<td>993.72</td>
<td>3.24*</td>
</tr>
<tr>
<td>A x B</td>
<td>3</td>
<td>82.75</td>
<td>27.58</td>
<td>0.09</td>
</tr>
<tr>
<td>A x C</td>
<td>2</td>
<td>200.11</td>
<td>100.06</td>
<td>0.33</td>
</tr>
<tr>
<td>B x C</td>
<td>6</td>
<td>1402.97</td>
<td>233.83</td>
<td>0.76</td>
</tr>
<tr>
<td>Error</td>
<td>452</td>
<td>138532.64</td>
<td>306.49</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>143999.02^a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^aThe total sum of squares discrepancy of 83.53 was attributed to an incomplete design (i.e. the AxBxC element was missing).

*Significant beyond the five percent level.

The analysis reported in Table 18 was performed on the data of unadjusted means; hence, the lesser significant F-value cited for treatment effects. Nonetheless, the main effect statistics of Table 18 tend to substantiate the previous tests of hypotheses 4, 5, and 6. Also, the interaction F-ratios of the factorial model were of such small magnitudes that null hypothesis number 7 could not be rejected.

C. Static Effects

Variables over which the investigator had little or no control or were of a non-replicable nature were also studied
and analyzed. The following eight hypotheses and their associated statistical tests have been presented.

Null hypothesis number 8: There were no significant differences in student achievement (as measured on the criterion score) among those students who were taught by the six instructors, when initial differences in ACT composite scores and high school ranks had been controlled.

Table 19 presented the unadjusted and adjusted criterion mean scores as achieved by students under the instructorship of the six instructors. A simple analysis of variance was performed on these mean scores and the resulting F-test was non-significant. When the effects due to ACT and HS%R were removed, the analysis of covariance reported in Table 20 produced another non-significant F (F=1.24). This ratio was insufficient to reject null hypothesis number 8.

Table 19. Unadjusted and adjusted criterion mean scores for students who were taught by one of the six instructors when ACT composite and high school rank were used as covariates

<table>
<thead>
<tr>
<th>Instructor</th>
<th>Criterion means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>A</td>
<td>198.57</td>
</tr>
<tr>
<td>B</td>
<td>203.00</td>
</tr>
<tr>
<td>C</td>
<td>200.02</td>
</tr>
<tr>
<td>D</td>
<td>196.99</td>
</tr>
<tr>
<td>E</td>
<td>199.33</td>
</tr>
<tr>
<td>F</td>
<td>200.70</td>
</tr>
</tbody>
</table>
Table 19 (Continued)

<table>
<thead>
<tr>
<th>Instructor Differences:</th>
<th>Criterion means</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
</tr>
<tr>
<td>A-B</td>
<td>4.43</td>
<td>4.17</td>
</tr>
<tr>
<td>A-C</td>
<td>1.45</td>
<td>1.27</td>
</tr>
<tr>
<td>A-D</td>
<td>1.58</td>
<td>1.97</td>
</tr>
<tr>
<td>A-E</td>
<td>0.76</td>
<td>0.11</td>
</tr>
<tr>
<td>A-F</td>
<td>2.13</td>
<td>3.70</td>
</tr>
<tr>
<td>B-C</td>
<td>2.98</td>
<td>2.90</td>
</tr>
<tr>
<td>B-D</td>
<td>6.01</td>
<td>6.14</td>
</tr>
<tr>
<td>B-E</td>
<td>3.67</td>
<td>4.28</td>
</tr>
<tr>
<td>B-F</td>
<td>2.30</td>
<td>0.47</td>
</tr>
<tr>
<td>C-D</td>
<td>3.03</td>
<td>3.24</td>
</tr>
<tr>
<td>C-E</td>
<td>0.69</td>
<td>1.38</td>
</tr>
<tr>
<td>C-F</td>
<td>0.68</td>
<td>2.43</td>
</tr>
<tr>
<td>D-E</td>
<td>2.34</td>
<td>1.86</td>
</tr>
<tr>
<td>D-F</td>
<td>3.08</td>
<td>5.67</td>
</tr>
<tr>
<td>E-F</td>
<td>1.37</td>
<td>3.81</td>
</tr>
</tbody>
</table>

Table 20. Analysis of covariance of differences in student criterion means between the six instructors when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instructors</td>
<td>5</td>
<td>1460.64</td>
<td>292.13</td>
<td>1.24</td>
</tr>
<tr>
<td>Error</td>
<td>462</td>
<td>108544.52</td>
<td>234.94</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>109609.07</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)The total residual sum of squares discrepancy of 396.09 was attributed to a lack of orthogonality in the X-matrix.
Proceeding through the decision framework of Figure 4 (p. 57), the next student characteristic (factor) studied in relation to student achievement was sex.

Null hypothesis number 9: There was no significant difference in student achievement (as measured on the criterion score) between male and female students, when initial differences in ACT composite scores and high school ranks had been controlled.

Unadjusted and adjusted criterion mean scores were tabulated in Table 21. Covarying on ACT and HS%R resulted in the

<table>
<thead>
<tr>
<th>Student sex</th>
<th>Criterion means</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>203.64</td>
<td>204.49</td>
<td></td>
</tr>
<tr>
<td>Females</td>
<td>196.07</td>
<td>195.32</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>7.57</td>
<td>9.17</td>
<td></td>
</tr>
</tbody>
</table>

Table 22. Analysis of covariance of differences in criterion means between sexes when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex of student</td>
<td>1</td>
<td>8631.84</td>
<td>8631.84</td>
<td>39.68**</td>
</tr>
<tr>
<td>Error</td>
<td>466</td>
<td>101373.33</td>
<td>217.54</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>108051.92⁴</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

⁴The total residual sum of squares discrepancy of 1953.25 was attributed to a lack of orthogonality in the X-matrix.

**Significant beyond the one percent level.
mean difference between sexes being raised from 7.57 to 9.17. The analysis of covariance reported in Table 22 tested the latter difference score.

The highly significant F-ratio of 39.68 was sufficient to warrant a rejection of null hypothesis number 9. That ratio was also significant beyond the one percent level. The difference in criterion means between the two sexes could have been explained by chance fewer than one time in one hundred attempts.

A regression analysis F-statistic was employed to test the tenability of null hypothesis 10.

Null hypothesis number 10: There were no significant differences in student achievement (as measured on the criterion score) among students of differing monthly age.

The F-statistic of table 23 revealed that the hypothesis was rejected. Evidence was shown by the 17.23 F-ratio that older students tend to score higher on the criterion measure.

Table 23. Analysis of regression, regressing criterion score on the student age (age in months)

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>5113.70</td>
<td>5113.70</td>
<td>17.23**</td>
</tr>
<tr>
<td>Residual</td>
<td>468</td>
<td>138885.33</td>
<td>296.76</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>143999.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Significant beyond the one percent level.
Examination of criterion mean scores as they relate to student marital status was the next hypothesis to be tested.

Null hypothesis number 11: There was no significant difference in student achievement (as measured on the criterion score) between married and single students, when initial differences in ACT composite scores and high school ranks had been controlled.

Because of the relatively small number of married students ($N_{\text{married}} = 23$) in the sample of 470, it was reasoned that an analysis of covariance was especially appropriate for comparing student achievement between the two categories of marital status.

Table 24 was used to depict the unadjusted and adjusted criterion mean scores for these two groups of students.

Table 24. Unadjusted and adjusted criterion mean scores for student marital status when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Student marital status</th>
<th>Criterion means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Married</td>
<td>206.74</td>
</tr>
<tr>
<td>Single</td>
<td>199.16</td>
</tr>
<tr>
<td>Difference</td>
<td>7.58</td>
</tr>
</tbody>
</table>

The covariate adjustment of means resulted in the mean difference being raised from 7.58 to 10.39, where the married student achieved better in both instances.
Table 25 presented the analysis of covariance on the criterion means of difference 10.39.

Table 25. Analysis of covariance of differences in criterion means between married and single students when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marital status</td>
<td>1</td>
<td>1192.32</td>
<td>1192.32</td>
<td>5.11*</td>
</tr>
<tr>
<td>Error</td>
<td>466</td>
<td>108812.84</td>
<td>233.50</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>110069.03</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The total residual sum of squares discrepancy of 63.87 was attributed to a lack of orthogonality in the X-matrix.

*Significant beyond the five percent level.

The significant F-ratio of 5.11 necessitated a rejection of the null hypothesis at the five percent level of significance. The difference in criterion mean scores between married and single students of this experiment could have been explained by chance fewer than five times in one hundred attempts.

The twelfth major hypothesis tested was the question of student access to an automobile while enrolled in college.

Null hypothesis number 12: There was no significant difference in student achievement (as measured on the criterion score) between those students who did have the availability of
an automobile and those who did not, when initial differences in ACT composite scores and high school ranks had been controlled.

Table 26 presented the unadjusted and adjusted group means for those having and those not having access to an automobile during the experiment. Mean adjustment for initial differences in ACT and HS%R resulted in the criterion mean difference being raised from 4.12 to 5.95 where those students who had access to automobiles scored higher.

Table 26. Unadjusted and adjusted criterion mean scores for student automobile availability when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Automobile availability</th>
<th>Criterion mean</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Automobile</td>
<td>202.26</td>
</tr>
<tr>
<td>No Automobile</td>
<td>198.14</td>
</tr>
<tr>
<td>Difference</td>
<td>4.12</td>
</tr>
</tbody>
</table>

The adjusted mean difference of 5.95 was tested through an analysis of covariance (Table 27). That analysis indicated a highly significant difference ($F=15.90$) in means. The null hypothesis was rejected. The probability of such a mean difference being explained by chance exceeded the one percent level of significance.

The number of quarters of college experience a student had had prior to the experiment was also examined.
Table 27. Analysis of covariance of differences in criterion means between students who did and did not have access to an automobile when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to automobile</td>
<td>1</td>
<td>3630.04</td>
<td>3630.04</td>
<td>15.90**</td>
</tr>
<tr>
<td>Error</td>
<td>466</td>
<td>106375.13</td>
<td>228.27</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>108160.67^a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

^aThe total residual sum of squares discrepancy of 1844.50 was attributed to a lack of orthogonality in the X-matrix.

**Significant beyond the one percent level.

Null hypothesis number 13: There were no significant differences in student achievement (as measured on the criterion score) among students of differing college experience.

A test of that hypothesis utilized regression analysis and was reported in Table 28. The highly significant F-ratio (F=27.02) indicated that the slope of the regression line was

Table 28. Analysis of regression, regressing criterion score on quarters of college experience

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regression</td>
<td>1</td>
<td>7859.79</td>
<td>7859.79</td>
<td>27.02**</td>
</tr>
<tr>
<td>Residual</td>
<td>468</td>
<td>136139.23</td>
<td>290.90</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>469</td>
<td>143999.02</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Significant beyond the one percent level.
significantly different from zero and that students of greater college experience were more apt to score higher on the criterion score than those of lesser experience.

Categories of student residence during the experiment were also examined for possible effect on criterion scores.

Null hypothesis number 14: There were no significant differences in student achievement (as measured on the criterion score) among those students who resided in the five residence categories, when initial differences in ACT composite scores and high school ranks had been controlled.

Unadjusted and adjusted mean criterion scores were presented in Table 29. Prior to the covariates adjustment, residence categories B and E were extremes. Upon application of covariates ACT and HS%R, the extreme categorical difference was between B and D. A single classification analysis of variance (not reported here) showed the B-E difference on

Table 29. Unadjusted and adjusted criterion mean scores for students living in each of the residence categories when ACT composite and high school rank were used as covariates

<table>
<thead>
<tr>
<th>College residence</th>
<th>Criterion means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Home (A)</td>
<td>198.67</td>
</tr>
<tr>
<td>Dormitory (B)</td>
<td>198.11</td>
</tr>
<tr>
<td>Rooming House (C)</td>
<td>205.22</td>
</tr>
<tr>
<td>Apartment (D)</td>
<td>211.13</td>
</tr>
<tr>
<td>Other (E)</td>
<td>212.51</td>
</tr>
</tbody>
</table>
Table 29 (Continued)

<table>
<thead>
<tr>
<th>College residence</th>
<th>Criterion means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Unadjusted</td>
</tr>
<tr>
<td>Differences:</td>
<td></td>
</tr>
<tr>
<td>(A-B)</td>
<td>0.56</td>
</tr>
<tr>
<td>(A-C)</td>
<td>6.55</td>
</tr>
<tr>
<td>(A-D)</td>
<td>12.46</td>
</tr>
<tr>
<td>(A-E)</td>
<td>13.84</td>
</tr>
<tr>
<td>(B-C)</td>
<td>7.11</td>
</tr>
<tr>
<td>(B-D)</td>
<td>13.02</td>
</tr>
<tr>
<td>(B-E)</td>
<td>14.40</td>
</tr>
<tr>
<td>(C-D)</td>
<td>5.91</td>
</tr>
<tr>
<td>(C-E)</td>
<td>7.29</td>
</tr>
<tr>
<td>(D-E)</td>
<td>1.38</td>
</tr>
</tbody>
</table>

unadjusted means to be highly significant. The B-D adjusted difference was reported via analysis of covariance in Table 30.

Table 30. Analysis of covariance of differences in criterion means between five categories of student college residence when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residences</td>
<td>4</td>
<td>5029.76</td>
<td>1257.44</td>
<td>5.55**</td>
</tr>
<tr>
<td>Error</td>
<td>463</td>
<td>104975.41</td>
<td>226.73</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>464</td>
<td>109958.36(^a)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)The total residual sum of squares discrepancy of 46.81 was attributed to a lack of orthogonality in the X-matrix.

**Significant beyond the one percent level.
The highly significant F-ratio of 5.55 was viewed as sufficient evidence to warrant rejecting null hypothesis number 14.

The last major hypothesis was stated as follows:

Null hypothesis number 15: There was no significant difference in student achievement (as measured on the criterion score) between those students who had transferred to St. Cloud State College and those who had not, when initial differences in ACT composite scores and high school ranks had been controlled.

Table 31 was generated to present the unadjusted and adjusted criterion mean scores for the two groups under study. Though a consideration of the covariates did little to spread the mean differences (8.18 to 8.32), an analysis of covariance was performed on the 8.32 difference in means. That analysis appeared in Table 32.

Table 31. Unadjusted and adjusted criterion mean scores for transfer status of students when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Student transfer status</th>
<th>Criterion means</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Unadjusted</td>
<td>Adjusted</td>
</tr>
<tr>
<td>Transfer</td>
<td>206.51</td>
<td>206.63</td>
<td></td>
</tr>
<tr>
<td>Non transfer</td>
<td>198.33</td>
<td>198.31</td>
<td></td>
</tr>
<tr>
<td>Difference</td>
<td>8.18</td>
<td>8.32</td>
<td></td>
</tr>
</tbody>
</table>

Null hypothesis number 15 was rejected with a highly
Table 32. Analysis of covariance of differences in criterion means between students who had and had not transferred to St. Cloud State College from other institutions of higher education when ACT composite and high school class rank were used as covariates

<table>
<thead>
<tr>
<th>Source of variation</th>
<th>d.f.</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Transfer status</td>
<td>1</td>
<td>4071.71</td>
<td>4071.71</td>
<td>17.91**</td>
</tr>
<tr>
<td>Error</td>
<td>466</td>
<td>105933.45</td>
<td>227.32</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>467</td>
<td>109868.33a</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The total residual sum of squares discrepancy of 136.83 was attributed to a lack of orthogonality in the X-matrix.

**Significant beyond the one percent level.

significant F-ratio of 17.91. The fact that a student had transferred to St. Cloud State College from some other college seemed to indicate that he would score higher on the criterion measure than those students who had not transferred. At least, the observed difference in this experiment could be explained by chance fewer than one time in one hundred attempts.

D. A Prediction Equation

With one major exception, the backward elimination procedure in regression model-building employed in this study was analogous to that of Draper and Smith (11). Rather than examine partial F-test values for every variable entered as Draper and Smith (11, p. 167) prescribe, this investigator based variable expulsion decisions on t-tests at each
regression of an abridged model. That t-value was a test of the hypothesis that the beta coefficient was equal to zero (H0: \( \beta_1 = 0 \)); computed as though that coefficient were the modifier of the last variable to enter the equation.

Five runs under the Helarctos program (19) were necessary before the least t-value in the system of variables was found to be significant. (The significant t-value decided upon prior to the running of the sequential tests was: \( t \geq 1.96 \).)

The "full" model consisted of ten variables selected on a priori assumptions. These assumptions centered on (1) the ease with which one might secure the information in the future and (2) the extent to which the variable correlated with the criterion variable.

Table 33 illustrated product-moment correlation coefficients for eight of the ten variables studied for possible criterion-prediction value. The two variables not included in this table were treatment condition and college residence. These were not included because their coding scheme was of a multiple-classification nature — requiring more than a simple product-moment index for adequate interpretation.

In addition to the eight possible predictors and the criterion, Table 33 revealed correlation coefficients for three other variables. Pretest scores and minutes studied per week have been discussed — "pre-post gain" scores have not. Pre-post gain scores were difference scores computed by subtracting the score a pretested student received on the 23-item
Table 33. Product-moment correlation matrix for selected variables

<table>
<thead>
<tr>
<th>Variables</th>
<th>A^a</th>
<th>B^a</th>
<th>C</th>
<th>D</th>
<th>E</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Pretest</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>B Pre-post gain</td>
<td>-.411</td>
<td>-.000</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>C Criterion</td>
<td>.515</td>
<td>.117</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D ACT</td>
<td>.383</td>
<td>.007</td>
<td>.485</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>E HS%R</td>
<td>.176</td>
<td>.024</td>
<td>.280</td>
<td>.527</td>
<td>1.00</td>
</tr>
<tr>
<td>F Minutes studied per week</td>
<td>-.010</td>
<td>.029</td>
<td>-.003</td>
<td>-.049</td>
<td>.032</td>
</tr>
<tr>
<td>G Quarters of college experience</td>
<td>.019</td>
<td>.061</td>
<td>.234</td>
<td>.045</td>
<td>.015</td>
</tr>
<tr>
<td>H Student age</td>
<td>.023</td>
<td>.053</td>
<td>.188</td>
<td>-.085</td>
<td>-.150</td>
</tr>
<tr>
<td>I Student sex</td>
<td>.158</td>
<td>.113</td>
<td>.215</td>
<td>-.006</td>
<td>-.308</td>
</tr>
<tr>
<td>J Marital status</td>
<td>.029</td>
<td>-.109</td>
<td>-.093</td>
<td>-.006</td>
<td>.016</td>
</tr>
<tr>
<td>K Automobile availability</td>
<td>.086</td>
<td>.027</td>
<td>.111</td>
<td>-.086</td>
<td>-.156</td>
</tr>
<tr>
<td>L Transfer status</td>
<td>-.062</td>
<td>.056</td>
<td>.165</td>
<td>-.004</td>
<td>-.031</td>
</tr>
</tbody>
</table>

^a The correlation coefficients reported for variables A and B were computed using only those students (234) who were pre-tested. All other table entries were computed using all students (470) in the study.
<table>
<thead>
<tr>
<th>F</th>
<th>G</th>
<th>H</th>
<th>I</th>
<th>J</th>
<th>K</th>
<th>L</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1.00</td>
</tr>
<tr>
<td>.058</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>.061</td>
<td>.366</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-.128</td>
<td>.131</td>
<td>.186</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-.022</td>
<td>-.173</td>
<td>-.584</td>
<td>-.049</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>-.062</td>
<td>.246</td>
<td>.410</td>
<td>.391</td>
<td>-.255</td>
<td>1.00</td>
<td></td>
</tr>
<tr>
<td>-.040</td>
<td>.580</td>
<td>.327</td>
<td>.150</td>
<td>-.157</td>
<td>.237</td>
<td>1.00</td>
</tr>
</tbody>
</table>
pretest from the score he received on those identical items in
the final exam.

The ten variables entered into the "full" model for the
initial regression analysis were:

\[ X_2 = \text{ACT composite score}, \]
\[ X_4 = \text{high school percentile rank}, \]
\[ X_5 = \text{college experience (in quarters)}, \]
\[ X_6 = \text{student age (in months)}, \]
\[ X_7, X_8 = \text{experimental treatment condition}, \]
\[ X_{17} = \text{sex of student}, \]
\[ X_{18} = \text{marital status of student}, \]
\[ X_{19}, \ldots, X_{22} = \text{residence while in college}, \]
\[ X_{23} = \text{automobile availability}, \text{and} \]
\[ X_{24} = \text{college transfer status}. \]

Incorporating all ten variables during the initial run of
the "full" model, the \( R^2 \) value was 0.37350. That same multiple
regression run showed variable \( X_{23} \) to have a beta-weight whose
t-value was less than 1.96. Variable \( X_{23} \) was eliminated for
the "Reduced-1" model. The regression of that model on the
criterion scores showed variable \( X_{24} \) to be non-contributory to
prediction. That procedure was followed until the least t-
value on a beta-weight was found to be significant. Table 34
summarized the procedure involved, and illustrated the serial
reduction in the multiple \( R^2 \).
Table 34. Summary of regression equation model-building process

<table>
<thead>
<tr>
<th>Model</th>
<th>Full model less:</th>
<th>$R^2$</th>
<th>Sequential</th>
<th>From full Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Full</td>
<td>--none--</td>
<td>0.37350</td>
<td>-0.000000</td>
<td>-0.000000</td>
</tr>
<tr>
<td>Reduced-1</td>
<td>$X_{23}$</td>
<td>0.37342</td>
<td>-0.00008</td>
<td>-0.00008</td>
</tr>
<tr>
<td>Reduced-2</td>
<td>$X_{23,24}$</td>
<td>0.37308</td>
<td>-0.00034</td>
<td>-0.00042</td>
</tr>
<tr>
<td>Reduced-3</td>
<td>$X_{23,24,18}$</td>
<td>0.37208</td>
<td>-0.00100</td>
<td>-0.00142</td>
</tr>
<tr>
<td>Reduced-4</td>
<td>$X_{23,24,18,19-22}$</td>
<td>0.36740</td>
<td>-0.00468</td>
<td>-0.00610</td>
</tr>
</tbody>
</table>

The resulting equation took the form:

$$\hat{Y} = 119.65 + 2.06(X_2) + 0.13(X_4) + 1.18(X_5) + 0.106(X_6)$$

$$- 1.37(X_7) + 3.28(X_8) + 3.70(X_{17})$$

Equation (IV.2) allowed for prediction of criterion scores with 36.74% efficiency ($R^2 = 0.36740$). In other words, given the variable data required by the equation, 36.74% of the variance in the criterion score was accounted for or explained by the independent variables of the equation. Equation (IV.2) took into account treatment condition -- a factor of questionable pragmatic value. Therefore, equation (IV.3) was generated from equation (IV.2) to predict criterion scores for students encountering "traditional" approaches to the study of Industry 192. This was accomplished by collapsing variables $X_7$ and $X_8$ into a constant (+3.28) for persons in the tradi-
tional approach to instruction. That constant was then combined (added to) the constant term of formula (IV.2) to produce the $b_0$ term of formula (IV.3). The final -- most usable -- formula for predictive purposes then became:

$$\hat{Y} = b_0 + b_2X_2 + b_4X_4 + b_5X_5 + b_6X_6 + b_{17}X_{17}$$

(IV.3)

where

$\hat{Y}$ = predicted criterion score for students experiencing the "traditional" approach

$b_0 = 122.93$

$b_2 = 2.06; \quad X_2$ = ACT composite score

$b_4 = 0.13; \quad X_4$ = high school percentile class rank

$b_5 = 1.18; \quad X_5$ = quarters of college experience

$b_6 = 0.106; \quad X_6$ = student age (in months)

$b_{17} = 3.70; \quad X_{17}$ = student sex (male=1; female=-1).
V. DISCUSSION

When viewed in retrospect, educational research is seldom without its shortcomings. The study reported herein has been no different in that respect. There are definite implications for what was found in this study, but there are also many details that could have been better handled were the experimental results and observations known prior to the design stages. Of course, that is not unique to educational research.

Limitations as to generalizability and data interpretation are present in all research; as are recommendations for improving upon and enlarging the experimental scope of a study. These, then, are the reasons for writing this chapter; to discuss implications, limitations, and recommendations as having come from the research reported in this volume.

A. Implications of the Findings

Null hypotheses 1, 2, and 3 were drafted to allow testing the veracity of the randomization processes involved in the experimental design. Each treatment condition of C, E1, and E2 was examined through an analysis of variance of high school percentile graduation class ranks, ACT composite scores, and pretest scores. In each instance, the F-statistic showed there to be no significant difference (probability greater than five percent) between any of the treatment conditions. Since HS%R was viewed as an index of past academic performance, ACT as an index of academic ability, and pretest score as an index of
initial course knowledge; the investigator concluded that randomization did, in fact, work. There were no significant differences in those three indices between any of the three treatment conditions. The conclusion was drawn that, at the inception of the experiment, the treatment conditions were composed of essentially identical samples.

Of the three experimental variables over which the experimenter had some form of control, treatment condition was the only one found to vary significantly. Single classification analyses of covariance revealed that: (1) the fact that a student does or does not participate in a pretest has no effect on the way he performs in the course and (2) the time of day (among four) a student is enrolled in the course has no apparent bearing on his performance. However, an analysis of covariance for treatment effect revealed that the Control Group (four class meetings per week) scored significantly higher (beyond the one percent level) than the Experimental-I group which met three times each week. Subsequent t-tests disclosed a significant difference (beyond the five percent level) between the Control Group and the Experimental-II sections. However, another t-test indicated that a significant difference did not exist between the two experimental (non-control) conditions of E1 and E2. That there was no difference in student achievement between E1 and E2 groups, but that the C group scored significantly higher than either was the main finding of experimental concern.
An explanation of that finding was neither easily nor completely formulated. While the Control Group met four times each week to three times each week for Experimental-I's, it seemed unusual that the Experimental-I's and Experimental-II's (one meeting per week) should exhibit no difference. This was especially difficult in view of the noted achievement difference between the C's and E1's. The only rationale the investigator could offer was that, were he to perform the experiment again, some group designation other than C, E1, and E2 would be employed. The finding of treatment differences was not viewed as something profound. Dissonance, however, did set in when it was realized that student achievement was not so much a function of time spent in the classroom as it was a function of some other, perhaps related, factor. It was strongly suspected that the audio tape (Appendix I) content may have produced an effect it was designed to reduce. The scriptual matter of the audio tape was edited to reduce student anxiety, acquaint students with the experiment, and to set a base from which the experiment could begin. Upon reviewing the finding of treatment differences, it was the investigator's belief that to tell a student (Appendix I, p. 167 of this paper):

Rest assured that your grade will be determined on the basis of how you compare to persons receiving the same treatment that you receive. In fact, your competitors for a grade are, in all probability, limited to those persons in this room right now. You will not be evaluated in competition with per-
sons receiving an experimental condition that differs from your own.
was perhaps detrimental to the experiment. It appeared as though motivation, competition, drive, or whatever produces study, may have been lessened as a result of an attempt to alleviate anxiety and frustration.

Analyses of covariance were employed to study six non-manipulated variables in relation to student achievement. Of those six, "instructor" was the only one found to be non-significant. The experiment failed to evidence existent differences between instructors insofar as student achievement was concerned.

It has long been contended that learning through instruction is best achieved through quality instruction. Contentions have also been made that a continuum exists to describe the quality of instructors. The facts of this experiment did not show that continuum of teacher attribute to be present. It was reasoned that one of three possibilities (or combinations of possibilities) accounted for the failure of this experiment to show instructor differences: (1) all instructors in the experiment were of comparable proficiency, (2) students learn subject matter content in spite of the instructor, or (3) the criterion measures used in this experiment were invalid. The investigator chose to waive speculation on any of those points and await results from additional studies specifically designed to ascertain instructor differences. This experiment was not
so designed.

The other five non-manipulated variables studied via analyses of covariance disclosed significant differences. Of those five, student marital status was found to be significant beyond the five percent level -- married student criterion mean scores were significantly higher than their single-status counterparts.

Criterion means for student groups classified within each of the four remaining student factors were also found to be significantly different. Those four factors (variables) studied through analyses of covariance were: (1) student sex, (2) student access to an automobile, (3) student residence while in college, and (4) student transfer status. Each of these factors was found to have criterion mean differences that could be explained by chance fewer than one time in one hundred attempts.

Male students scored consistently higher than did female students. Either the course, Modern Technology and Civilization, had a sex bias, the criterion measures had a sex bias, or the subject matter of the course was such that males "naturally" grasped it more readily. Of those three possibilities, the investigator chose to completely discount the latter and view the first two with suspicion. The investigator believed the course to have had a sex bias; resulting from the differing experiences males and females have in their society as a
result of their sex, and the ways in which instruction was probably given. This is to say the instruction may have been male-oriented, where the male's original (not "basic" or "natural") appreciation for the subject matter may have been viewed as the point of departure for additional instruction -- instruction paying little heed to the relative course-specific knowledge not possessed by females.

That a student had access to an automobile during the experiment indicated better achievement than that of non-driving colleagues. That a student had transferred colleges at some time in his college career indicated better achievement than that realized by those who had not transferred. That a student resided in some particular residence served as an index of probable achievement. Each of these factors showed significant differences in criterion means across their respective classifications -- significant beyond the one percent level.

Actually, access to an automobile and transfer status should have been expected to be good indices of achievement. Both variables were apparent functions of student age; where the correlation coefficient between age and automobile availability was 0.410 and the correlation between age and transfer status was 0.327. Neither of those coefficients was particularly high but each was significantly different than a zero correlation. There was some relationship between each of those variables and student age. With a greater student age, one can
logically assume that his college experience has been greater (r=0.366). When one has experienced more college, he has been a "survivor" of the system. He has survived much of the natural and selective attrition in the early college years. (Recall that the course in which this experiment was run was a Freshman-level course.) Older students, then, were seen as surviving students and could have been expected to out-perform the younger student. Better performance could have been expected; not because of greater age, but because of those abilities and experiences possessed by "older" students. There were certainly very capable younger students in the sample, but the "poorer" students of the experiment were also in their number. This was viewed as explaining the observed differences in criterion means within the automobile availability and transfer status groups of the experiment.

The observed differences in achievement between students of different housing categories was viewed in much the same manner. Students living at home or in dormitories accounted for 85.32% of the total sample, while achieving the least criterion mean scores. The next high achievement group within residence categories was the "rooming house" category (N=50). These were followed by "apartment renters" (N=15) and "others." The "others" category contained less than one percent (N=4) of the total sample and was deemed too small to consider representative. The other two groups comprised 10.64% and 3.19% of the sample, respectively.
In all probability, students who lived in their parents' home or in a dormitory were the younger students. Students residing in rooming houses and apartments were probably older, more mature students -- students who had the resources and responsibility for the more non-chaperoned living conditions. Again, age (and its presumed inclusions) in the college student seemed to be a factor in achievement.

Quarters of college experience and student age have been discussed at some length as to their probable influence on student achievement in Industry 192. Each of these factors was statistically examined through a linear regression routine and each was found to be highly significant. Such significance was interpreted to mean that the resultant regression (prediction) lines were of a slope other than zero. This is to say that the age of a student or the quarters of his experience are better predictors of his achievement in the course than the simple mean from the total sample. The slope of the regression line considering student age was 0.1218 while the comparable slope for quarters of college experience was 2.1425.

The prediction equation generated in Chapter IV was generated via one of several ways in which such equations can be generated. Since only 36.74% of the criterion score variance could be explained by it, the investigator did not place a great deal of confidence in the value of the equation.
B. Limitations of the Study

The extent to which the findings of this study were generalizable to a parent population was limited to that group of St. Cloud State College students entering Industry 192 and studying from the syllabus designed for the experiment. The experimenter sees no reason to further restrict the parent population.

Employing the assumption that the sample was a truly representative sample of Industry 192 students, two questions become paramount: (1) were the data valid?, and (2) was the criterion sufficiently reliable?

Data selected to describe individual student characteristics were decided upon on the investigator's logic and availability of those data. As such, content validity was the only validity-type applicable (8). Also, test items were selected on the basis of how the investigator felt a particular item related to and measured a stated objective.

Content validity does not lend itself to quantitative indices. Content validity is necessarily limited to and determined by rational, judgmental processes. Other types of validity were deemed inappropriate and unavailable for the purposes of this study.

Since the majority of statistical analyses performed on the data made use of the mid-quarter - final examination composite (criterion) score, the reliability of that score was of crucial importance. As has been noted, an estimate of the
criterion reliability (KR-20) was 0.78. That index was not as high as the investigator would have liked, but it was seen as being sufficiently high to warrant faith in the statistics employing its data. However, were this experiment to be replicated, the researcher should attempt to redraft certain test items to allow for better discriminating power among items.

C. Recommendations for Further Study

This study was designed to avoid many of the pitfalls experienced by other behavioral science researchers. However, this study has not been without its shortcomings or failures to capitalize on experimental design potentials.

Were this experiment to be replicated, the investigator suggests:

1. an elimination of group designations C, E1, and E2. The experimental conditions should be titled in some non-meaning manner. That change should be accompanied by an appropriate placebo so that the experimental conditions are not as obvious to the students as was the case in this experiment.

2. balancing the design so as to have each instructor teaching each of the experimental conditions. This arrangement would allow for an extensive study of instructor differences. Used in conjunction with appropriate personality inventories, it would also permit factor analytic techniques to examine "types" of teachers.

Were the data of this experiment further analyzed, the investigator recommends:
1. an examination of the data within each time period. Then, in possession of four separate experiments, compare the findings. This would allow for a truly replicated study under identical (except for instructor variables) conditions.

2. the use of other approaches to the generation of prediction equations.

3. analyses of the data within a strictly *ex post facto* framework. Such an approach could produce results or insights as yet not hypothesized.

Finally, the investigator suggests that the General Education Committee at St. Cloud State College seriously consider employing similar experimental studies in all General Education curricula. Educators laud and preach the virtues of "improvement." Improvement is not possible until that which is being improved is completely understood. That understanding is best realized through research.
VI. SUMMARY

This experimental study was designed to examine student achievement in a college-level General Education course. The experimental variable of primary concern was a differing time requirement for student exposure to formal classroom routine. In addition to that primary variable, several student variables were studied with respect to their effect on student achievement.

This experiment was performed at St. Cloud (Minnesota) State College during Winter Quarter, 1971. Participant subjects of the experiment included 470 male and female undergraduate students of varied curricula.

The logic-base on which the experiment was built was: Students are individuals -- individuals possessed of ability - knowledge - motivation combinations that produce uniqueness. That uniqueness was viewed as suggesting the possibility of certain student "types" capable of assimilating knowledge in various ways. Among those "various ways," the investigator chose to examine the time-honored tradition of requiring one formal class meeting for each hour of college-credit received.

Modern Technology and Civilization (Industry 192), the course in which the experiment was performed, was a four-credit General Education course, typically required to formally meet four hours each week. The experiment was so devised as to have three treatment conditions. Students and instructors of
each treatment condition worked from a common experimenter-produced syllabus (Appendix A). The syllabus contained specific course objectives and simple test plans for the mid-quarter and final examinations. The three treatment conditions employed were: (1) Control Group (C) -- this group met four times each week. Instruction was instructor-developed so as to maximize student realization of the course objectives. (2) Experimental-I (E1) -- this group met three times each week. Instruction was instructor-developed so as to maximize student realization of the course objectives. (3) Experimental-II (E2) -- this group met once each week and received no formal instructor-delivered presentations. E2 sections were thought of as independent study groups.

Students of all sections worked and studied from the same set of objectives. All experimental sections were measured by the same pencil and paper examinations (Appendices E and F).

Each experimental condition (C, E1, and E2) was composed of students having come from a single population. That population was that group of students enrolled in Industry 192 for a particular time of day during Winter Quarter, 1971. Students were randomly assigned to treatment conditions within one of four time periods (9:00, 11:00, 1:00, and 2:00) during the day. As such, there were four simultaneous replications of the experiment.

Approximately one-half of each treatment group was administered a 25-item pretest. The pretest score was viewed as an
indication of a student's course knowledge prior to course exposure.

American College Testing Program (ACT) composite scores and high school percentile graduation class ranks (HS%R) were secured for each student involved in the study. ACT composite scores were viewed as an indication of a student's academic ability. High school percentile ranks were viewed as indications of past academic performance.

These three data (pretest score, ACT, and HS%R) were examined within each of the three treatment conditions to ascertain the effectiveness of the randomization process. There was no evidence of mean differences among treatment groups within any of those three indices. The contention was made that, at the time of the experiment's beginning, the three experimental groups (C, E1, E2) were essentially equal in prior knowledge, academic ability, and past academic performance.

The experimental design was a modified Solomon four-group design; modified to the extent that three treatment conditions were present instead of the two prescribed under the Solomon format. Also, those three conditions were present during each of four times during the day. And, like the Solomon arrangement, this experiment involved pretested and non-pretested samples within each treatment condition.

It was found that neither pretest participation nor time of day for instruction had any effect on student achievement in any of the three treatment conditions. Treatment condition,
however, did seem to effect achievement. Students meeting in a formal classroom environment four hours each week scored significantly higher than either the three-hours-per-week or one-hour-per-week groups. There was no difference in student achievement between students of the latter two experimental groups. First-order interaction effects of pretest participation, time of day, and treatment condition were also studied. No interaction terms were found to be statistically significant.

Although all six instructors involved in the experiment did not teach under each experimental condition, instructor effect was analyzed in regard to student achievement. In this experiment, instructor effect was found to be non-significant.

Seven student characteristics (factors) were also studied in relation to student achievement. Those factors were:

1. student age,
2. quarters of college experience,
3. student marital status,
4. college residence,
5. automobile availability,
6. student college transfer status, and
7. student sex.

Student age (coded in months) and prior college experience (coded in academic quarters) were studied through analyses of regression. In each instance, the F-ratio was significant beyond the one percent level.
The remaining five variables were analyzed through analyses of covariance. The covariates used in every instance were American College Testing Program (ACT) composite score and high school graduation percentile rank (HS%R).

Student achievement between the two marital categories (married versus single students) differed significantly at the five percent level. Married students in this study consistently scored higher on the criterion measure than did single (non-married) students.

Each variable of college residence, automobile availability, transfer status, and student sex proved to be significant beyond the one percent level when analyzed via analyses of covariance.

Students living in a dormitory or at home performed less well than students residing in rooming houses or apartments.

Students having access to an automobile during the experiment achieved higher criterion scores than those students who did not have access to automobiles.

Students who had transferred to St. Cloud State College achieved more than those students who had not transferred colleges.

Male students scored consistently higher on the criterion measure than did their female counterpart.

A prediction equation was generated utilizing a modified version of the backward elimination procedure of model-building as described by Draper and Smith (11, pp. 167-169). Beginning
with ten predictive variables, the subsequently reduced equa-
tion took the form (adjusted for students in the Control --
traditional -- Groups):

\[ \hat{Y} = b_0 + b_2X_2 + b_4X_4 + b_5X_5 + b_6X_6 + b_{17}X_{17} \quad \text{(VI.1)} \]

where

\( \hat{Y} = \) predicted criterion score for students experiencing
the "traditional" approach

\[ b_0 = 122.93 \]
\[ b_2 = 2.06; \quad X_2 = \text{ACT composite score} \]
\[ b_4 = 0.13; \quad X_4 = \text{high school percentile class rank} \]
\[ b_5 = 1.18; \quad X_5 = \text{quarters of college experience} \]
\[ b_6 = 0.106; \quad X_6 = \text{student age (in months)} \]
\[ b_{17} = 3.70; \quad X_{17} = \text{student sex (male=1; female=-1).} \]

That equation accounted for 35.74 percent of the variance
in the predicted criterion score.
VII. BIBLIOGRAPHY


VIII. ACKNOWLEDGMENTS

Educational research is seldom possible without the cooperation and encouragement of many behind-the-scene persons. Likewise, this research has had its share of "inconspicuous" personnel.

In addition to the Iowa State University faculty members who so faithfully served on my Thesis Committee, a special debt of gratitude is most certainly in order for others. Among those others, several stand out in particular.

Dr. Raymond H. Larson, Dean, School of Industry, St. Cloud State College, has been a driving force behind my academic and professional pursuits for many years. Without his encouragement and confidence, it is very unlikely that I would have undertaken any graduate study. It has been that same encouragement, that confidence, and that cooperation from Dr. Larson that led to the experiment described herein. It is most difficult to adequately thank Dr. Larson.

The entire instructional staff of the School of Industry, St. Cloud State College, was also most cooperative in allowing the experiment's administration. Of that staff, six members deserve a special expression of gratitude. Those six persons directly involved in the experiment as control and experimental instructors were: Philip G. Bergstrom, Lorimer R. Bjorklund, P. John Carter, Gerald E. Nestel, Howard R. Walton, and Stanley F. Wood.
Also, for providing data and information on each student in the experiment, I am indebted to the expertise and cooperation of the person and staff of Mr. Keith J. Rauch, Director of Admissions and Records, St. Cloud State College.

Though cited last, the indulgence, patience, and drive provided by one's family cannot be truly appreciated as "last." Rather, they must be first. If it is "most difficult" to thank Dr. Larson, it is most impossible to thank Phyllis and my other two girls.
IX. APPENDIX A:

COURSE SYLLABUS
MODERN TECHNOLOGY & CIVILIZATION

property of: ________________

COURSE INFORMATION:
1. of record. 2. of fact.

___ section no. ___
___ instructor ___
___ room no. ___

Industry 192
Winter, 1971
Catalog Description

Ind. 192 - Modern Technology and Civilization -- Analysis of contemporary technology and its effects on man and society. Special emphasis is placed on change created by technology, as well as such topics as modern industrial structure, the labor force, leisure, automation and the resulting social consequences. 4 credits.

Text


This text was originated in commemoration of the Twentieth Anniversary of Kaiser Aluminum and Chemical Corporation. It first appeared in a special series of six issues of Kaiser Aluminum News. Other series are now available on such diverse topics as creativity, education, communications, the corporation as a creative environment, motivation, the children of change, and others.

It is recommended that each student read this text carefully, paying close attention to the materials presented in the margins. Although the text cannot cover all areas of the course it will act as a catalyst for your introduction to technology and change.

Reading Assignments

It seems illogical to have to specifically "assign" a definite list of readings to a college-caliber class. For that reason, no such "required readings" are included in this syllabus. However, you are strongly encouraged to utilize your assumed library skills in developing a personal satisfaction of the course objectives. That satisfaction is perhaps best realized through extensive, self-directed, reading.

In addition to those sources cited in the Reading List, you should make extensive use of:

1. Card catalogs,
2. Bibliographies appearing at the ends of many chapters or articles,
3. Various indices (e.g.):
   a. Applied Science and Technology Index (1958 - date)
   b. Business Periodicals Index (1958 - date)
   c. Industrial Arts Index (1945 - 1957)
Introduction to the Course

The concept of technology is by no means new, it is not a creation of the 20th century; rather, it is as old as man himself. As you proceed throughout this quarter you should ask yourself what technology really is. And, equally important, where is it taking you and how does it affect your life.

All men are not engineers or scientists. Not all men understand technology in its true perspective, yet technology has changed life both negatively and positively. Man takes the concept of technology for granted, probably because he does not understand it or because he is afraid of it. Yet the present revolution is the basis for understanding social change. Many questions must be answered. For example: What about the population explosion? Will the computer eventually do all of the thinking for man? How will we learn in the 21st century? Who should have more leisure time? Will technology eventually destroy man? Such questions are seemingly without end.

If we wish to place the term "technology" in the framework of a theoretical construct, we find that it does not exist in the abstract but exists to meet the needs and social goals of the people. Technology creates problems while it attempts to free man from burdens, pushing him further and further into an era of abundance, often at a pace with which he cannot cope. Man must be able to analyze new situations, develop rational and feasible solutions and then be able to communicate the results to those concerned. Every member of society must be vividly aware of the influence, reactions, problems, and advancements of the highly industrialized era of which he is a part.

The course content of Industry 192 has been organized to develop a broader background of knowledge and understanding of change -- change brought about through industry and her technologies. As a result of this broadened scope, it is hoped that the individual student will be able to formulate a base for opinions, attitudes, and actions; thereby becoming a more informed and contributory member of our technological society.

Course Content: Objectives

Unless you are very different and atypical of the other class members, you are very concerned about the final grade you will receive as a result of your efforts in this class. Two major contributions to your final grade will be scores you receive on the mid-quarter and
final examinations. The test items on these exams will have been designed to measure your understanding of a particular course objective—in part or in whole. Considerable effort has been taken to design test items that reflect and measure your mastery of a given objective.

So that you might better budget your own time in studying for this course (and its tests), the following schedule is provided for your consideration. Each element of this schedule is perhaps self-explanatory but so as to remedy any misunderstandings, the following key is offered.

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<thead>
<tr>
<th>column number</th>
<th>description</th>
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<tbody>
<tr>
<td>I</td>
<td>the course objectives to be realized by the student (in an approximate order of coverage during the quarter)</td>
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<td>II*</td>
<td>approximate percent emphasis placed on this objective in the mid-quarter examination</td>
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<td>III*</td>
<td>approximate number of items designed to measure this objective in the mid-quarter examination</td>
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<tr>
<td>IV*</td>
<td>approximate percent emphasis placed on this objective in the final examination</td>
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<tr>
<td>V*</td>
<td>approximate number of items designed to measure this objective in the final examination</td>
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</table>

* Circled entries in these columns are subtotals for the objectives that immediately follow.

NOTE: It is suggested that you consult your text and/or one or more of the appropriate books listed in the Reading List for a satisfaction of any given objective. The Reading List is NOT an exhaustive listing of sources pertaining to these objectives; NOR is it, necessarily, a list of the best sources.

Upon completion of this course, you should (in responding to written objective test items) be able to:

<table>
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<tr>
<th>I course objectives for student realization (approximate order of coverage)</th>
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<td>test content analysis</td>
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<td>mid-quarter</td>
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Upon completion of this course, you should (in responding to written objective test items) be able to:

| A. Understand the essential elements of product development and production in American industry. |
|---|---|---|---|---|
| 1. contrast natural and synthetic materials | 50 | 30 | 13 | 16 |
| 2. trace the history of synthetic materials development | 5 | 3 | 2 | 2 |
| 3. identify the primary characteristics and limitations of natural materials in today's commercial products | 3 | 2 | 1 | 1 |
| 4. compare the characteristics and limitations of thermoplastic and thermostetting plastics | 3 | 2 | 1 | 1 |
| 5. define mechanization, automation, cybernation | 7 | 4 | 2 | 2 |
| 6. trace the histories and interrelationships of mechanization, automation, and cybernation | 3 | 2 | 1 | 1 |
| 7. trace the process of research and development in product design | 3 | 2 | 1 | 1 |
| 8. identify the five essential elements of computers and relate the functions of each to the others | 4 | 2 | 1 | 1 |
| 9. from a list, select those purposes to which computers are presently put | 5 | 3 | 2 | 2 |
| 10. differentiate between hand tools, machines, and machine tools | 3 | 2 | 1 | 1 |
| 11. define, identify, and contrast the six basic industrial techniques of: | | | | |
| a. drilling and boring | e. turning | | | |
| b. planing and shaping | f. grinding | | | |
| c. milling | | | | |
| d. forging, shearing, pressing | | | | |
| 12. define, identify, and contrast the industrial techniques of casting, extruding, and stamping | 3 | 2 | 1 | 1 |

B. Understand the structure, composition, and functions of American industry.

<table>
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<tr>
<th>1. differentiate between industry's organizational structures</th>
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<th>30</th>
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<td>2. identify the various components within an organisational (industry) structure</td>
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<td>3. list the functions performed by each component within an industrial structure</td>
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<td>4. contrast power, authority, and status within an industrial structure</td>
<td>5</td>
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<td>5. differentiate between monotony and fatigue as affecting assembly line workers</td>
<td>5</td>
<td>3</td>
<td>&lt;1</td>
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<tr>
<td>6. place in perspective: job enlargement and job reduction as related to job satisfaction</td>
<td>3</td>
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<td>7. list the primary functions and activities of labor unions</td>
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<td>8. trace the history of labor unions</td>
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<td>9. identify the public(s) for which various industries are geared</td>
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<td>10. list the factors of employment and unemployment</td>
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<td>11. define industry</td>
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<tr>
<td>12. define technology</td>
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C. Comprehend the significance of technology as it has affected change in our society.

1. compare and contrast the rates of technological change prior to and since World War II
2. identify effects on current employment brought about by technological advancement
3. relate military and non-military technological advances
4. identify current demographic trends in the world
5. list several problems (and suggested solutions) of urban America
6. relate recent technological advancements to current problems of population and food
7. identify the causes of environmental pollution

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MID-QUARTER EXAMINATION 60 items
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<td>8.</td>
<td>list current attempts at abating environmental pollution in the United States</td>
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<td>9.</td>
<td>define and cite examples of technological-cultural lag</td>
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<td>D.</td>
<td>Evaluate the impact and influence education and technology have on one another.</td>
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<td>differentiae between vocational, avocational, and general education</td>
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<td>identify and list ways in which technology has affect (or effected) contemporary American education</td>
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<td>list the primary functions and objectives of education in our society</td>
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<td>differentiate between research and development in the industry-education arena</td>
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<td>identify recent trends in vocational education programs</td>
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<td>E.</td>
<td>Appreciate the dichotomy of free time - leisure time.</td>
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<td>identify several ramifications of increased free time</td>
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<td>cite examples of societal attempts at converting free time into leisure time</td>
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<td>list five industries that are geared in total or in part for the leisure time &quot;market&quot;</td>
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<td>F.</td>
<td>Anticipate future and developing technologies.</td>
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<td>list and define technologies within the transportation industries that are in developmental stages</td>
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<td>list and define technologies within the agricultural industries that are in developmental stages</td>
<td></td>
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**FINAL EXAMINATION**

120 items
Reading List: (Remember! The following list is not at all exhaustive and is not, necessarily, a list of the best sources. This list is meant to only assist you in getting a start on your own "reading program." Read (and study) for a personal satisfaction of those objectives listed on preceding pages of this syllabus.)


X. APPENDIX B:

PERSONAL FACTORS QUESTIONNAIRE
PERSONAL FACTORS QUESTIONNAIRE

INDUSTRY 192
winter, 1971

1. NAME ____________________________________________

2. SEX ____________________________________________
        male    female

3. DATE OF BIRTH: ____________________________ month, year

4. MARITAL STATUS: ____________________________ married single

    NOTE: Indicate "single" if you are: 1. not married, 2. engaged to be married, 3. widowed, or 4. divorced.

5. AVAILABILITY OF AUTOMOBILE WHILE IN COLLEGE: __________  yes  no

    NOTE: To mark "yes," the automobile must be:
        1. available for your personal use throughout most of this quarter, and 2. registered in your or your guardian's name.

6. QUARTERS OF COLLEGE EXPERIENCE: __________ quarters

    NOTE: Enter the number of college quarters (one academic year equals three quarters -- two summer sessions equal one quarter) you have completed up to the beginning of this quarter.

7. RESIDENCE WHILE IN COLLEGE: home dormitory rooming fraternity, other (specify)

8. TRANSFER STATUS: ____________________________ yes  no

    NOTE: Have you ever transferred to SCSC from another institution of higher education? If yes, mark "yes."

9. INDUSTRIAL EXPERIENCE: ____________________________ yes  no

    NOTE: Include military and non-military experiences you consider to have been of an "industrial" nature.

9.a. If "yes" to #9, about how many months did you spend in TOTAL in this type of employment? __________ months

9.b. If "yes" to #9, briefly describe those typical duties you performed in this (these) line(s) of work.

_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
XI. APPENDIX C:

CLASS RECORD FORM
ST. CLOUD STATE COLLEGE - CLASS RECORD

Experiment in INDUSTRY 192
winter, 1971

<table>
<thead>
<tr>
<th>√</th>
<th>*</th>
<th>MID-</th>
<th>FINAL</th>
<th>NOTES</th>
</tr>
</thead>
</table>

= must be pretested

*The number appearing in this column indicates the ORIGINAL section for which the student initially enrolled. In reporting final grades for college and student records, it will be necessary to transcribe the above course grades according to class lists held by:

________________ ; for section (*) __ , or

________________ ; for section (*) __ .
XII. APPENDIX D:

PRETEST
PRETEST
Industry 192
Modern Technology and Civilization

INTRODUCTION:

Tests are constructed and administered for a number of different reasons. The reason for the test you are about to take is this: The following twenty-five items have been found to have a degree of discriminating power for persons not enrolled in Industry 192. It is our desire to determine if the score attained on this test is of any value in predicting a person's mid-quarter and final examination score.

GRADING:

As far as you are concerned, the "results" of this test will have absolutely no bearing on your grade in this class. Remember, the only reason for this test is to determine the validity of the test as a possible predictor of "success" in this course. If found to be valid, the test will be used as a counseling tool for persons contemplating taking Industry 192 in the future.

DIRECTIONS:

1. Do not place any marks on this or the following three pages.

2. Print your name and today's date on the appropriate lines of the IBM answer sheet.

3. Place the number of this test on the "Sex" line.

4. Place the letters "PRE" on the "Date of Birth" line.

5. Copy your Social Security number in the column of boxes headed by the red arrow. Code this number in the blanks to the immediate right of the number. Note: A Social Security number has nine digits.

6. Follow the directions for responding to each item as suggested in the "directions" block of the IBM answer sheet.
1. Traditionally, labor unions have made serious attempts to gain Negro members.
   A. True
   B. False

2. The first transition from hand to machine work took place in
   A. oil industries.
   B. textiles.
   C. iron mining.
   D. automobile manufacture.

3. Moonlighting is a slang term used to describe those tasks one performs while working the "night" shift.
   A. True
   B. False

4. The job picture for 1975 appears exceedingly bright for certain areas of employment. Which of the following does not look bright?
   A. professional
   B. skilled
   C. unskilled
   D. service

5. Increased productivity, uniform quality, and better control of the flow of production are all competitive advantages of
   A. work simplification.
   B. automation.
   C. organization.
   D. advertising.

6. The Industrial Revolution had its beginnings in
   A. America.
   B. England.
   C. France.
   D. Germany.

7. Studies within an industry to indicate the efficiency of production are
   A. motion studies.
   B. time studies.
   C. time and motion studies.
   D. loneliness studies.

8. Man is mentally ready to cope with free time.
   A. True
   B. False

9. The laser can be used for communication.
   A. True
   B. False
10. The most consistent indicator (predictor) of high income is
   A. I.Q.
   B. education.
   C. family background.
   D. grades in school.

11. The planned orderly and continuous progression of commod-
     ity through the shop, the delivery of work to workmen,
     and the analysis of operations into constituent parts are
     part of
   A. automation.
   B. mass production.
   C. mechanization.
   D. cybernation.

12. Cybernation is a word used to include
   A. automation and computers.
   B. tooling in industry.
   C. chemical reactions.
   D. computers and cryogenics.

13. It has been suggested that the work-day of the future will
     be much less structured and that there will be definite
     lappings of "work" and "leisure" activities in a worker's
     day.
   A. True
   B. False

14. The automobile industry has become synonymous with the term
   A. mechanization.
   B. standardization.
   C. interchangeability.
   D. all of the above.

15. The closed shop was declared illegal with the passage of
     the
   A. Labor Management Relations Act.
   D. Landrum-Griffin Act.

16. Of all known scientists, ___ per cent are alive today.
   A. 10
   B. 20
   C. 40
   D. 90

17. The first stage of American Technology was characterized by
   A. agricultural innovations.
   B. many inventions.
   C. production in the home.
   D. the machine age.
18. One of the following countries has set a pattern of doubling its GNP every seven to eight years: That country is
A. The United States.
B. Russia.
C. Japan.
D. West Germany.

19. The AF of L and the CIO merged in
A. 1946.
B. 1955.
D. they have not merged.

20. Technology is a good friend of labor.
A. True
B. False

21. Today, women compose a greater percentage of the labor force than at any period in American history (excluding WW II). The current percentage is approximately
A. 20%
B. 25%
C. 35%
D. 40%

22. The recent technological advance with greatest effect on the electronics industry is
A. television.
B. telestar.
C. ion engine.
D. semiconductors.

23. If technology is to continue to advance and succeed, man must
A. change his attitude about manual labor.
B. build more and better industrial complexes.
C. offer free public higher education to all.
D. acknowledge the superiority of one nation over others.

24. Of all the people that ever lived, ___ per cent are alive today.
A. 15
B. 25
C. 35
D. 45

25. Our present problems of land, air, and water pollution are due to
A. lack of technical knowledge.
B. outmoded political thinking.
C. population explosion.
D. mass production.
XIII. APPENDIX E:

MID-QUARTER EXAMINATION
MID-QUARTER EXAM

Industry 192

Modern Technology and Civilization

DIRECTIONS:

1. Do not place any marks on this or the following pages.

2. Print your name and today's date on the appropriate lines of the IBM answer sheet.

3. Place the number of this test on the "Sex" line.

4. Place the letters "M-1" on the "Date of Birth" line.

5. Copy your Social Security number in the column of boxes headed by the red arrow. Code this number in the blanks to the immediate right of the number. Note: A Social Security number has nine digits.

** 6. PART I - multiple choice: select THE BEST RESPONSE and record the number of your choice on the answer sheet

** 7. PART II - true or false: if the statement is true, mark the "1" space for that item; if the statement is false, mark the "2" space for the item

DO NOT OPEN THIS BOOKLET

UNTIL YOU ARE TOLD TO DO SO

BY THE EXAMINER ....
1. Synthetic materials are those that
   1. have their origin in a chemical synthesis.
   2. have resulted from a conditioned raw material.
   3. are used in place of the more expensive raw material counterpart.
   4. comprise the "plastics family."
   5. scorch easily.

2. Which of the following is a basic industrial process?
   1. analytical
   2. synthetic
   3. extraction
   4. ALL of the above are considered basic industrial processes
   5. none of 1, 2, or 3 satisfies the original question

3. The first plastic made in the United States was
   1. plexiglas
   2. celluloid
   3. polyethylene
   4. cellophane
   5. urethane foam

4. Wood or wood by-products are instrumental in all but which one of
   the following?
   1. many varieties of plastic materials
   2. fire-resistant insulation board
   3. printed media industries
   4. laminated structural members
   5. ALL of the above use wood or wood by-products

5. The greatest problem of refinement in raw material processing is
   1. chemicals for process.
   2. quantity.
   3. affinity to other elements.
   4. sedimentary rock.
   5. generation of sufficient heat.

6. An economic disadvantage of automation is its
   1. flexibility.
   2. changing technology.
   3. low initial cost.
   4. production rigidity.
   5. adaptability.

7. Cybernation is not the mere extension of mechanization and automation;
   it is a new way of thinking about
   1. industry and development.
   2. ourselves and about machines.
   3. food and water problems.
   4. theology.
   5. activities for the living.
8. Mass production has four basic elements — which of the following is not one of the elements?
   1. continuous flow of the product through the process
   2. analysis of the operation into its basic parts
   3. electronic control
   4. bringing the work to the worker
   5. division of labor

9. The transition from hand to machine production first took place on a large scale in the
   1. textile industry.
   2. oil industry.
   3. foundry industry
   4. iron industry.
   5. none of these.

10. The process of sending back information about what is happening to the product in automatic machining is called
    1. transfer.
    2. feedback.
    3. regulator.
    4. storage.
    5. conveyance.

11. The ability of a good or service to satisfy a want is defined as
    1. technology.
    2. production.
    3. utility.
    4. synchronization.
    5. competition.

12. Information storage in a computer is in the _____ number system.
    1. binary
    2. decimal
    3. FORTRAN
    4. alphameric
    5. 1 and 2, above

13. The capacity of an electronic computer must have
    1. control.
    2. storage.
    3. accuracy.
    4. input/output
    5. all of these

14. Basically, the computer is useful because
    1. its initial cost is low.
    2. it is easy to operate.
    3. it is maintenance free.
    4. it saves time.
    5. electricity is cheap.
15. A computer is capable of
   1. thinking.
   2. following instructions.
   3. subjective analysis.
   4. objective analysis
   5. all of the above

16. The difference between a hand tool and a machine tool lies basically in
   1. its size.
   2. its use.
   3. the source of power used to operate the tool.
   4. the user
   5. the designation given it by the manufacturer.

17. The electronic computer would generally categorized a machine tool because
   1. of its capacity to reason.
   2. of the various applications man has ascribed it.
   3. of its mechanical nature.
   4. it is man made.
   5. all of the above aid in the answering of the original question.

18. The work most commonly done on an engine lathe is called
   1. drilling.
   2. turning.
   3. shaping.
   4. grinding.
   5. boring.

19. Forming a workpiece by means of an abrasive action where particles
    of the workpiece are removed is known as
    1. milling.
    2. shaping.
    3. boring.
    4. turning.
    5. grinding.

20. "Chemical milling" refers to
    1. metal machinery.
    2. lasers designed to cut metal parts.
    3. producing metal products by etching.
    4. the grinding and pulverizing of chemicals.
    5. all of these.

21. The process of forcing plastic through a die opening as a continuous
    bar or rod is called
    1. casting.
    2. extrusion.
    3. compression molding.
    4. transfer molding.
    5. impact.
22. To have an industrial organization meeting the demands of machine logic and the personal and social demands of the workers refers to an organization that is highly
   1. specialized.
   2. automated.
   3. socialized.
   4. integrated.
   5. computerized.

23. Which of the following represents the "diagonal" relationship in an industrial plant?
   1. superior - subordinate
   2. peer to peer
   3. superior to non-subordinate
   4. subordinate - superior
   5. none of the above satisfy the original question

24. All of the following are phases of production in industrial organization except
   1. sales.
   2. making.
   3. assembly.
   4. packaging or crating.
   5. research and development.

25. A manufacturing establishment with congregated labor housed together with production is known as
   1. the domestic system.
   2. handicraft.
   3. congregated labor.
   4. the factory.
   5. mechanized production.

26. Interactions between two or more members of a work organization — as determined by their respective ranking on a value scale — are termed
   1. authority relations.
   2. power relations.
   3. human relations.
   4. status relations.
   5. industrial relations.

27. Chain of command passed down from the president to workers is termed
   1. authority relations.
   2. power relations.
   3. human relations.
   4. status relations.
   5. industrial relations.

28. A major sociological problem of the assembly line is
   1. unhealthy working conditions.
   2. depersonalization of the job.
   3. lower pay.
   4. more dangerous work.
   5. job enlargement.
29. In the future, satisfaction from doing a complete piece of work on the job may seldom occur. This may not be a problem because of
1. a change in human values.
2. more leisure time.
3. more pay.
4. incentives other than 2 and 3.
5. man's physical removal from the actual work.

30. Reduce job monotony, utilize employee intellectual capabilities, and decrease job specialization are all objectives of
1. the Scanlon Plan.
2. automation.
3. mass production.
4. the Scientific Method.
5. job enlargement.

31. In which of the following may the employer immediately hire anyone he may want to?
1. preferential shop
2. closed shop
3. open shop
4. union shop
5. he may do so in any or all of 1, 2, 3, or 4

32. The first task undertaken in the incorporation of a Scanlon Plan in a plant is to
1. define the industry in which the plan has been proposed.
2. establish a "normal" labor cost for the plant under consideration.
3. develop firm unionization in the plant.
4. remove the unionization from the plant.
5. graphically analyze the wage structure of the industry under consideration.

33. Into which of the following market arenas are there the greatest number of "new" industrial products/services?
1. space hardware
2. transportation
3. electronic components
4. education
5. recreation

34. The service industries are primarily geared for the market of
1. the military man.
2. man, in general.
3. governmental employ.
4. communications industries.
5. power generation industries.

35. Man's command of technology has enabled him to
1. have his environment adapt to him.
2. become more dependent upon automation.
3. better understand production techniques.
4. retrain for machines.
5. design and master the future.
36. According to recent research and speculation, a drastic reduction in the work week will probably lead to
   1. increased leisure time.
   2. higher salaries.
   3. greater numbers in the work force.
   4. more moonlighting.
   5. increased population growth.

37. The impact of automation has set certain trends; one such trend that is sure to continue is
   1. more people will move from industry to farming.
   2. smaller companies will predominate.
   3. lessened unionism in industry.
   4. fewer jobs for the unskilled will be available.
   5. a lessened need for research and development.

38. From a managerial standpoint, the primary function of industry is
   1. to satisfy wants.
   2. to make a reasonable profit.
   3. to form a larger G.N.P.
   4. to make a prosperous nation.
   5. to provide jobs for the populous.

39. An institution in our society, which tending to make a profit, applies knowledge and utilizes natural and human resources to meet the needs of man. (a definition)
   1. organization
   2. office
   3. industry
   4. technical group
   5. company-corporation

40. Scientific knowledge applied to industry. (a definition)
   1. technology
   2. mass production
   3. automation
   4. world of work
   5. standardization

---

PART II
true — false

(SEE: Direction #7
on the cover sheet)

41. The primary purpose of incorporating a business is to obtain a more favorable tax base.

42. The blast furnace requires raw materials from at least three separate mining processes.

43. The New York Stock Exchange determines and sets the price for which stocks are bought and sold.
44. "Power relations" is a horizontal arrangement whereby equal tasks are performed by industrial authorities to insure efficient operation.

45. The management of big business believes that the place to cut payroll costs is through the use of computers in the plant.

46. There are factories in the U.S. now producing unitized, prefabricated vacation homes from plastic materials.

47. Job monotony is a result of fatigue.

48. Plastic resins are sometimes in liquid form and can be cast in molds.

49. Plastics are relatively easy to bend.

50. Job reduction enriches the job for the worker.

51. Automation consists primarily of mechanization and standardization.

52. Collective bargaining is the process by which unions share in making business decisions, decisions involving the terms of employment and the price of labor.

53. Unions are usually powerful in times of prosperity and relatively weak in times of depression.

54. As a percentage of the labor force, labor union membership is presently at an all-time high.

55. Research and development departments within an industry are usually low on the priority lists of funding.

56. There is no significant difference in the unemployment rate between the white and non-white American.

57. "Time-sharing" or multiple use of a computer by several industries seems to be the direction of the future for the computer leaser.

58. Forging is a process of hammering or squeezing metal into the desired shape.

59. Almost all metals can be cast.

60. Modern technology may be perceived as an environment within which we live, made up of external and tangible things which we modify from time to time and which modify us.
XIV. APPENDIX F:

FINAL EXAMINATION
FINAL EXAM

Industry 192

Modern Technology and Civilization

DIRECTIONS:

1. Do not place any marks on this or the following pages.

2. Print your name and today's date on the appropriate lines of the IBM answer sheet.

3. Place the number of this test on the "sex" line.

4. Place the word "FINAL" on the "Date of Birth" line.

5. Copy your Social Security number in the column of boxes headed by the red arrow. Code this number in the blanks to the immediate right of the number.
   Note: A Social Security number has nine digits.

** 6. PART I - multiple choice: select the BEST RESPONSE AND record the number of your choice on the answer sheet

** 7. PART II - true or false: if the statement is true, mark the "1" space for that item; if the statement is false, mark the "2" space for the item

DO NOT OPEN THIS BOOKLET

UNTIL YOU ARE TOLD TO DO SO

BY THE EXAMINER.
1. Synthetic materials are those that
   1. have their origin in a chemical synthesis.
   2. have resulted from a conditioned raw material.
   3. are used in place of the more expensive raw material counterpart.
   4. comprise the "plastics family."
   5. comprise the modern-day textile industry.

2. The transition from hand to machine work first took place in
   1. oil industries.
   2. textile industries.
   3. iron mining industry.
   4. automobile manufacturing.

3. Some future architectural structures/types under consideration are
   1. Kleenex architecture.
   2. underground structures.
   3. geodesic domes.
   4. all of these

4. The planned orderly and continuous progression of commodity through
   the shop, the delivery of work to workmen, and the analysis of
   operations into constituent parts are part of
   1. automation.
   2. mass production.
   3. mechanization.
   4. cybernation.

5. Increased productivity, uniform quality, and better control of the
   flow of production are all competitive advantages of
   1. work simplification.
   2. automation.
   3. organization.
   4. advertising.

6. Cybernation is a word used to include
   1. automation and computers.
   2. tooling in industry.
   3. chemical reactions.
   4. computers and cryogenics.

7. Studies within an industry to indicate the efficiency of
   production are
   1. motion studies.
   2. time studies.
   3. time and motion studies.
   4. loneliness studies.
8. The capacity of an electronic computer must have
   1. at least 20K storage units.
   2. input/output.
   3. FORTRAN.
   4. the capability of data interpretation.
   5. all of these

9. The first stage of American Technology was characterized by
   1. agricultural innovations.
   2. many inventions.
   3. production in the home.
   4. the machine age.

10. The automobile industry has become synonymous with the term
    1. mechanization.
    2. standardization.
    3. interchangeability.
    4. all of the above.

11. The process of hammering or squeezing metal into the desired shape
    is known as
    1. shearing.
    2. stamping.
    3. turning.
    4. forging.
    5. casting.

12. The process of forcing plastic through a die opening as a continuous
    bar or rod is called
    1. casting.
    2. extrusion.
    3. compression molding.
    4. transfer molding.
    5. impact.

13. To have an industrial organization meeting the demands of machine
    logic and the personal and social demands of the workers refers
    to an organization that is highly
    1. specialized.
    2. automated.
    3. socialized.
    4. integrated.
    5. computerized.

14. All of the following are phases of production in industrial
    organization except
    1. sales.
    2. making.
    3. assembly.
    4. packaging or crating.
    5. research and development.

15. In introducing production changes, the best key to employee
    acceptance is
    1. to give a wage increase as a bonus for a short time.
    2. to work through their union.
    3. to incorporate employee participation in the change.
    4. to organize the change in small units.
16. A major sociological problem of the assembly line is
   1. depersonalization of the job.
   2. lower pay.
   3. more dangerous work.
   4. job enlargement.
   5. all of the above

17. The production of more goods at less cost has evoked a characteristic common to all people, that of
   1. job satisfaction.
   2. job reduction.
   3. job enlargement.
   4. resisting change.
   5. welcoming change.

18. The closed shop was declared illegal with the passage of the
   3. Fair Labor Standards Act

19. The Industrial Revolution had its beginnings in
   1. America.
   2. England.
   3. France.
   4. Germany.

20. The AF of L and the CIO merged in
   1. 1946
   2. 1955
   3. 1961
   4. ... they have not merged.

21. Today, women compose a greater percentage of the labor force than at any period in American history (excluding WW II). The current percentage is approximately
   1. 20%.
   2. 30%.
   3. 40%.
   4. 50%.
   5. 60%.

22. From a managerial standpoint, the primary function of industry is
   1. to satisfy wants.
   2. to make a reasonable profit.
   3. to form a larger G.N.P.
   4. to make a prosperous nation.
   5. to provide jobs for the populace.

23. Scientific knowledge applied to industry. (one definition)
   1. technology
   2. mass production
   3. automation
   4. world of work
   5. standardization
24. The name "Andrew Carnegie" is best associated with
   1. private libraries.
   2. the iron and steel industry.
   3. the railroad industry.
   4. the automobile industry.
   5. good fortune, coupled with considerable "luck."

25. The "machine" was welcomed in the United States because of
   1. abundant capital
   2. the presence of machine tools.
   3. trained workers.
   4. a labor shortage.
   5. our untapped natural resources.

26. One of the grave problems of the machine age is
   1. insufficient sources of energy.
   2. technological surpluses.
   3. technological unemployment.
   4. lower standards of living.
   5. descending gross national product.

27. Technologically, the world has/will
   1. reached a peak.
   2. reach a peak soon.
   3. accelerate.
   4. begun to decline.
   5. begun to level off.

28. When did the "technological curve" approach vertical proportions?
   1. 1751
   2. Civil War
   3. 1900
   4. WWI
   5. WWII

29. The final step in elimination of the worker in a production
   process will be
   1. the highest possible cost of labor.
   2. the development of a logic machine.
   3. automation.
   4. a decision by management to decrease absenteeism.
   5. ... production processes will always have laborers.

30. One of the following countries has set a pattern of doubling its
    GNP every seven to eight years: That country is
    1. the United States.
    2. Russia.
    3. China.
    5. West Germany.

31. Of all the people that ever lived, _____ per cent are alive today.
   1. 15
   2. 25
   3. 35
   4. 45
32. In the last few years, the birth rate in the United States has been
1. rapidly increasing.
2. rapidly decreasing.
3. slowly increasing.
4. slowly decreasing.
5. staying about the same.

33. Which of the following population areas experienced the greatest percentage increase in the last decade?
1. suburban rings
2. central cities
3. nonmetropolitan areas (cities of less than 50,000 persons)
4. rural communities
5. ... census data from the 1970 census are not yet available to allow for our drawing any such conclusion

34. An income plan proposed to work through a negative income tax is the
1. AFDC.
2. welfare fund.
3. pension plan.
4. guaranteed minimum family income.
5. Socialistic ideal.

35. Within the next 20 years, about ____ of the world's population will live in urban areas.
1. 25%
2. 50%
3. 75%
4. 95%
5. none of these

36. Cities are made up of basic elements. Which of the following is not a basic element of the city?
1. man
2. society
3. shells
4. networks
5. all of the above are basic elements of a city

37. Which method of population regulation best complements the current trend in United States philosophy?
1. abortion
2. fertilization through legal "permit" only
3. reduction of medical research
4. contraceptives
5. allow food supply to serve as a limiting factor

38. Identify the incorrect statement.
1. D.D.T. kills plankton which produce a substantial portion of the earth's oxygen supply.
2. The half-life of D.D.T. is two years or less.
3. Traces of D.D.T. have been found in Penguins.
4. D.D.T. is carried by the wind.
5. D.D.T. is presently used in considerable quantity.
39. The expression, "The Green Revolution" refers to
   1. our apparent obsession for money.
   2. present-day demands for the legalization of marijuana.
   3. ecological interests; e.g., anti-litterbug campaigns.
   4. increased agricultural production.
   5. the preponderance of youth in our population.

40. Which of the following pairs of names are best associated with a
    current abortion bill before the Minnesota Legislature?
   1. Zwach-Montgomery
   2. Bell-McMillan
   3. Kemp-Ryan
   4. Perpich-Henry
   5. Mitau-Sweet

41. The world's supply of water
   1. is increasing.
   2. is decreasing.
   3. remains relatively constant.
   4. is disappearing.
   5. ... its "life" cannot be assessed

42. According to Fabun, our present problems of land, air, and water
    pollution are due to
   1. lack of technical knowledge.
   2. outmoded political thinking.
   3. population explosion.
   4. mass production.

43. Wherein lies the greatest potential for combating and controlling
    environmental pollution?
   1. the individual — you, me
   2. philanthropic organizations
   3. individual industries
   4. industry and her technologies
   5. state and federal governments

44. Which of the following techniques is currently being employed to
    assist in abating pollution?
   1. recycling
   2. education
   3. legal constraints
   4. intense heat
   5. all of the above

45. The time interval between invention (technological advancement) and
    the specific adjustments called for by that invention is termed
   1. technological change.
   2. cultural lag.
   3. time lapse.
   4. negative technology.
   5. pending law.
46. In making the social adjustments to change as caused by technology, the most critical element is
   1. time.
   2. money.
   3. understanding of the change.
   4. labor unions.
   5. obtaining a good job.

47. The electronic invention that was most widely and rapidly accepted into the American way of life has been
   1. the telephone.
   2. radio.
   3. television.
   4. stereo.
   5. laser technology.

48. Which answer is not an objective of industrial arts?
   1. understanding of industry
   2. development of leisure time activities
   3. development of a salable skill
   4. consumer education
   5. exposure to possible vocational choices

49. Individual skill development for the objective of increasing one's employability is best thought of as an objective of
   1. vocational education.
   2. avocational education.
   3. professional education.
   4. general education.
   5. none of the above

50. That education which is so designed as to allow student exploration of and exposure to an area of study — a discipline studied in breadth. (a definition)
   1. vocational education
   2. avocational education
   3. technical education
   4. professional education
   5. general education

51. Our technical knowledge will double in ____ years.
   1. 5
   2. 10
   3. 20
   4. 30

52. The most consistent indicator (predictor) of high income is
   1. I.Q.
   2. education.
   3. family background.
   4. grades in school.

53. Schools of the foreseeable future will likely change their role of preparing for a world of work to preparing for a world of
   1. recreation.
   2. social work.
   3. "synthetic" work.
   4. free time.
   5. leisure time.
54. Of all known scientists, ____ per cent are alive today.
   1. 10
   2. 20
   3. 40
   4. 90

55. In which of the following has the federal government had the greatest financial involvement insofar as research and development are concerned?
   1. education
   2. the manufacturing industries
   3. the nonmanufacturing industrial concerns
   4. health and medicine
   5. ... such data is unavailable

56. The burden of job training should be placed upon
   1. industry.
   2. the individual.
   3. government.
   4. colleges.

57. If technology is to continue to advance and succeed, man must
   1. change his attitude about manual labor.
   2. build more and better industrial complexes.
   3. offer free public higher education to all.
   4. acknowledge the superiority of one nation over others.

58. What is likely to happen to many present day workers as industrial trends continue? They will
   1. work fewer hours, allowing more persons to be employed.
   2. be retrained for new jobs.
   3. work more hours to continue on present standards of living.
   4. start up their own businesses.
   5. move to rural areas because of lack of work.

59. Time spent in activities relating to the enjoyment or personal satisfaction of the individual is known as
   1. free time.
   2. leisure time.
   3. a desirable job.
   4. vacation.
   5. civilization.

60. One of the following gentlemen is regarded as a leader in explaining time, work, and leisure.
   1. Robert Goddard
   2. Sebastian DeGrazia
   3. C. Wright Mills
   4. Charles R. Walker
   5. Don Fabun

61. The chief contributor to increased free time is the
   1. computer.
   2. power machine.
   3. modern technologies.
   4. the development of recreational facilities.
   5. lessened demand for products.
62. Which of the following pairs of words/phrases are most closely associated?
   1. leisure time - employment
   2. employment - subsistence
   3. subsistence time - commuting time
   4. free time - leisure time
   5. unemployment - free time

63. If one had to explain our increased number of "free-time" hours as being attributable to some one thing, he would probably credit
   1. a heightened emphasis placed on recreational facilities.
   2. an ever increasing efficiency of work performed.
   3. our affluent way of living.
   4. our natural bent for work.
   5. an increased time spent in earning our subsistence.

64. Those who will first be affected by increased free time are the
   1. white collar workers.
   2. blue collar workers.
   3. unskilled workers.
   4. professional occupations.
   5. service workers.

65. All of the following are characteristic of the "leisure age" work force except
   1. shorter work week.
   2. retraining for new jobs.
   3. younger persons entering the labor force.
   4. increased vacation time.
   5. better working conditions.

66. In order to experience leisure, all of the following are essential except
   1. the activity is chosen for its own sake.
   2. time must not be critical.
   3. the activity must be profitable.
   4. the activity must be free from everyday necessity.
   5. the choice of the activity must be the individual's choice.

67. If the future holds that America will be composed of a work-less society at leisure, which of the following must become a reality?
   1. The government must set up mass leisure pursuits.
   2. Private enterprise must set up mass leisure pursuits.
   3. Society must recognize leisure activities as a fulfillment of life's work.
   4. Industry must establish extensive recreational activities for its employees.
   5. Man must strive for other ways of earning a living.

68. Leisure
   1. has varying affects on jobs.
   2. creates more jobs.
   3. eliminates jobs.
   4. has no effect on jobs.
   5. is always met with positive anticipation.
69. Which of the following industries has no involvement in the leisure time "market?"
1. meat packing
2. electronic component manufacturers
3. machinery manufacturers
4. chemical and allied products
5. ... none of the above satisfies the original question

70. Which of the following individuals is associated with the geodesic dome method of construction?
1. de Jouvenel
2. Buckminster Fuller
3. Walter Sullivan
4. Frank Lloyd Wright
5. Sir Brian Medewar

71. The industry with the greatest current growth rate is
1. transportation equipment.
2. iron and steel.
3. machinery.
4. chemical.

72. When a visual image is transmitted through a flexible "pipe" of glass fibers, the technology of ____ is being utilized.
1. translucent acrylics
2. fiberoptics
3. transparent phenolics
4. fiber glass
5. ... it is not possible to transmit a visual image in such a manner.

73. The industry group contributing the most to the G.N.P. is
1. agriculture.
2. manufacturing.
3. wholesale and retail trade.
4. construction.
5. public administration.

74. There is a movement under way to scrap our English system of measurement and replace it with the metric system. Some people oppose this move on the grounds that
1. it is too costly.
2. will make life uninteresting.
3. the metric system will soon become obsolete.
4. no one understands the metric system.
5. extensive retraining would render the system prohibitive.

75. All of the following are indicators of possible trends in transportation except
1. hydrofoils.
2. high compression domestic automotive engines.
3. turbine driven trucks.
4. emphasis on passenger safety.
5. economy engines.
76. When properly adjusted, the following engine emits less than one percent of its energy source as pollutants in the air.
   1. gasoline internal combustion
   2. diesel
   3. Wankel
   4. gas turbine
   5. steam

77. The proposal of having liquid-oxygen and liquid-hydrogen as a source of power for automobiles suggests which of the following?
   1. turbine engines
   2. fuel cells
   3. battery-powered vehicles
   4. an impossible "Buck Rogers" dream
   5. solar batteries

78. The laser beam is used to produce 3-dimensional photography, resulting in
   1. laser pictures.
   2. holography.
   3. telephoto pictures.
   4. transitography.
   5. ... 3-dimensional photography is not possible.

79. The "sandwiching" of electronic circuits into usable components results in pieces of electronic gear which are referred to as
   1. chips.
   2. transistors.
   3. computers.
   4. sensors.
   5. vacuum tubes.

80. With what do we associate coherent, monochromatic light?
   1. micro-electronics
   2. macro-electronics
   3. lasers
   4. industrial lighting
   5. television

81. Which phrase best describes the modern-day method of composition in the graphic arts industry?
   1. linotypography
   2. paste-up
   3. computer-aided justification
   4. punched-tape copymaking
   5. hyphenation

82. The recent technological advance with greatest effect on the electronics industry is
   1. television.
   2. telestar.
   3. ion engine.
   4. semiconductors.
83. The name, Dr. Norman Borlaug, is best associated with
1. nuclear physics at the University of Chicago.
2. cancer research.
3. track.
4. the School of Industry, St. Cloud State College.
5. agricultural innovations; specifically, wheat.

84. The 1970 Nobel Peace Prize winner was involved in
1. diplomacy.
2. journalism.
3. agriculture.
4. the military.
5. ... as is sometimes the case, the 1970 Nobel Prize for Peace
   was not awarded.

PART II
true -- false

(SEE: Direction #7
on the cover sheet)

85. The blast furnace requires raw materials from at least three
   separate mining processes.

86. Thermosetting plastics are capable of being reheated and reshaped
   numerous times.

87. "Time-sharing" or multiple use of a computer by several industries
   seems to be the direction of the future for the computer leaser.

88. The medical profession, one profession that is finding very little
   application for the computer.

89. Fabun believes that in the future two percent of the population
   will be able to produce the food and manufactured goods required
   by the remaining ninety-eight percent.

90. Technological developments rarely occur as a response to a social
   demand.

91. Moonlighting is a slang term used to describe those tasks one
   performs while working the "night" shift.

92. There is presently a shortage of people trained to work with
   computers.

93. We have no reason to believe that there will ever be an increase
   in the number of unskilled workers in the United States.

94. Some companies have entertained thoughts of offering some of their
   employees "loneliness pay."
95. Nuclear reactors for electrical generation purposes contribute to water pollution through radioactive discharges.

96. The laser can be used for communication.

97. The average annual growth rate of the world's population at the present time is 7%.

98. Water can logically be considered an "inexhaustible resource."

99. Traditionally, labor unions have made serious attempts to gain Negro members.

100. The population explosion is the result of increased fertility of the human species.

101. A lack of technical knowledge seems to be the only barrier to eliminating causes of environmental pollution.

102. Pollution experts contend that the internal combustion engine is a minor contributor to air pollution.

103. The problems of air and water pollution are complicated by the fact that we have no uniform regulations equally applied throughout the U.S.

104. Educational technology is made up of aids for the teacher who will be eventually replaced by a computer or a TV screen.

105. With our present system of education, it is very possible that a person can obtain the necessary education in the first twenty years of his life to last the next forty years of working life.

106. Our society as a whole tends to believe that the diffusion of knowledge must be advantageous, and the consequences of ignorance fatal.

107. We have in our society today almost no concept of training people for a life of leisure.

108. The best and most effective way of combatting unemployment is to have an overall increase in education.

109. The trend of federal funding of industry research and development programs has been steadily decreasing over the past ten years.

110. Approximately 4% of the net sales in the manufacturing industries is spent on research and development. This is very comparable to that portion of educational budgets spent in analogous pursuits.

111. The American concept of "time" is shared by most other cultures in the world.

112. Free time is that time spent away from your primary job.

113. One's "free time" is often turned back into his work.
114. Man is mentally ready to cope with free time.

115. Leisure is not possible until we extricate ourselves from the "time machine."

116. It seems that the average American worker is more interested in increasing his income rather than working fewer hours.

117. Snowmobile manufacturers are exclusively concerned with the leisure time "market."

118. The recent developments in electrically operated automobiles are a "first" in such an application of battery power.

119. The aircraft industry has been largely dependent upon government contracts for its development.

120. Kelp is a fish presently being developed for food to feed some of the lesser developed countries of the world.
XV. APPENDIX G:

COMMON LESSON PLAN FOR DAY #1
RESEARCH IN INDUSTRY 192
(plan for day #1)

instructor__________________  date______ Jan.____, 1971

time of class__________________ meeting room HH -______

Preparation:

1. **prior to class**, place the following on the chalkboard

<table>
<thead>
<tr>
<th>(C)</th>
<th>(E-1)</th>
<th>(E-2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rm 116</td>
<td>Rm 230</td>
<td>Rm 230</td>
</tr>
<tr>
<td>Thursday, Jan. 7</td>
<td>Thursday, Jan. 7</td>
<td>Thursday, Jan. 7</td>
</tr>
<tr>
<td>Friday, Jan. 8</td>
<td>Friday, Jan. 8</td>
<td>Friday, Jan. 8</td>
</tr>
<tr>
<td>Tuesday, Jan. 12</td>
<td>Tuesday, Jan. 12</td>
<td>Tuesday, Jan. 12</td>
</tr>
</tbody>
</table>

2. have the following materials (in sufficient numbers) in your possession
   a. 3x5 lined recipe cards
   b. "Personal Data Questionnaire" (handout)
   c. course syllabus: "Modern Technology & Civilization"
   d. this "plan"—the one you now hold

Procedure:

1. distribute the 3x5 cards to the students
2. have the student place his name (last name first) on the red line
3. collect the 3x5 cards and deliver the same to Lacroix
4. introduce yourself to the students
5. distribute the Personal Data Questionnaire and have the students complete them
6. collect the Personal Data Questionnaire
7. distribute the course syllabus, "Modern Technology & Civilization"

a. have the students complete the "1. of record." (left side) section on the cover sheet of their syllabus as follows:

\[
\begin{align*}
\text{_________} & \quad \text{section no.} \\
\text{_________} & \quad \text{instructor}
\end{align*}
\]

you may want to illustrate this on the chalkboard

b. introduce the students to the course, Ind. 192, and elaborate as you see fit; allowing AT LEAST TEN (10) MINUTES for the completion of items 8 and 9.

8. announce: (read the following to the class)

"You undoubtedly noticed that the instructor names for Industry 192 were not listed on the class schedule for this quarter. This was neither an oversight on the part of the administration, nor was it an attempt to "hide" anything. We knew when you enrolled for the ____ o'clock section, that you would be instructed by either _________ or me. We did not know which of us you would ultimately have. That, then, is the basic reason for eliminating the names from the schedule. Another, equally valid reason and one that underpins the first, is that we are performing some research this quarter that necessitates eliminating your choice-of-instructor as a variable.

"That research is also the reason you were asked to submit your name on the 3x5 card at the beginning of this period. Those cards have now been processed so that this section will be subdivided into three groups. The three groups into which you were divided were determined on a strictly random basis and no one (even if it were possible or advantageous) has been given any preferential treatment. Each of these groups still meet at ___ o'clock, so your overall schedule has not been altered. You will hear more about this research, and your part in it, when you attend the next class period of Ind. 192.

"Your next class period for this course will be in the following rooms on the following days. Please copy the appropriate
section designation, the instructor, and the room number on the cover sheet of your syllabus. Also, note when your next class of 192 will meet.

9. ask for and answer any questions pertaining to any misunderstandings (especially as to their understanding as to where/when to go for day #2)

10. dismiss the class

RETURN THE CARD DECKS TO LACROIX
(final listings must be made)
XVI. APPENDIX H:

COMMON LESSON PLAN FOR DAY #2
RESEARCH IN INDUSTRY 192
(plan for day #2)

instructor_________________ date____ Jan., 1971

begin class________________ meeting room HH-______

A. Preparation:

have the following materials in your possession . . . . . . . . . . . . . . . [secure at/from:]

1. class record for this experimental section . . . . . . . . . . . . . . . . . . . . . . . Lacroix

2. "Audio-Tape Supplement" (handout) . . your packet

3. Audio-Tape___________________________

4. cassette recorder _______________________

5. "Pretest" test booklets ___________________

6. IBM answer sheets _______________________

B. Procedure:

1. call roll according to A.1., above (this will serve as a check on the follow-through of instructions given during day #1 of the experiment)

   a. absent students must be noted so that they can obtain day #2 information at a later date

   b. students not listed as "members" of this section but who are now present should be sent to immediately

      (if blank, send to HH-216)

2. introduce yourself to the class—you are to be their instructor for the remainder of this quarter

3. have the students complete the "2. of fact." (right side) section on the cover sheet of their syllabus as follows:

   section no.________________
   instructor_________________
   room no._________________

[you may want to illustrate this on the chalkboard]
4. briefly introduce the audio-tape the students are about
to hear—the tape explains an overall view of the ex-
periment and offers specific information for this
experimental section

5. distribute the handout, "Audio-Tape Supplement"

6. play the tape (NOTE!! be sure that the tape you are
playing is marked___________.)

   this tape will consume __________ minutes

7. ask for (and answer as best you can) any questions the
students might have as relating to the experiment

8. BEGIN INSTRUCTION in the content of Ind. 192 in the
manner most appropriate to your method(s) of teaching
(except! no formal lecture in E-2 sections)

9. if an outside assignment is a part of your instructional
technique, announce it now

10. announce: "This class will meet in this room (_____
      on ______________ at ___:00 for the remainder of
      the quarter."

   ALLOW AT LEAST FIFTEEN (15) MINUTES FOR THE REMAINDER OF THE PERIOD

11. read the names of those to be pretested (those with a
(✔) preceding the name on the class record--A.1., above)

12. dismiss those persons not to be pretested

13. distribute:
   a. IBM answer sheet (announce: "Do not place any
      information on this sheet until later.")
   b. "Pretest" booklets

14. announce: "You must use a pencil in responding to this
test."

15. read to the class the: "Introduction," "Grading," and
"Directions" sections on the cover sheet of "Pretest"

16. have the class complete the IBM answer sheet as per the
"Directions" (#'s 2., 3., 4., and 5.)
17. **announce:** "It is expected that you will have to guess on some of the items in this test. If you have NO idea as to the best answer, respond with your best guess. When you have completed this test, leave the test booklet and answer sheet in its appropriate stack on the front desk and quietly leave the room."

C. **After class:** (in order that the other elements of the experiment run smoothly, it is necessary to tend to the following "immediately" after the completion of your class)

   deliver to:

1. Audio-Tape
2. cassette recorder
3. "Pretest" test booklets
4. completed "Pretest" IBM answer sheets
5. extra copies of "Audio-Tape Supplement" (handout)
XVII. APPENDIX I:

AUDIO SCRIPT FOR DAY #2
Welcome to Industry 192. Actually, this is the second class period you have attended in this course, but it is the first opportunity I have had to welcome you; so welcome you, I do.

My name is Bill Lacroix and I am presently on a leave of absence from St. Cloud State to, as the academician says, "to pursue knowledge." That "pursuit" finds me at Iowa State University where I am now an Educational Research Fellow.

As that title implies an interest in and concern for educational research, I would like to digress slightly from the main intent of this tape and talk about education in general. Each of us has a vested interest in what is passingly referred to as "education." Some of us are interested in education as a profession--some of us are educationally concerned only insofar as being students. Our educational and life goals will certainly differ from person to person. However, there is that institution—the institution of formal education—that surrounds us all from the time we're about five years old until we're educationally saturated, educationally disgusted, or educationally broke.

Each of us is involved in education for our own unique purposes. And, each of us can find many faults with the education we have experienced--hopefully, we can also find some good in the system.

Education is, admittedly, a behavioral science. And few, if any, of the behavioral sciences now enjoy the relative ease of scientific manipulation and prediction available to the natural sciences. This, of course, does not mean that all is lost for the behavioral scientist or that his profession must be relegated to those confines once inhabited by the alchemist. Rather, it only means that there is a great deal yet to be done.
in the behavioral sciences. So it is with education: there is a great deal yet to be done in education.

No one—not even the most enthusiastic supporter of our present educational structure—no one can logically claim that education, and her methods, is without fault.

It is often said that the recognition of a problem is the essential first step to an alleviation of that problem. Let us recognize that education does have her ills, and let us proceed logically and methodically to a solution of those ills.

Research in education has traditionally centered on descriptive research—those kinds of research that describe what we have; what we have had; and what we, perhaps, should have. Unfortunately, precious little has been done in examining the very basics of the ways in which we teach and in the ways in which we learn. It seems to me that the time is ripe for research of that nature.

Research in Industry 192, "Modern Technology and Civilization," at St. Cloud State College, St. Cloud, Minnesota, is perhaps a small step in needed educational research, but it is a step; and one from which considerable worth can come.

You have undoubtedly noticed that this course has been given something other than the "normal" beginning. Most of you are no longer in that section for which you originally registered. Some of you are perhaps unhappy about that. However, all that has been done so far has been done with an honest intent and with good reason. That reason is that, this quarter in Industry 192, we are experimenting to see—among other goals—if there is an optimum number of class hours per week that will result in essentially the same understanding of the subject matter material. Perhaps you have wondered yourself as to what "magic" there is in requiring one hour of classroom lecture-recitation each week for each college credit earned. We, too, wonder and are concerned about that "magic." Perhaps the underlying logic of that requirement is sound—perhaps it is not. This quarter, we intend to make a dent in the research
that should be done in this area. You are now a part of that research and a part of that experiment.

Your membership in this particular section was determined on a strictly random basis. Preferential treatment (even if it was possible) was given no one.

So that you might better visualize and understand what has taken place so far and what will take place for the remainder of this quarter, I have prepared the handout you now hold. That handout is entitled, "Audio-Tape Supplement."

Please refer to Figure A. This diagram schematically describes the entire selection process. Notice the left-hand portion of the diagram that includes the numbers 9, 11, 1 and 2. These numbers refer to the four time periods during the day when this experimental research is being conducted. Circle that number that represents your class time. Note that two lines lead from that number and are terminated at the numbers 116 and 230. This indicates that when you enrolled in Industry 192, you either enrolled for classroom 116 in Headley Hall or you enrolled for classroom 230 in Headley Hall. All students in each of these two rooms, then, were combined into one group and were subsequently randomly assigned (indicated by the circled "R")—were randomly assigned to one of the three experimental conditions—or, experimental sections. These sections are indicated by the three rows of five blocks labeled "C," "E-1," and "E-2." The section of which you are now a part is one of these three experimental sections. I will elaborate on the particulars of your section in a later portion of this tape.

Now, if you would focus your attention on Figure B of the handout and notice that there is actually very little difference in the overall instructional format of this course than that which one would normally expect.

Classes began on January 6. There will be a mid-quarter examination on an as yet-to-be-determined date in February. And, there will be a final examination during final exam week.
in March.

Hopefully, you have already noticed that your course syllabus tells you exactly how many items in the mid-quarter and how many items in the final will be devoted to each of the objectives of the course. There will be sixty items in the mid-quarter and one hundred twenty items in the final. Your instructor will not construct these examinations.

To allow the experiment to have more power and interpretability, it is necessary to eliminate an instructor's tendency to "teach-to-the-test." Therefore, your knowledge of what will be in each of these exams is identical to that knowledge held by your instructor. He, too, is limited to interpret test content from the stated weights given the various objectives in the syllabus. It seems foolish to have to say it, but I will: It would be very wise indeed to become very familiar with the course objectives.

These two exams will be constructed by me and I will do my best to avoid "trick" or "ambiguous" questions. I will try to avoid questions of trivia and will surely attempt to measure your mastery of concepts—as opposed to petty specifics. I will construct the exams by examining the objectives—you could perhaps best study by examining the objectives.

Also contained in Figure B is the reference to a "pretest - no pretest" division near the beginning of the quarter. At the time you were randomly assigned to this section, you were also randomly assigned to "take" or "not take" a pretest. About half of you will take a twenty-five item multiple-choice test later during this period. The score you attain on the pretest (if you are one of those who take it) will in no way affect the grade you will earn in this course. These pretest scores will be examined at the end of the quarter to see if there is any relationship between pretest scores and scores received on the mid-quarter and final. If there is a relationship the pretest could serve as a valuable tool in counseling future students as to their probable success in 192. If a relationship does not
exist, we can assume that this particular pretest is of no predictive value and should not be used for such. Regardless of the outcome, you stand to lose nothing by having to take the test.

For those of you who will be taking the pretest, keep in mind that the content of the test does not, necessarily, represent the content of the course but that the pretest content is but a partial reflection of what Industry 192 could be—not what it is.

The topic of grading—grading or evaluating a student's mastery of a given course content—is, at best, an unpleasant topic. However, since the dilemma of grading is still present and you are undoubtedly concerned about your grade, it is a topic that cannot be ignored. This quarter you are involved in an experiment involving various time requirements for classroom lecture-recitation. As such, it would be grossly unfair to compare, for grading purposes, one student to another across classroom time requirements. Rest assured that your grade will be determined on the basis of how you compare to persons receiving the same treatment that you receive. In fact, your competitors for a grade are, in all probability, limited to those persons in this room right now. You will not be evaluated in competition with persons receiving an experimental condition that differs from your own. Other than being the writer of the two tests you will take, I will have nothing to do with the grade you receive. Your instructor will submit your grade to the College at the end of the quarter and it is he you should question as to how final grades will be determined in your section.

On the first day of this class you were asked to complete a questionnaire, the "Personal Factors Questionnaire." The information obtained from that form will be used in much the same way that scores on the pretest will be used. The questionnaire information will be examined and statistically analyzed at the end of the quarter to see if there is a "type" of student
that succeeds best in any of the three experimental approaches to this course.

There is one remaining portion to the handout you hold. I refer you to Figure C. Seven times during this quarter you will be given one of the forms as printed in Figure C. The purpose of this form is to establish an average—whatever "average" is—an average of the number of hours students spend in studying for this course outside the classroom. When you receive this form, please fill it out completely.

Allow me to read the statement with you:

"Please be candid in this report of out-of-class time you have spent studying for this course. These reports are being used by an educational researcher to determine if the amount of time spent in studying for this course is related to the scores you attain on the mid-quarter and final examinations.

"This report will IN NO WAY affect your grade. In fact, your instructor will not even have access to this information."

I have gone to considerable length (and expense) to assure you that you can be candid in your report. Your instructor will not see this information until, if he wants it, until well after grade submittal time.

At the time your instructor distributes these forms, he will have a stamped, addressed envelope in his possession. I have asked that he give this envelope to a student or group of students and that that student collect the forms, stuff them in the envelope, and mail them at the nearest mail box. It is most difficult to convey sincerity by way of a tape recorder, so I can only give you my word: Your instructor will not have access to this information until after you've received your final grade report.
At this point in each of the three tapes there appeared a specific portion that was unique to one of the experimental conditions.

For continuity of presentation for any of the experimental conditions, please refer to the following pages in this dissertation for the appropriate textual matter of a particular script.

control groups . . . . page 170
experimental-I groups . page 171
experimental-II groups . page 173

All of the preceding has been designed and presented to accomplish two goals. The first goal being an attempt to acquaint you and your involvement in this experimental condition with that condition and with the overall experiment. The second goal, and the one for which I feel an especial concern, is that of sincerity and frankness. I have been involved in educational experiments without having ever been told about my involvement, my performance, or the success or failure of the research. Perhaps you have had similar experiences. I have tried to be honest and frank with you so that your feelings are of a positive nature toward this research.

Please feel free to ask your instructor about any aspect of this research that is not yet clear to you. If he cannot answer your question to your satisfaction, please feel free to pursue the question by writing to me.

Of course, questions pertaining to outcomes or conclusions cannot be answered until sometime during Spring Quarter. I will make arrangements to present the findings of the experiment. I cannot now say where or when that presentation will take place, but I will ask that that notice be placed in The Chronicle when final arrangements are made. I encourage you to attend that presentation. Do come with your questions and your criticisms.

I wish you well in your study of "Modern Technology and Civilization"—it can be a fascinating study.
At this time I'd like to refer back to Figure A of your handout. The experimental section of which you are a part is that section referred to as "C." The "C" makes reference to "control" where your section is one of four control sections.

The research design after which this experiment is fashioned necessitates a "control" group or a "traditional" group. Yours is the group against which the others--the (E-1) and the (E-2)--will be compared. Conclusions about which method of instruction is best cannot be made unless those methods are compared against some standard. Your section is one of the four "standards" in this research design.

When you enrolled in this course, you should have expected and anticipated exactly what section "C" entails. You will meet four times a week. You will participate in the mid-quarter and final exam. And, you will submit seven reports of outside-time spent in studying for the course. Yours is the experimental section most like the "traditional" approach to 192. However, this is not to say that you are not an integral part of the research. On the contrary, without your section, the experiment would be worthless and uninterpretable.

Obviously, the statistical requirements of this entire experiment demand that the randomization process not be violated. With such a requirement it is impossible to honor any request of transfer to one of the other conditions within the experiment. Such requests cannot be considered.

(return to page 169 for the remainder of the script)
At this time I'd like you to refer back to Figure A of your handout. The experimental section of which you are a part is that section referred to as "E-1." The "E-1" makes reference to "experimental - first condition." Other than serving the function of simply identifying your section and the conditions under which instruction will be given, the "E-1" notation has no "magic."

Those persons in the "C" sections will receive instruction in the "traditional" method of teaching this course. The only difference between your section and their section is that they will meet four times per week while you will meet three times per week.

In conjunction with meeting three times each week, you will participate in the mid-quarter and final exam and you will submit seven reports of outside-time spent in studying for the course.

Yours, like the others, is a very vital part of this experiment. Consider the now-hypothetical result where, if your section achieves as well on the mid-quarter and final as do the "C" section people, the argument of one class period per week for each credit earned becomes invalid. Do remember though, that the grade you receive in this course will be determined on the basis of how you compare to the persons in this section. At any rate, if we can show that a student achieves just as much—or more—with one less class period per week than other students, we have a very persuasive argument for considering change.

Obviously, the statistical requirements of this experiment demand that the randomization process not be violated. With such a requirement it has been necessary to establish some "rules." As members of this section, I encourage you to maintain your "E-1" designation for the duration of the quarter--
you stand no better chance of improving your final grade by being in either of the other two experimental conditions.

(return to page 169 for the remainder of the script)
At this time I'd like you to refer back to Figure A of your handout. The experimental section of which you are a part is that section referred to as "E-2" makes reference to "experimental - second condition." Other than serving the function of simply identifying your section and the conditions under which instruction will be given, the "E-2" notation has no "magic."

Those persons in the "C" sections will receive instruction in the "traditional" method of teaching this course. Those persons in the "E-1" sections receive essentially the same treatment but meet three days per week instead of the four days per week required of "C" section students. Your section is the most radical of groups in this research— you meet only once each week and are very nearly totally responsible for the learning you will accumulate during the quarter. The logic behind including this section in the experiment was a desire to examine the extent to which college students are capable of assuming the responsibility for their own learning— their own learning through independent study. Granted, your learning will not be "totally" independent, for you do have an instructor to whom you can turn for assistance. In fact, you are encouraged to solicit his help whenever you run into a problem in your studies you cannot resolve on your own. He expects that you will, necessarily, have to do this.

During the one time per week that you do meet with your instructor, you will not receive a formal lecture or presentation as such. Your instructor will be there to assist you and to monitor and coordinate discussion you and your classmates have. These classroom discussions should, hopefully, bring into focus and perspective those readings you have done during the preceding week.

It is anticipated that it will be necessary for your
instructor to communicate with you at times other than during the weekly class meeting. He may want to announce a film to be shown, a guest lecturer's presentation to be given, or a host of other such announcements. To accommodate such communication, a bulletin board has been constructed that will enable you to note any announcements your instructor wishes to make. That bulletin board is placed in this building (ask your instructor where) and it is recommended that you refer to it at least twice during the week other than on the day of your class meeting.

In conjunction with meeting once each week, you will participate in the mid-quarter and final exam and you will submit seven reports of outside-time spent in studying for the course.

Yours, like the others, is a very vital part of this experiment. Consider the now-hypothetical result where, if your section achieves as well on the mid-quarter and final as do the "C" section people, the argument of one class period per week for each credit earned becomes invalid. Do remember, though, that the grade you receive in this course will be determined on the basis of how you compare to persons in this section. At any rate, if we can show that a student achieves just as much—or more—with one class period each week as do those persons who attend four times per week, we have a very persuasive argument for considering change.

Obviously, the statistical requirements of this experiment demand that the randomization process not be violated. With such a requirement it has been necessary to establish some "rules." As members of this section, I encourage you to maintain your "E-2" designation for the duration of the quarter—you stand no better chance of improving your final grade by being in either of the other two experimental conditions.

(return to page 169 for the remainder of the script)
XVIII. APPENDIX J:

AUDIO TAPE SUPPLEMENT
Please be candid in this report of out-of-class time you have spent studying for this course. These reports are being used by an educational researcher to determine if the amount of time spent in studying for this course is related to the scores you attain on the mid-quarter and final examinations.

This report will IN NO WAY affect your grade. In fact, your instructor will not even have access to this information.